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PREFACE

The Agricultural Engineering Board of the Hungarian Academy of Sciences which supervises the development of this branch organises annually a conference at Gödöllő, which is the central place of the Hungarian agricultural scientific activity.

During the sessions, research scientist, developing engineers, experts of institutions engaged in agricultural engineering development strong in numbers the organizer, the hungarian universities and other higher grades of education, the research institutions: Hungarian Institute of Agricultural Engineering at Gödöllő, Faculty of Agricultural Engineering of the University of Agriculture at Gödöllő and foreign guests give account of their results obtained in the research work and development of agricultural machinery.

This yearly English-Language publication the „Hungarian Agricultural Engineering", started at 1988, contains selected papers presented at the conference of 1994. To the published scientific papers are enclosed reports of the test performed by the Hungarian Institute of Agricultural Engineering at 1991. We do hope that this publication will be found interesting to a big part of agricultural engineers.

György Mészáros
Director

Hungarian Institute of Agricultural Engineering
Gödöllő

125 years' anniversary
Hungarian Institue of Agricultural Engineering

GÖDÖLLŐ 1869 - 1994 FMMI

125 years in the service of the Hungarian Agriculture

From the Machinery Experimental Station to the Hungarian Institute of Agricultural Engineering

Lecture on the Plenary Session – György Mészáros director, HIAE

HISTORICAL BACKGROUND

The FMMI (Hugarian Institute of Agricultural Engineering) celebrates the 125th anniversary of the foundation of its legal predecessor, the Machinery Experimental Station established in Magyaróvár (today called Mosonmagyaróvár). Pursuant to a ministerial decision adopted in 1869, the Machinery Experimental Station had become the second of its kind in Europe after the one established in Halle only two years before that date. The foundation of the Station was part of the efforts which began in the second half of the 19th century to mechanize certain agricultural production procedures and to replace some of the manual tools and animal-drawn implements.

According to its deed of foundation, the task of the Station is to assess thoroughly and comparatively the theoretical and practical aspects of the agricultural machinery and implements as well as to evaluate

1. the construction and the durability;
2. the performance;
3. the profitability; and
4. any other aspects which may influence the value.

It is clear from the foregoing that the Station had a precise task description already at the begining. In fact, the theoretical assessment was completed with thorough practical analysis which, following the establishment of a technical cooperation with the manufacturers, turned into tests to improve the development of the machines. The above elements, integrated in the local engineering operations, determined life at the Station for some 80 years.

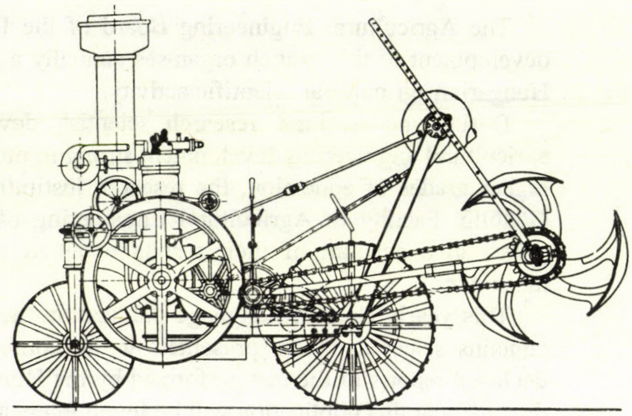
Today, when land owners appeared who are unable to estimate their production and mechanization needs because of the oversupply of foreign and domestic goods, it is worth reconsidering a statement made prior to the establishment of the station and saying that „the farmers intending to purchase some machines cannot rely on the annual agricultural exhibitions or commissioned experiments only since their lack of thorough engineering skills will make them unable to make a well-informed decision."

The founder and first director of the Station, *János Fuchs* who was, at the same time, Head of the Department of Technics, always said that „the practical value of a machine can be more safely determined if it has been operated for some time under proper farming conditions and the constant supervision of knowledgeable professionals."

In addition to duty-free imports and cheap shipment, the goverment covered all the test costs.

The second director of the Station was *Viktor Thallmayer*, an outstanding mechanical engineer, who determined the trend of development between 1873 and 1908.

During this period of 35 years he worked diligently and gained a good international reputation. His studies were regularly published in such technical journals as the „Engineering" or the „Wochenblatt des Ingenieur-wesens". He established professional relations with European, US and Canadian machinery experimental stations. He wrote valuable studies, among others, about steam powered ploughs, threshing machines, seed cleaners and harvesting machines. However, his favourites were the drills on which he wrote an important book rewarded with a gold medal at the Paris World Exposition in 1900.



Rotary frazer (Mechwart) from 1898

The third director of the Station was *Pál Sporzon jr*. During his term between 1908 and 1917 he worked hard to promote the mechanization of agriculture in Hungary. He was, at the same time, chairman of the Mechanization Committee of the Hungarian Agricultural Association and as such, he organized numerous machine competitions and exhibitions. The most important events organized with the involvement of the Agricultural Engineering Department of the Budapest Technical University, were the Ploughing Competition of Mezőhegyes in 1909 and the Tillage Implement Exhibition of Galánta in 1913.

After the first World War the Station was managed by *Endre Wladár, Ákos Karkovány and Gábor Sass* up until 1949. In 1949 it was named Machinery Experimental Institute, and it was moved to Budapest. It should be noted that there had been previous plans which called for the moving of the Station to Budapest or to Gödöllő and an area of 16 ha was even allocated for such purpose.

BUDAPESTI MŰSZAKI EGYETEM
GÉPSZERKEZETTANI INTÉZET MEZŐGAZDASÁGI GÉPTAN TANSZÉK

The Budapest Technical University building where the reorganized „Machinery Experimental Institute" started its operation in 1949

The reorganized Institute, which was accomodated by the Agricultural Engineering Department of the Budapest Technical

University, was led until 1956 by professor *Imre Rázsó*, one of the greatest personilities in Hungarian agricultural engineering. He started to set up, according to professional lines, research groups of 6 and then 20-24 members in order to introduce the element of specialization in the R & D operations.

As a matter of fact, *Imre Rázsó* played a decisive role in the activites of the Insitute and in determining the direction for agricultural mechanization (e.g. introduction and development of track layer tractors, new ploughs, sprayers, combine harvesters, grass cutters, windrowers, field choppers, etc.).

From 1957 the Institute was led by *Gyula Bánházi* who was a prominent theoretical and practical expert in the field of agricultural engineering. Under his management the Institute, located in the neighbourhood of the Budapest Techninal University, expanded its operation dynamically.

At that time the research activities were performed by eight scientific departments. The most important new lines included the dynamic studies of four-wheel drive tractors, the development of complete machine systems for corn and silage production, the poultry farming and fodder drying machines, the acceleration of the mechanization of plant protection, etc.

In 1969 i.e. for the 100th anniversary of the Institute the construction of the present premises was completed in Gödöllő providing the long-deserved conditions for coherent R & D and testing operations.

At the time of the centenary the Institute, having a staff of 350, was able to meet its statutory tasks as well as to build direct contractual relations with the manufacturers, distributors and large-scale farms in various engineering fields. Such attitude resulted in an increase of the output. At that time the operation of the Institute fully covered the traditional fields as the field machines and implements, transportation equipment and horticultultural machines. In addition, other topics as the mechanization of animal husbandry and farm operations, machine repair and maintenance, instrumentation and automation and energy management were also covered. The staff of the various divisions was completed with experts representing such associated fields as architecture, animal husbandry, agronomy, etc. As a result the Institute, while remaining active in the development of individual machines, became able to work out complete mechanization technologies and systems.

At that time the Institute operated four engineering offices and a further training office, outside its premises. Between 1969 and 1975 the Institute, while receiving, in nominal value, the same state subsidy as it does today, reported an annual staff increase of 100 and a proportional revenue increase. However, after that period its workforce was reduced gradually in line with the discontinuation of the external assignments and technical development needs.

During the 25 years spent in Gödöllő the Institute, now named FMMI (Hungarian Institute of Agricultural Engineering), played an important role in the R & D programs initiated by the Ministry of Agriculture and in the development projects funded by the National Committee for Technical Development and the World Bank. For the purpose to show their results, the researchers of the Institute have published more than 6,000 articles, held some 11,000 lectures (also within the framework of graduate engineer training) and patented more than 100 machines, processes and devices.

The research activities have been expanded, with the share of basic research being increased, and the scientific training has been strenghtened. The researches of the Institute have obtained some 80 MsC, 13 PhD and 5 acedemic doctor's degrees.

The most important R & D results of this period included the following:

- the introduction of high-output drills and combine-harvesters for cereals and corn production;
- the development of reduced tillage machines;
- the development of agrochemistry centers and pesticide application machines;
- the development of complete machines for silag, silo corn and sugar-beet production;
- the development of crop protection machinery and a special cereal production technology;
- the development of complete cattle husbandry machines including mobile feeding systems and milking parlour automation;
- the development of complete machines for the storage, preservation and utilization of wet corn feed;
- protection of the cutting edge of tillage tools, development of the ÉLKEFÉM welding electrode and implementation of hard metal powder production;
- development of a new anticorrosion technology and an anticorrosive agent (MULTIVAX).

Inspite of the strong recession, the Institue maintained its good working relations with the domestic large-scale farms and the leading foreign machine manufacturers. An example of that is the development study performed on the latest high-output CLAAS combine-harvester in France last year.

The overall privatization of the production and marketing facilities has resulted in the substantial rearrangement of the Hungarian agriculture in the past five years. The penetration of the highly demanding and strongly protected western markets and the competition with import goods enjoying subsidy levels of 60 to 80 % represent new challenges to the producers and, in particular, to the new farms in an environment of general capital shortage. The decrease in the demand for agricultural machinery and the serious problems of the machine manufacturers led to a dramatic fall in the development activities and, consequently, in the utilization of the research capacities.

Currently, the Institute employs a staff of 125 and hopes that no more reduction will be necessary in the future as a further erosion of the existing staff.

Fortunately, meeting the mechanization demand of small- and medium-sized farms represented no difficulties at all, since that the Institute has been dealing with this issue for decades. Nevertheless, the new cooperative farms will survive and the concentration efforts now popular in Western Europe will be strengthened in Hungary, it is almost sure that the majority of the agricultural production will be performed, at least with regard to the major crops, under large-scale conditions. Therefore the Institute continues to develop intensive cultivation technologies based on high-output machines fitted with instruments and control systems. Despite the present recession such high-output machines dominate the large international exhibitions. This tendency creates new forms of machine use and justifies the necessity of the widespread domestic application of such machines.

Nowadays the Institute is more actively involved in the development of new technologies with respect to environment control which can be used to improve agricultural production and integrat the strategy of sustainable agriculture. The most important tasks include the development of modern crop protection technologies (low rates, even application and no use of pesticides) and the treatment of hazardous wastes and the impacts of improper pesticide applications.

The Institute performs intensive research to reduce the number of cultivation steps and the extent of soil compaction, and on the development and adoption of mulching technologies used against erosion and for the preservation of the water content in the soil.

Furthermore, the Institute studies the harmful emission of exhaust gas, the dust loading of grain drying and storage as well as the reduction of the odour level in the practice of stable ventilation and manure utilization.

The future activities of the Institute will be in the field of:

- basic research programs;
- R & D activities in agricultural engineering;
- the development of teh Hungarian agricultural machinery industry;
- tests and quality control of agricultural machines.

The Institute makes efforts to utilize its international relations and to keep ap with the developed technologies.

It is hoped that the Institute will soon develop several new machines to make them available for the users.

PART I.

ABSTRACT OF SELECTED PAPERS

DIELECTRICAL PROPERTIES OF AGRICULTURAL MATERIALS

Dr. P. SEMBERY
University of Agricultural Sciences, Gödöllő

Dielectrical constants of maize, soybean and wheat grists were measured in 1 to 40 MHz frequency interval. The measurments included the examination of the effect of moisture content, porosity, grain size, volume weight and produce species. From the diagrams showing the examination results and from the mathematical equations describing the curves it can be concluded that the dielectrical constant are influenced by the porosity and grain size of the grists. So that they are error sources at moisture content measurement. In the case of measuring grist humidity it is important to examine with same grain size and porosity in order to minimise measuring error.

According to the examinations carried out with different crops the dielectrical constant slightly depends on the produce species. The values are determined first of all by the volume weight. This perception supports the assumption that a common moisture scale can be made for the same grain size and porosity grists, but the measuring result should be corrected according to the effect of the volume weight.

Measuring the moisture content of the crops in the form of grists may simplify making moisture scale of instruments. However, the grist processing and screening require additional work. On the other hand the method is not applicable in the case of continuous moisture content measurement in operation.

MODERATION OF THE ENVIRONMENTAL POLLUTION OF ANIMAL HUSBANDRY

GY. MÉSZÁROS - Dr. L. FENYVESI - Dr. B. KULI - L. MÁTYÁS
Hungarian Institute of Agricultural Engineering, Gödöllő

Studied R&D fields in headlines were as follows:

i. Adaptation of water-saving feeders
ii. Elimination of slurry production of pig husbandry by using of bioactive deep litter
iii. Developing of water-saving slurry handling technology for pig farms
iv. Reduction of the emission of pig houses by straw bale biofilters
v. Rate control system for uniform slurry application, environmental protecting slurry distribution methods
vi. Computer-aided system for environmentally – friendly utilization of manure/slurry

By means of application of devices, equipment, technologies and measuring-evaluation methods, developed during years of R&D work in our institute, advantages are as follows:

- minimizing of water consumption and odour emissions of pig farms,
- considerable reduction or elimination of slurry production,
- distribution of slurry in the required rate,
- application and utilization of slurry according to all the requirements and demand of soil and plant by advanced methods and systems.

SOME PROBLEMS OF DETERMINING THE HAMMERMILL'S DECIMAL EFFICIENCES

Dr. I. BÖLÖNI - PROF. Dr. J. CSERMELY
Hungarian Institute of Agricultural Engineering, Gödölllő

The decimal efficiency as it determined in the machinery science, there is a white spot in hammer milling. That is a why the authors wanted to check the above efficiency in feed milling by means of experimental methods.

Tests were carried out with a Hungarian made hammer mill, type D-24 (having 48 hammers each weighing 260 g) and driven by an asynchrony electric motor of 19 kW performance. Mill was fed tangentialy from an upper hopper and the grind was sucked away by a pneumatic conveying fan built on the mill rotor's shaft. Hole diameter of the screen applied: Ø 4 mm. Barley of Hungarian sort having 13.2 % water content w.b. was comminuted. Seven power losses were measured, e.g. power loss of the electric motor, heating air etc. The 8th member of the balance is the P_g „remainder" that was supposed to be equal to the power consumption of grinding (creating new surface area) and other possible losses (drying, vibration, sound etc.) which are not to be determined for the time being.

The following findings can be taken:

- The decimal efficiency was round $\eta = 2$ % in the given case.
- The most important components of the mill's power balance are:
  - the strain work heating up grit by permanent set 40.15 %
  - the idle running power input 20.76 %
  - the electric losses 15.74 %
  - the power requirement of heating air 10.64 %
- Power losses of pneumatic conveying of driving and the mill's radiation vary between 3...4 %.
- Since the power requirement of permanent set is quite high it can be concluded that the impacts initiating ruptures might have been practically inelastic collisions, that is the whole kinetic energy of particles had been transferred to permanent strain work.

EXPERIENCES GAINED BY TESTING OF A MODERN DRYING-STRORAGE SYSTEM

Dr. M. HERDOVICS - Dr. Z. BELLUS - GY. KOMKA
Hungarian Institute of Agricultural Engineering, Gödöllő
J. ZSÁK
PROGRES, Selice, Slovak Republic

Main part of the U.S.A. made CHIEF type drying-storage plant is a storage tower equipped with a ventilating floor, 2 units of fans and a heating unit. Grain distribution is carried by a rotating distributor of thrower paddles. Mixing of grain in the tower is done by augers dipping vertically into the grain, moving on circular orbit. Drying is carried by warm air flow forced through an about 2.5 m thichness of grain layer. Thickness of pre-drying zone is 170 cm while the drying one is 80 cm. Unloading of the dried grain is done automatically by a collecting-unloading auger equipped on the bottom of the tower according to the required moisture content. Evaporating output of the drying unit at maize was 1,612 kg/h while the wet-matter output was 14 t/h. Specific heat consumption was 4-4.5 MJ/kg of water.

INVESTIGATION OF COMPONENT CHARACTERISTICS OF DRIED FRUITS

Dr. A. LENGYEL - Dr. K. BENEDEK
University of Agricultural Sciences, Gödöllő
Agricultural Engineering College, Nyíregyháza
Dr. J. NÁDASDI
EKO Cannery, Nyíregyháza

The effect of the characteristics of the drying air induces significant changes in the food chemical composition of the dried material.

It is resonable to examine which alterations should be considered in the case of different drying fluid flow velocity, relative moisture content and temperature. References show the decrease of these factors. The aim is to establish drying fluid properties optimal to this reduce.

Composition changes during plum and sour cherry drying were measured. The evaluation results show that the sugar and vitamine content change significantly compared to the fresh state. The magnitudes of the changes are in relation to the length of the drying time. An analysis of the measurement data shows that besides the remoisturing of the dried material the composition quality is an important factor affecting the technology parameters.

ENERGETIC MODELLING OF BATCH VACUUM COOLERS

T. FEJES
Ph.D. student
University of Agricultural Sciences, Gödöllő

Vacuum cooling is used when rapid cooling off foodstuffs is required. Energetic analysis and calculation method were presented on the basis of an experimental result with a pilot plant vacuum cooler. The applied vapour-compression vacuum cooler can handle large volume of water vapour and it is particularly suitable for cooling cooked or baked products. The aim of the performed research work was to find out the most relevant operating parameters and features, which enable me to work out an energetic model for batch vacuum coolers. Experimental and computational results present a procedure of determining the time of evacuation, the volume of rosen water vapour, steam consumption, counter pressure and the efficiency of the steam-jet ejector, desired water flowrate in the condenser, power demand and suction capacity of the water-ring vacuum pump. Keywords: Energetic modelling, steam-jet vacuum pump, vacuum cooling.

CHANGES OF THE MACHINE AND IMPLEMENT TYPES IN THE COURSE OF THE TRANSIENT STATE OF THE AGRICULTURE

Dr. J. HAJDÚ - Dr. Z. PESZEKI
Hungarian Institute of Agricultural Engineering, Gödöllő

In the tension accompanying the reformation of the agriculture in Hungary one can often hear about debates on recompense, privatisation, estate re-allocation as well as keeping and conformability of the laws and acts. Much less are spoken about the objects necessary for production including the technical background of the production. In the last year our institute undertook the job of examining and evaluating the changes having taken place so far, first of all concerning happenings to the former large scale machine stocks. The examinations started for almost the complete circle of firms existing before the transformation numbering 1190 agricultural plants. Appreciable data could be collected only for 343 cooperative farms so that they were evaluated. The agricultural plants included into the evaluation represents a 25 % sample allowing general conclusions for the overall situation in this country.

ECONOMY AND ENVIRONMENTAL IMPORTANCE OF ALTERNATIVE FUELS

Dr. L. GOCKLER
Hungarian Institute of Agricultural Engineering, Gödöllő

First of all PB gas, compressed natural gas and the esterificated rape oil (RME) can be the alternative fuels in Hungary. In the agriculture only the last one can be considered, exclusively. The price of RME is mainly determined by the production, pressing and esterification costs of the rape as well as the price of the press-cake, glycerin and rape straw. Such way the production cost of RME is between 34 and 87 Ft/l. It is 78-201 % of the price of fuel oil without VAT, and 102-262 % of agricultural price of diesel oil. Applying RME pollutes the environment in less extent than fuel oil does. The polluting emission can be reduced by catalizers, new system engines and alternative fuels. It seems On the basis of calculations that the increased needs and the technical development results in more favourable effect of catalizers and new system engines, so that RME may play an important role only in avoiding CO_2 production.

PROBLEMS AND POSSIBILITIES OF MACHINERY DEVELOPMENT IN THE MIRROR OF LISA-PHILOSOPHY

Dr. I. HUSTI - Dr. M. DARÓCZI
University of Agricultural Sciences, Gödöllő

The main objective of our paper is to show some elements of LISA-philosophy - first of all those ones, which have to be taken into consideration during the machinery development of the Hungarian agriculture. It seems to be clear that it isn't suitable to offer uniform systems for our agriculture in the period of transformation. We do think at the same time that the way of thinking suggested by LISA is useful to enforce the short-and long-term strategies of agricultural development. In accordance with the importance of these strategies dealing seriously with the development of agricultural machinery is especially important for us. The practical success of LISA-conception must not be limited at the same time.

We would like to continue our research activities.

REDUCTION OF THE NITROGEN AND PHOSPHORUS CONTENT IN LIQUID MANURE BY SEPARATION

H. SONNENBERG
FAL, Braunschweig, Germany

The nutrients of the nearly 200 million tons of liquid manure (slurry sludge) being yearly produced in Germany could be profitably used as fertilizer on the agricultural acreage, if they were available in case of need on the right place at the right time, and all that without any burden of nitrate and danger for the groundwater and the atmosphere. These problems can be solved by a special treatment, eliminating the problematic nutrients nitrogen and phosphate from the liquid manure, improving the storability and handling and increasing the value for transportation.

The first and often already sufficient step is the mechanical separation into a liquid and a solid phase using marketable separators. Preserving the composting ability of the solid phase 24 p.c. of the nitrogen and 77 p.c. of the phosphate can be eliminated by a decanting centrifuge.

- 40 p.c. resp. 90 p.c. have been achieved by help of flocculation additives.
- Press-drum separators and press-screw separators attain a relief of about 28 p.c..

HEAT AND MATERIAL TRANSPORT PROCESSES IN DRYING OF HYBRID MAIZE

PROF. Dr. J. CSERMELY - Dr. Z. BELLUS - Dr. M. HERDOVICS - GY.KOMKA
Hungarian Institute of Agricultural Engineering, Gödöllő

Continuing of some years of an OTKA theme titled „Heat and Material Transport Processes of Seed-grain Processing and their Relations to the Biological Features" a drying process of hybrid maize, by the help of a chamber-type drier utilizing of primer and secunder drying air, was elaborated and evaluated in 1992. Drying test of hybrid maize was carried out at the seed processing plant of the district of Szenttamás of the Törökszentmiklós State Farm. Material features during loading and unloading (w_0,t_0,φ_0), material and air technical features of the drying process ($W_{1,6,7,8}$, $t_{1,6,7,8}$) as well as heat technical ones (t_k, φ_h, $t_{1\text{-}5}$, $\varphi_{4\text{-}5,9}$) in primer and secunder running method were determined.

In the course of the drying process of hybrid maize in chamber-type drier 60 m^3 of maize-ear with a 36.0 % of averge moisture content were dried.

Dewatering took place under primer and secunder operative conditions of the upper and lower layers of the grain heap. The drying process was followed by shelling then 55 hours later the heap of corn was cooled from 33.5 °C and 11.5 % moisture content down to 16.0 °C temperature.

DRYING CHARACTERISTICS OF MAIZE HYBRIDS' COMPONENTS

M. NEMÉNYI - I. CZABA - A. KOVÁCS
PANNON Agricultural University, Mosonmagyaróvár
I. FARKAS
University of Agricultural Sciences, Gödöllő

A comparison was elaborated between the hybrids of different initial moisture content. A method was also carried out to measure the pericarp permeability and the surface-area of kernels.

During the work the following statements were derived. There were no differences of germs (scutellum) found in the drying characteristics of the tested hybrids. At the same time the drying intensity of the endosperm of fast drying hybrids was significantly higher then that of slow drying ones.

The result getting out of this work could give some extension to the mathematical models of maize drying especially in the extent of the accuracy, and furthermore it provides a great assistance in breeding of fast drying hybrids.

QUESTIONS OF CORN DRYING DYNAMICS WITH TOWER DRIERS

Dr. E. JUDÁK
University of Agricultural Sciences, Gödöllő

The literature of drying is rich and wide, especially in the case of different disciplines. Methods of moisture measurements, modeling drying, quantitative analysis of drying properties of produces, the comparison of the measurement and model samples are deeply elaborated. Concerning quality questions of process control of drying grain materials the literature and the practical adaptations are less wide.

In addition to the economy questions the reason for it is the complicated nature of the task as detailed analysis can be carried out only on realistic models. The deterministic parameters of the process can be modeled considering disturbing factors, nevertheless the crucial points of the control (time constants, precisity of sampling moisture measurement, real drying/ operation diagrams) can only be determined and evaluated for the final system in the course of the process. That is why the paractical experiences are so valuable and they should be built into the system.

Basic questions are the automatic the method of sampling from the material flow, the transport of the sample to the measuring place, end the effect of this procedure to the measuring accuracy.

The stochastic distribution and fluctuation of the input moisture content is a significant disturbing factor.

Considering above mentioned facts it is resonable to examine the quality parameters of the drying control in an analysing and synthetising work.

QUICK ENDURANCE EXAMINATION OF THE INTERNAL COMBUSTION ENGINES

F. DEZSŐ
University of Agriculturlal Sciences, Debrecen
Animal Husbandry College, Hódmezővásárhely

The endurance and reliability examination of the internal combustion engines expends long time and high cost. The considerable reduction of the testing time, the quicker applicability and the decreased expenses can draw the attention and interest.

On the basis of the theory elaborated by Dr. Endre Pásztor professor in the Aeroplane and Ship Department of the Vehicle Machinery Institution of the Budapest Technical University a test apparatus has been made which is used for practical measurements at the Department of Technology of the DATE Animal Husbandry College, Hódmezővásárhely.

GRAPHOANALITIC METHOD TO HELP THE COMPARATIVE EXAMINATION OF ENGINE CHARACTERISTICS

Dr. K. NAGY - Dr. L. SIKOLYA - Z. BORSOS
University of Agricultural Sciences, Gödöllő
Agricultural Engineering College, Nyíregyháza

In the process of the comparative examination of the alternative fuels the optimal adjustment parameters of the engine should be sought. The comparison has an importance for engine adjusted to its optimum. The technique elaborated for seeking the parameters of the unknown engine can be adapted to the complex adjustment of the engine.

The grphoanalytic method described in the article is quite applicable to examine characteristic curves. Its essence is taking two important input and output parameters (e.g. specific consumption and torque) and making differences of them to which regression lines are fitted. The desirable direction and extent of the examination continuation is concluded from the orientation of the lines.

HOME AND ABROAD EXAMINATION OF FAMILY FARMS OPERATION

Dr. G. DÁVIDHÁZY
University of Agricultural Sciences, Gödöllő
Agricultural Engineering College, Mezőtúr

In my research titled „Technical and operation condition system of new undertaking size farms" three typical profile family farms were examined in Hungary and abroad:

- arable land plant production farms,
- milking cow farms,
- mixed – arable land plant, fodder producing and animal husbandry – profile farms.

In addition the organisations

„CONTRACTOR" enterpreneurs and the
„ACHINERY RING" machine centers

were also examined which helps the farm works.

With finishing my work finding and elaborating the home introduction possibilities of machinery rings are planned.

SOIL CULTIVATION CONDITIONS FOR ADAPTIVE PLANT PRODUCTION

Dr. M. BIRKÁS
University of Agriculturlal Sciences, Gödöllő

In the classical sense the soil cultivation is the base of the fruitful plant production. The soil physics conditions of the plant production are ensured by different tools and several process in the traditional soil cultivation. In the no tillage system the direct sowing and the chemical plant protection ensures the conditions of the growing.

In the adaptive cultivation the depth, the method and the tool is adapted to the state of soil. The harmful acts to the soil are ignored. The main goal of the tillage is the protection of the soil and the reduce of the moisture content loss. The plant pronduction conditions can be ensured such way. The passes are reduced and rationalised and the tools are mainly soil friendly elements and combinations.

ENVIRONMENTAL POLLUTING EFFECT OF DIESEL ENGINES AND THE EXPERIENCES WITH THEIR EXAMINATIONS

Dr. A. VAS - Dr. V. VARGA
University of Agricultural Sciences, Gödöllő

The paper presents the air polluting effect of diesel engines applied in vehicles, construction industrial and agricultural machines. The paper presents not only the prescribed emission limits and tests specified to deleterious material components of exhaust gas of diesel engine driven vehicles but the experiences with them, too.

RECOGNITION AND CORRECTION OF MACHINE DESIGN WEAK POINTS

Dr. P. VERMES
University of Agricultural Sciences, Gödöllő
Agricurtural Engineering College, Mezőtúr

The reliable operation of the machines and equipments applied in agriculture is important for the operators, the maintainers and the manufacturers. The paper touches only a small part of the wide topic, but it aimes to show the importance of the customer's service and the maintenance in providing systematic information from machine operation and to demonstrate how the manufacturer can modernise the machines and to increase their reliability making use of this information. As an example a pulled hydraulic rotating loading machine is analysed for fault analysis during warraty time.

INFLUENCING MILKING FACTORS CONCERNING THE FREEZING POINT OF THE RAW MILK

Dr. J. BAK - Dr. L. TÓTH - J. BOLYÓS
Hungarian Institute of Agricultural Engineering, Gödöllő

Examination of the freezing point of the milk for determining its foreign water content is a routine in the practice of the dairy industry.

Aim of research was to explore the factors, related mainly to machine milking, that influence the freezing point of the raw milk in home practice.

According to our examinations foreign water content of the milk varied between 15-60 litres that means about 0.8-15 % of volume. Analysing the reasons we have stated that the foreign water content (V_i %) is influenced the followings:

Volume of water remained on the surface of the udder „*A*" (litre/cow), volume of water remaind in the inner spaces of the milking units „*b*" (litre), average milk production per cow per milk „*F*" (litre/cow), and the total amount of milk in one shift „*Q*" (litre).

SLIP/PULL RELATIONSHIP

Dr. A. FEKETE - Dr. B. BORSA
Hungarian Institute of Agricultural Engineering, Gödöllő

The slip/pull relationship was analysed with special respect to the correlation coefficient. Considerable variations were found in the time delay depending on the soil conditions, tractor characteristics control mode of the hitch and other factors. Relationship was determined between the period of integration of the variables and the coefficient of correlation.

THE DETERMINATION OF PHYSICAL CHARACTERISTICS OF SEEDS FOR THE CONSTRUCTION OF SEEDING MACHINES

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Modern cultivation technology means stricter and stricter requirements for sowing and spreading machines. Precise portioning are of special importance among work quality indecies for these machines. Thus physical charactereistics of seeds amd fertilizer particles must be taken into consideration in the design and development of portioning and spreading devices. This study summarizes our initial results in this field.

VACUUM COOLING OF VEGETABLES

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The current desire of vegetables produsers to reach more distant markets, prolong storage life, and market a product that better satisfies consumers often ruquires more uniform or faster cooling.

Vacuum cooling is a rapid and uniform cooling process suitable especially for leafly vegetables. By some references the vacuum cooling is particularly recommended when the cool chain of the products is broken because, for example, the produce is offered for sale at ambient temperature as it is common in small greengroceries.

At the Department of Agroenergetics and Food Engineering a pilot plant scale refrigerated vacuum cooler was designed and afterwards that was built up and installed at the Lab. In this paper the calculation method for this type of vacuum cooler is presented and is checked by vacuum cooling of mushroom.

PARAMETER ESTIMATIMATION OF SZENDRŐ CHAFF LENGTH DISTRIBUTION

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The chaff length distribution is an important characteristics of the chaff chopped by machines. It is known that the histograms taken from representative samples are dissymmetrical and similarly to the logaritmic normal distribution are stretched along *x* axis. such a way the homogenity of the chaff are described only approximately by the empiric expectable (mean) value and the deviation. At the same time these parameters of chaff length distribution are hardly applicable to characterise chopping machines. Such research is induced by these problems which try to explain the distribution characteristics starting from the physical phenomenon, the nature of the chopping. In this aspect the analysis of P. Szendrő (1976) is claimed as a most successful one.

INFLUENCE OF THE TECHNOLOGICAL CHARACTERISTICS ON ABRASIVE RESISTANCE

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Aim of the research was to examine the effects among the granular fodder components and some characteristics of the pelleting mill on the physical characteristics, mainly on the abrasive resistance of pellets.

Measurings were carried out under laboratory conditions by CPM type labor size pelleting mill with three different given particle sizes of fodder mixture, different hole sizes and die speeds. Abrasive resistance of pellets was measured by Q-Tester.

Results are represented by tables and graphs.

APPLICATION OF NO CONNECTOR SOCKET CHIP CARDS IN THE OPERATION OF AGRICULTURAL MACHINES

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As a result of the development measuring and control elements are used with tractor-implement aggregates in an increasing number. It means that the number of electronic parts of compounds is increasing continuously. These parts are not replaceable or connectable, at most in the case of a single manufacturer. Simultaneously increasing attention should be paid to the cableing of the sensing and intervening elements and of the timing, adjusting and control devices. The relevant problems can be solved by modernisation of elements and information flow, standardisation, introducing such a bus system where the parts and subsystems can be connected using only a few wires.

TECHNOLOGY RESEARCH ON THE APPLICATION OF DIGITAL CODE IDENTIFIERS INJECTABLE INTO ANIMALS

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There are several method having been elaborated for identifying stock animals to recognise them individually.

In the most methods marks, marking devices are placed and fixed on body surface of the animals. They meet the fundamental requirements, but they have some drawbacks. They age, become dirty and may be mechanically hurt and may be lost. There is no such kind of drawbacks with injectable identifiers, and at the same time the farm, transport and slaughter-house technology applications have several details to solve.

ELABORATING MEASURING METHOD FOR SEED DIELECTIC PERMITTIVITY

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In the frame of OTKA No. 1522 research project during the recent years a seed processing technique was developed. This procedure – based on electrodynamical effects – with certain seed mixture made an efficient sorting but with others not. This problem forced us to design an instrument for measuring one of the basic electrical properties of materials: the dielectrical permittivity.
Using this instrument in the Institute of Farm Machinery of the Gödöllő University of Agricultural sciences the dielectrical permittivity of severel sorts of seeds was measured.

The accuracy of the instrument was checked with Corning 7052 plastic granule, the permittivity of which is given and ensured by the manufacturer. According to the tests the dialectrical permittivity of this plastic was 5.34, which is very close to the data given by the manufacturer: 5.1-5.2. The 2.7-4.6 % difference proves the possible application of this instrument.

FAN CONTROL SYSTEM BASED ON HEAT LOSS SENSOR

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Heat sensing of animals is influenced not only the temperature but the air velocity, the heat-radiation of surrounding surfaces and the relative humidity too.

In the interest of a more correct ventilation of livestock houses our purposes were to develop an electric heat loss sensor for sensing the resultant effect of heat comfort characteristics listed above, an electric dew point sensor for determining relative humidity, a digital control unit for processing the signals of the sensors.

The system includes two combined sensor-transmitter units and two digital-analog outputs for independent controlling two groups of fans. It is – for decreasing the disturbing effect of cross-wind – also a novelty.

PART II.

SELECTED SCIENTIFIC PAPERS

DIELECTRICAL PROPERTIES OF AGRICULTURAL MATERIALS

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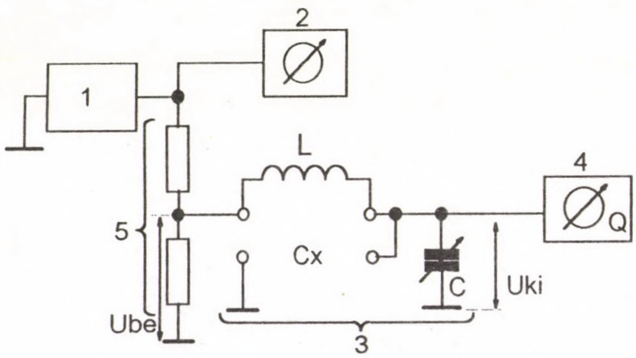
Introduction

Learning the physical properties of materials is extremely important for both the field of measuring techniques and production technologies. The dielectrical characteristics of the agricultural materials, and especially that of grain materials play role in the fields of moisture measurement, drying control and some high frequency handling technologies.

Concerning dielectrical characteristics of produces examinations have been being conducted for longer time. The aim of the examinations is to improve the preciseness of the moisture measurement. In the present phase of the research properties of grists is examined starting from the assumption that the size and shape differences of grains play no role in ground state. If the dielectrical characteristics of different produce grists depend only on the moisture content and specific volume weight then the moisture scales can be unified i.e. it is not necessary to have different scales for each produce. This would simplify the calibration of the moisture meters significantly.

Material and method

The dielectrical properties were measured by Tesla made BM 311 G type goodness factor meter (Q-meter). The scheme of the measurement is given in the figure.



Denotations of the figure:

1 - radiofrequency generator;
2 - input voltage meter;
3 - measuring circuit;
4 - output voltage meter;
5 - voltage attenuator;
L - inductivity;
C_x - measuring condenser; *C* - tuning capacity;
U_{be} - input voltage;
U_{ki} - output voltage

The measuring capacitor (C_x) is connected serial to the inductivity (*L*) and parallel to the tuning capacitor (*C*). The inductivity value necessary to tune on a given frequency are calculated with the equation:

$$L = \frac{1}{C \cdot \omega_0^2} \qquad (1)$$

In the case of given U_{be} input voltage the Uki voltage of output voltage meter is determined by the goodness factor of the circuit. Substituting the resultant capacity $C_e = C_x + C$ and the *R* loss resistance we obtain:

$$Q_0 = \frac{1}{R \cdot C_0 \cdot \omega_0} = \frac{X_C}{R} = \frac{i \cdot X_C}{i \cdot R} = \frac{U_{be}}{U_{ki}} \qquad (2)$$

In order to measure the dielectric constant of the material the capacity of measuring cell empty and filled with material.

$$\varepsilon_r = \frac{C}{C_0} \qquad (3)$$

The measuring process is the following:

1. Complemented the measuring circuit with the unknown empty C_x measuring capacitor the circuit is tuned to resonance. The measure of the capacity is called C_1. After removing the measuring capacity the resonance ceases which is reset by turning the tuning capacity. The tuning capacity is then C_2. Since the capacity of the measiring condenser was substituted by the tuning capacity, the difference of the two adjusted capacity gives the capacity of the measuring condenser:

$$C_0 = C_2 - C_1 \qquad (4)$$

2. The capacity of the measuring condenser filled by material is measured the same way. The adjusted tuning capacity values are C_3 and C_4, then

$$C = C_4 - C_3 \qquad (5)$$

And the dielectrical constant of the material:

$$\varepsilon_r = \frac{C_4 - C_3}{C_2 - C_1} \qquad (6)$$

The examinations were carried out with maize, soybean and wheat grists. In the case of the corn ground a detailed, several parameter examinations were carried out, while in the case of the soybean and wheat only comparative examinations were performed.

The examination program:

1. Maize of 32 % moisture content after the harvest was kept on room temperature then dried in exsiccator to 10 %.
2. In the course of drying several samples were taken and ground in kitchen mill.
3. Three fraction of grists were separated by Ø1 mm and Ø2.5 hole size sieve to 3 fractions, and stored separately.
4. The grist porosities were measured by porosimeter (n %).
5. The moisture content of the samples were measured by means of standard procedure: drying in exsiccator and measuring the weight loss.
6. The dielectrical constants of the grists were measured by the resonance method described previously in detail. The used frequency band was 0-40 MHz.
7. At two temperatures, 11 °C and 22 °C measurements were performed to study the effect of the temperature. 11 °C samples were produced by putting the airtight closed bins of grists samples into refrigerator and cooling them to the desired temperature.

Evaluation of the results

The dielectrical constant of the corn grist was investigated as function of of frequency, moisture content, grain size and porosity. The examination results are shown in the diagrams 1 to 3. By computer evaluation the equations of the curves and the correlation coefficients were determined.

In the appendix 4 the dielctrical constants of the corn, soybean and wheat grists are compared as fuctions of the volume weight at same moisture content.

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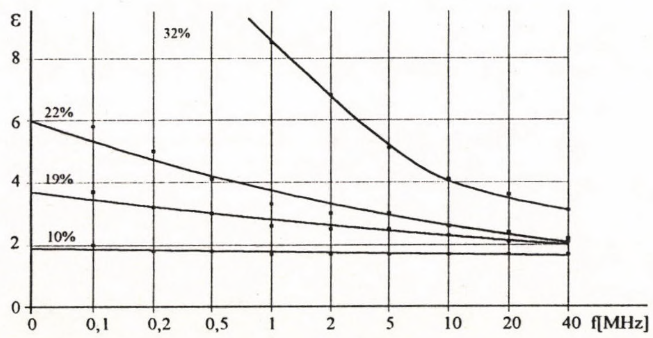
Appendix 1

Dielectrical constant (ε) of the maize grist in relation to the frequency

Parameters: moisture content
temperature: T = 24 °C
porosity: n = 74.57 %
grain size: ∅ 1 mm alatt



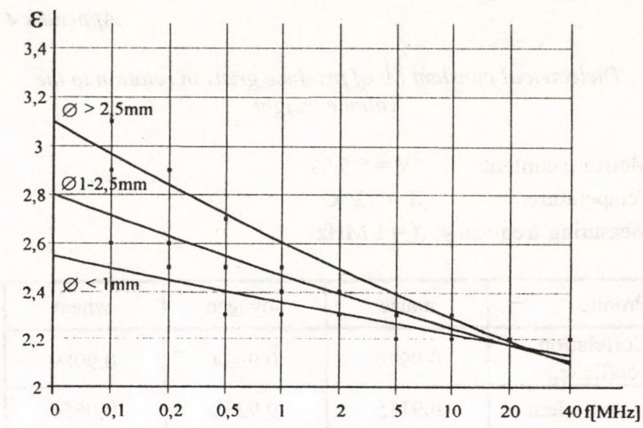
Regression: exponential $y = b \cdot exp(a \cdot x)$

Humidity w %	10	19	22	32
Correlation coefficient	- 0.0955	- 0.5079	- 0.9444	- 0.9660
a coefficient	0.6393	1.3077	1.7892	2.9164
b coefficient	- 0.0155	- 0.0686	- 0.1180	- 0.2048

Appendix 2

Dielectrical constant (ε) of the maize grist in relation to the frequency

Parameters: grain size
temperature: T = 24 °C
moisture content: W = 14 %



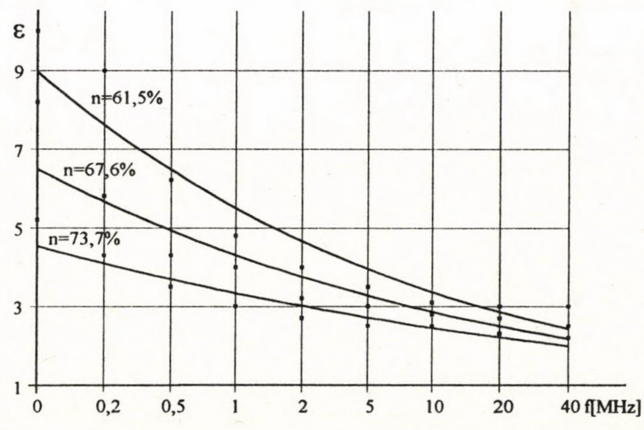
Regression: exponential $y = b \cdot exp(a \cdot x)$

Grain size ∅ mm	< 1 mm	1- 2.5 mm	> 2.5 mm
Correlation coefficient	- 0.8795	- 0.9147	- 0.9500
a coefficient	0.9347	1.0301	1.1308
b coefficient	- 0.0197	- 0.0317	- 0.0434

Appendix 3

Dielectrical constant (ε) of the maize grist in relation to the frequency

Parameters: porosity
temperature: T = 24 °C
grain size: ∅ 2.5 mm felett
moisture content: 18.6 %



Regression: exponential $y = b \cdot exp(a \cdot x)$

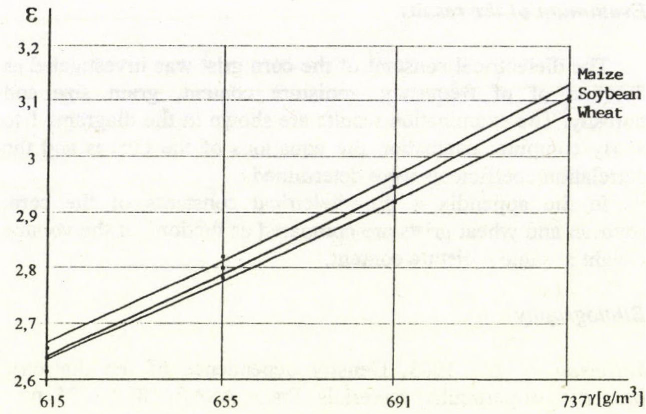
Porosity %	61.5	67.6	73.7
Correlation coefficient	- 0.9164	- 0.8813	- 0.8827
a coefficient	1.6150	2.0056	2.2805
b coefficient	- 0.1280	- 0.1365	- 0.1519

Appendix 4

Dielectrical constant (ε) of produce grists in relation to the volume weight

Moisture content: W = 5.5 %
Temperature: T = 22 °C
Measuring frequency: f = 1 MHz

Produce	maize	soybean	wheat
Correlation coefficient	0.9979	0.9994	0.9989
a coefficient	0.9115	0.9238	0.0556
b coefficient	0.0532	0.0535	0.0556



Regression: exponential $y = b \cdot exp(a \cdot x)$

MODERATION OF THE ENVIRONMENTAL POLLUTION OF ANIMAL HUSBANDRY

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Introduction

Daily slurry production of large-scale pig farms is 0.2-0.5 m^3 per sow unit. Dry matter content of the slurry is only 0.5-3 %, while the total nutrient content is 1.5-3.0 kg/m^3. Utilization of such kind of slurry is uneconomic, 'hiding' without causing environmental damage is impossible.

Odour emission of pig farms is also considerable. In the last three years, within the scope of R&D works, supported by the National Committee for Technological Development (OMFB) and the Ministry of Agriculture and Food (FM), our Institute carried out developments for the purpose of reducing the damaging effects of animal husbandry to the environment. In the course of the R&D works effective cooperation was developed among the experts and researchers of our Institute, the University of Agricultural Sciences at Gödöllő and the Bábolna joint-stock company (RT).

Studied R&D fields in headlines were as follows:

i. Adaptation of water-saving feeders.
ii. Elimination of slurry production of pig husbandry by using of bioactive deep litter.
iii. Developing of water-saving slurry handling technology for pig farms.
iv. Reduction of the emission of pig houses by straw bale biofilters.
v. Rate control system for uniform slurry application, environmental protecting slurry distribution methods.
vi. Computer-aided system for environmental-friendly utilization of manure/slurry.

Results of the R&D

i. Water output of the widely used bowl-type drinkers in pig husbandry is 12-15 dm^3/min. Using of this drinker 6-8 dm^3/min spilling water dilutes the slurry. For avoiding the unnecessary dilution combined wet-feeders with built-in nipple drinkers were used. Water consumption of the experimental stock varied between 1.8-3.2 litre per pig per day while this value was 5.1-9.1 litre in the case of the control stock. Water consumption of the experimental stock was 34.9 % in percentage of the control one. Water saving was 65.1 %. Results of the test are shown on Fig.1.

ii. Advantages of the litter-housing systems are well known. Introduction the bedding increases the specific place requirement of pigs from 0.6 m^2 to 1 m^2/pig. During the experiment saw dust, unchopped barley straw with and without bioactive additives were used as litter. Using of saw dust after two fattening cycles specific load of faeces and urine was 1,060 kg/m^3 litter. Against it the surface of the litter was semi-dry because one part of the water content was evaporated by the generated heat. Health of pigs was good. Pathogens e.g. E.Coli and Salmonella were not reported by laboratory analyses.

Bioactive additives also decreased the odour level. In another fattening cycle when unchopped straw was applied as deep litter with and without bioactive additives, using the combined feeders, there also was no slurry production. Bioactive additives did not make better the quality of straw or the mixture of straw litter, urine and faeces. The average nutrient content of both kind of litter corresponded to the good quality manure standards. After 18 weeks of fattening dry matter content (DM) of litter-manure mixture was 24.1-27.6 %, organic matter (OM) content was 19.9-22.4 %, nitrogen (N) content was 0.73 % while the C/N ratio was measured as a 15.4-17.1 values. Layout of the fattening unit can be seen on Fig.2.

iii. During the test of the technology the pig farm was running with 245 head of sows. Between 1st of January and 20th of April fodder consumption was 130.4 tons, while the slurry production was 614 m^3 with a DM content of 3.6 %. Dilution rate of faeces and urine against slurry was 2:1 in comparison with the state before reconstruction when this rate was 4:1. Separated solids from slurry was 72 tons. Treated and recycled liquid phase to one gutter was 8 m^3. Quantity of additives to the recycled luquid was its 0.2 vol.%. Reduction of slurry produced was more than 50 % in comparison with the original state. Flow scheme of the slurry handling system can be seen on Fig.3.

iv. Odour emission of animal houses may cause conflicts with residents living near the farm. A relatively simple and not expensive solution had to be found for minimizing the unpleasant odour. We found that a simple construction of straw filter built up from small bales was suitable for this purpose. After 6 weeks of running wad-like colonies of fungus could be observed on the inner surface of the bales. According to odour tests, carried by sense organ, unpleasant odour could not felt against the characteristic „pig smell" inside the house. According to the results of olfactometric measurements decreasing of odour intensity was about 50 %. Layout of the biofilter can be seen on Fig.4.

v. In order to ensure the required nutrient content of the plants a rate controlled manure slurry distribution is necessary. Using the developed rate controll system, mounted on a slurry tank with injectors, 885 m^3 of pig slurry was injected on 3x4 hectare fields. Adjusted application rate were 40-80-120 m^3/ha. Deviation to the adjusted rate were + 1.7 % - 5.6 % and - 4 % respectively. The required application rate can be adjustedwithin 0-200 m^3/ha at a step of 0.5 m^3/ha. The system raised the price of the tank approx, by 50 %.

vi. According to the test results based on the evaluation of normal and infra-red aerial photos from 500-1,500 m heights and laboratory analyses the developed method is suitable for evaluating the composition of the upper layer of the soil of arable land, e.g. for determining the nitrogen and humus content, the required amount ancomposition of manure/slurry, for measuring the effects of the former environmental pollution etc.

Conclusions

By means of application of devices, equipment, technologies and measuring – evaluation methods, developed during years of R&D work in our institute, advantages are as follows:

- minimizing of water consumption and odour emissions of pig farms,
- considerable reduction or elimination of slurry production,
- distribution of slurry in the required rate,
- application and utilization of slurry according to all the requirements and demand of soil and plant by advanced methods and systems.

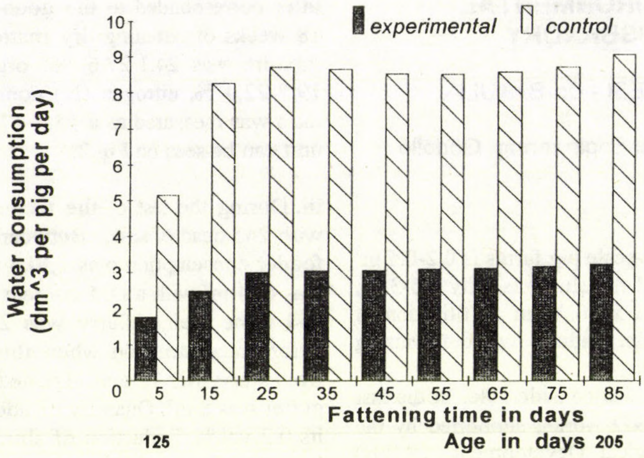
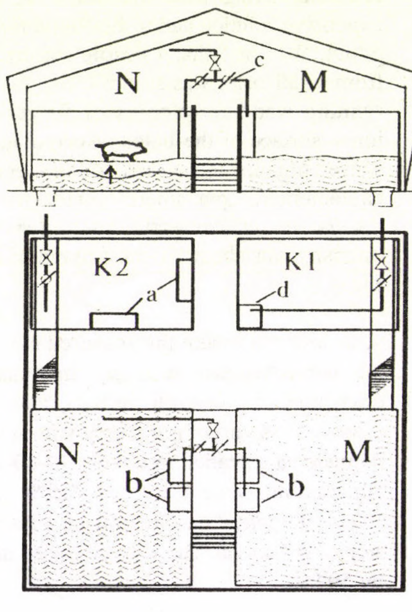
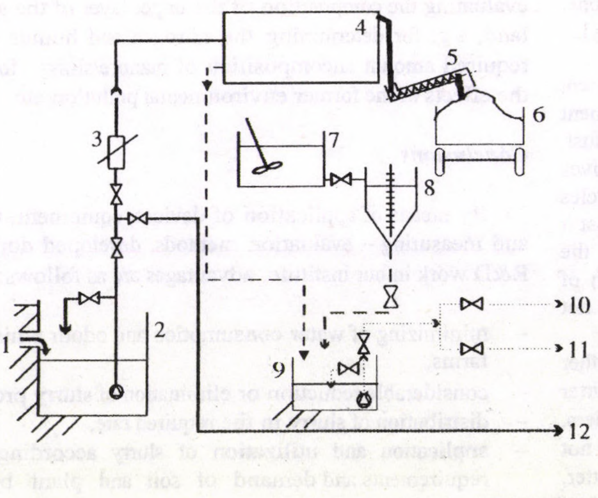


FIGURE 1.
Daily water consuption



a - conventional self feeders;
b - VERBA type combined wet feeder;
c - water meters;
d - AVEVE type combined wet feeder;
N - increasing deep litter without additive;
M - deep litter handled with additive;
K1 - control pen with VERBA feeder;
K2 - control pen with convertional self feeder and bowl type drinker

FIGURE 2.
Layout of the fattening unit



1 - collecting gutter of the pig farm;
2 - collecting pit;
3 - flower meter and summarizer;
4 - drum screen;
5 - auger for separated solid phase,
6 - trailer;
7 - bin for treating material;
8 - metering device;
9 - temporary storage for treated liquid phase;
10 - recycling of treated liquid phase to the gutters of the house;

Line codes:
——> slurry; - - -> separated liquid phase;
⟶ separated solids; · · · > treating material;
·······> separated and treated liquid phase

FIGURE 3.
Flow scheme slurry handling system

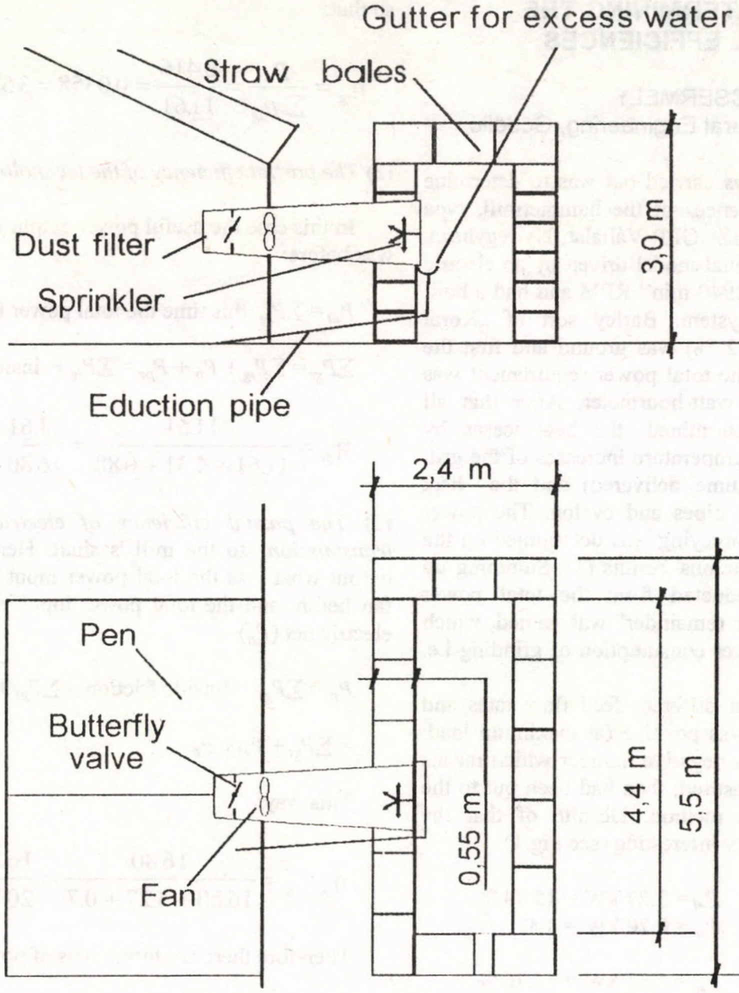


FIGURE 4.
Layout of the straw bale biofilter

SOME PROBLEMS OF DETERMINING THE HAMMERMILL'S DECIMAL EFFICIENCES

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The aim of the investigations carried out was to determine the often debated decimal efficiences of the hammermill, type D-24 F, manufactured by the MEZŐGÉP Vállalat, Nyiregyháza, Hungary. The mill was conventional model driven by an electric motor of 19 kW performance at 2940 min^{-1} RPM and had a built in pneumatic grit conveying system. Barley sort of „Korai Kompolti" (moisture content 13.2 %) was ground and first the idle running power input, then the total power requirement was stated by means of a 3-phase watt-hourmeter. After that all possible power losses were determined: the heat losses by measuring the quantity and the temperature increases of the grit, of the aspirating air (+ air volume delivered) and the heat radiation of the mill 's house + pipes and cyclon. The power requirement of pneumatic grit conveying was determined on the bases of former detailed investigations' results (1). Summing up all power losses and then deducted from the total power requirement the so called „power remainder" was gained, which can be considered as the net power consumption of grinding i.e. creating new surfaces.

Three test runs were done at different feed flow rates and from that first „the remainder" was positive (at maximum load: Q_g= 0.9748 t/h) and twice it was negative number which means that more power losses were measured, then had been put to the mill! This is the error of the method. Despite of that the distribution of power losses is very interesting (see Fig.1)

1. Electric power loss: P_{el} = 3.27 kW = 15.74 %
2. Loss of power transmission: P_{tr} = 0.70 kW = 3.37 %
3. Idle running power requirement: P_{ir} = 4.31 kW = 20.76 %
4. Power consumption of pneumaticgrit conveying: P_{pc} = 0.88 kW = 4.23 %
5. Power loss for heating grit: P_{hg} = 8.34 kW = 40.19 %
6. Power loss for heating aspirating and conveying air: P_{ha} = 2.21 kW = 16.64 %
7. Power loss of mill 's radiation: P_r = 0.644 kW = 3.10 %
8. Total power loss P_{li} = 20.354 kW = 97.99 %
9. Total power input: P_{ti} = 20.77 kW = 100 %
10. „Power remainder": P_u = 0.416 kW = 2.01 %

This way the decimal efficiency of the mill – which is the physical efficiency of comminution – in the given case – ammounted to η_{com} = 2.01 %. Since the „remainder" was negative number twice, it can be concluded that the physical efficiency is really very small, lies under 2 %.

The so called technical efficiency of the mill can be figured out when all the last four items of the power balance (5 + 6 + 7 + 10) that are transferred to feed grains and particles by impact is considered „useful" from the point of view of grinding process. This makes up

$$\eta_{tech} = 0.559 \rightarrow 55.9\ \% \text{ at } Q_g = 0.9748 \text{ t/h}$$

feed flow rate.

Otherwise there are three further terms used for the partial efficiences of the whole process in the technical science:

(l) *Partial efficiency of the impact grinding* process when the total power input is:

$$\Sigma P_{ig} = 11.61 \text{ kW } \; P_u + P_{hg} + P_{ha} + P_r$$

so that:

$$\eta_{ig} = \frac{P_u}{\Sigma P_{ig}} = \frac{0.416}{11.61} = 0.0358 = 3.58\%$$

(2) *The partial efficiency of the technology:*

In this case the useful power output is as the total power input was before:

$P_{ut} = \Sigma P_{ig}$ this time the total power input amounts up to

$$\Sigma P_{gt} = \Sigma P_{ig} + P_{ir} + P_{pe} = \Sigma P_{ig} + \text{ inside friction}$$

$$\eta_{gt} = \frac{11.61}{11.61 + 4.31 + 0.88} = \frac{11.61}{16.80} = 0.6911 \rightarrow 69.11\%$$

(3) *The partial efficiency of electric and mechanic power transmission* to the mill 's shaft. Here it is the useful power output what was the total power input to the hammers and the fan before and the total power input, what was taken from the electric net (P_{ti})

$$P_{ti} = \Sigma P_{gt} + \text{outside friction} = \Sigma P_{gt} + \text{outside friction} =$$

$$= \Sigma P_{gt} + P_{el} + P_{tr}$$

This way:

$$\eta_{el+tr} = \frac{16.80}{16.80 + 3.27 + 0.7} = \frac{16.80}{20.77} = 0.8088 \rightarrow 80.9\%$$

Therefore there are three steps of power transmission

(a) from the electric net to the mill 's shaft
(b) from the mill' s shaft to the hammers and the fan
(c) from the hammers to the feed grains and particles.

Of course the product of the three partial efficiencies makes up the final physical efficiency of comminution.

$$\eta_{com} = \eta_{e+tr} \cdot \eta_{gt} \cdot \eta_{ig} = 0.8088 \cdot 0.691 \cdot 10.0358 = 0.0201$$

It is to be seen, that the very low value of the physical efficiency is initiated by the as well very low partial efficiency of the impact grinding process. After that one can also conclude, that the hammer milling is a quite simple physical phenomenon during which just about 98 % per cent of the total power input is dissipated as heat in the ambient. It has been stated that the grit, the aspirating air and the mill 's house is warmed up significantly. Fig. 2. shows all the temperature increases at all three test runs.

Since the only source of all temperature increases (grit, aspirating air and mill house) the warming up of the feed is and this is transferred to the air and to the machine structure, it can be supposed, that in the moment of impact the feed (or grit) temperature might had been much higher, then we calculated first (Fig. 2.): T = 14.1 ... 17.3 °C.

On the bases of theoretical calculations – taking into accont the whole heat flow (grit + air + mill radiation) – the temperature increase of feed would reach at the three test runs as muchs a much as ΔT_{calc} = 22.6 ... 56.7 °C (2)!! All that heat flow came from the perfectly inelastic collisions of particles with hammers, screens etc.

To further investigations the measurement technique must be significantly developped.

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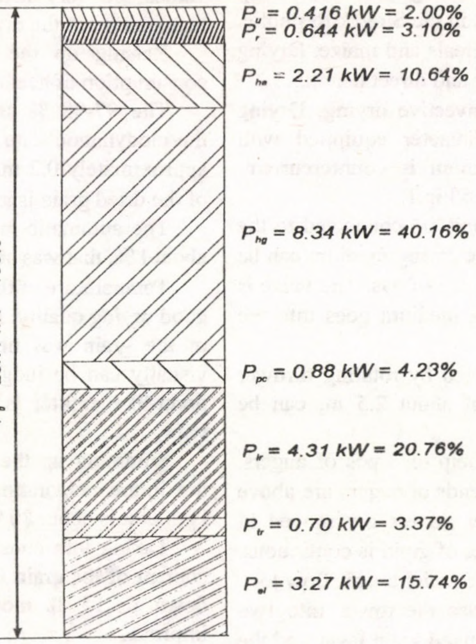
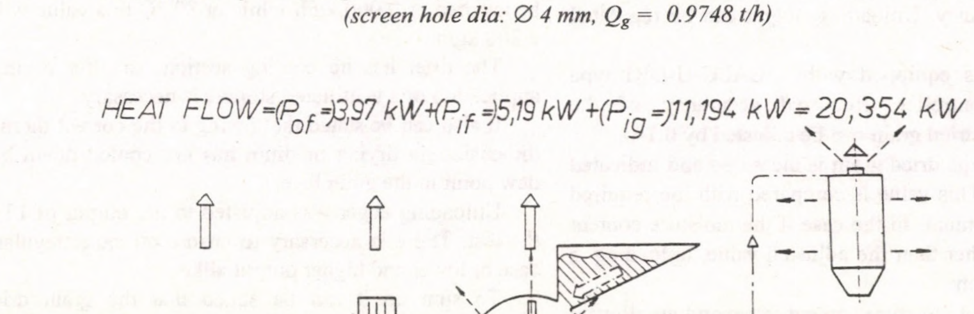


FIGURE 1.

Distribution of the total power requirement of the hammermill, type D-24 F, grinding barley (screen hole dia: ∅ 4 mm, Q_g = 0.9748 t/h)



Symbols: P_{of} = outside friction; P_{if} = inside friction; P_{ig} = inside grain
P_{ti} = total input; P_{msh} = mill's shaft; P_{tech} = technology

FIGURE 2.

The ambient temperature and the temperature increase of the grit, of the aspirating air and of the mill's house (the hammermill type D-24 F) grinding barley at different feed flow rates. (Screen hole dia: ∅ 4 mm).

EXPERIENCES GAINED BY TESTING OF A MODERN DRYING-STORAGE SYSTEM

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The U.S.A. made CHIEF type drying-storage plant was set up at the Progress Agric.Cooperative, Selice, in the Slovak Republic. The plant is used for drying mainly of cereals and maize. Drying unit is a system of continnously operating and direct heating.

It works on the principle of the convective drying. Drying takes place in the tower of 14 m diameter equipped with ventilating duct and floor. Drying medium is countercurrent. Scheme of the drying tower can be seen on Fig.1.

Two centrifugal fans and a heating unit are connected to the drying tower. Required temperature of the drying medium can be adjusted by a valve that regulates the volume of gas. The valve is operated by a pressure regulator. Drying medium goes into the tower through the perforated slab floor.

Grain, fed info the tower, is distributed by rotating thrower paddles. Thickness of the grain layer of about 2.5 m, can be adjusted by level sensors.

Mixing of grain takes place by the help of 3 pcs of augers, dipping vertically into the tower. Lower ends of augers are above the perforated slab about 80 cm. Auger mixers are moved in circle and in radial direction. Turning over of grain is continuous. Auger mixers loosening up the grain make easier the air flow too.

Arrangement of auger mixers, divides the tower into two parts, namely the pre-drier section with mixed grain layer and the lower section. Unloading of dried grain takes place by two of unloading augers adjusted on the bottom of the tower. Unloading augers operate continuously. Unloading output can be regulated by a gate valve.

The drying tower is equipped with a CALC-U-DRI type automatic moisture controller. Required accurancy of the moisture content of the dried grain can be adjusted by 0.1 %.

Moisture content of the dried grain is measured and indicated at the unloader augers. This value is compared with the required value of the moisture content. In the case if the moisture content of the dried grain is higher than the adjusted value, unloading is allowed by the automation.

In the case if the final moisture content is beyond an allowed limit, (+ 0,3 %), unloading will be stopped by the automatic moisture controller. Following the stopped unloading, drying takes place periodically in accordance with the adjusted values on a timer, e.g. 15-30-45 min, until the final moisture content will meet the required value.

Periodical samplings, needs 2 minutes in one occasion, also prevent the undesirable settling. Unloaded warm grain has to be cooled. Temperature of the grain can be called down of the moisture content regulator. For the purpose of cooling a ventilation system adjusted in the last storage, is necessary.

Evaluation of the results

Drying-storage system was tested during drying of maize. Moisture content of the wet grain varied between 18-19 % and 22-24 %. Average temperature of the ambient air was 6.9-23.2 °C. Relative air humidity was 39.3-91.9 %. Average temperature of the drying medium was 47.8-70.0 °C.

Results of test can be seen in Table 1.

Drying output was up to 14 t/h concerning the wet grain. Maximum evaporating capacity was 1,612 kg/h. Beside test measures drying took place with 25-28 % of moisture content of grain. Consumption of natural gas of the drying unit varied between 103-194 m^3/h.

Consumption of electric energy of fans was 59-61.3 kWh/h while of the unloading auger was 1.8-2.0 kWh/h. Measured specific heat consumption was 4-4.5 MJ/kg of water. These values are very favourable taking into consideration the low temperature of the drying medium.

Raising up the temperature of the drying medium, the consumption of heat energy can improve.

The 97-98 % saturation of the air indicates an optimum thermodynamic state. Air speed, going through the grain layer, is approximately 0.2 m/s. Uniformity of the final moisture content of the dried grain is ± 1 %, that meets the requirement.

The automatic moisture controller operated with an error of about 1 %, that was acceptable.

Temperature of the dried grain was max. 56-60 °C that meant good drying quality. In the course of the drying process damaging of the grain was negligible. Chaff production of the unit by visually can be judged very low and because the unit is not a point-like emitter is acceptable from environmentally point of view.

Summing up the results it can be stated that the measured maximum evaporating output of the dryer is approximately 1,600 kg/h that is about 80 % of the 2,000 kg/h nominal value.

Taking into consideration the low initial and final moisture content of the grain in the case of the drying process from 25 % down to 15 % moisture content, capacity of the drier will improve.

According to the thermodynamic calculation, evaporating output of the drier at 75 °C temperature of the drying medium can be awaited as 2,000 kg/h while at 80 °C this value will be about 2,200 kg/h.

The drier has no cooling section, so after drying of grain application of a ventillated storage is necessary.

It also can be stated that owing to the correct thermodynamic dimensioning drying medium has not cooled down beneath the dew point in the grain layer.

Unloading auger was adjusted to the output of 13 t/h during the test. There is necessary to ensure on exact regulation in the case of lower and higher output alike.

To sum up it can be stated that the grain drier is well applicable to drying maize. From technical aspects of view drying of wheat causes no kind of problems. From thermotechnical point of view the drying unit has rather favourable characteristics. It is possible to dry grain with higher moisture content then 25-28 % by adjustment of the drier reducing its output, higher temperature of the drying medium as well as by reducing the thickness of the grain layer.

Drying unit of present construction, characterized by a 2,000-2,200 kg/h evaporating capacity at drying from 30 % to 15 % moisture content, is equivalent to a dryer with a drying capacity of about 10 t/h.

An other advantage of the drying unit is, that apart from the drying function, it can be used as a storage.

Changing the dimensions of the tower the drying unit can be applied for satysfying wide range of capacity demand.

Owing to the probable favourable installation and investment costs, related to the tower-driers, and because the low heat energy consumprion, application of this modern drying--storage system can come into consideration in small, medium size and large-scale drying plants alike.

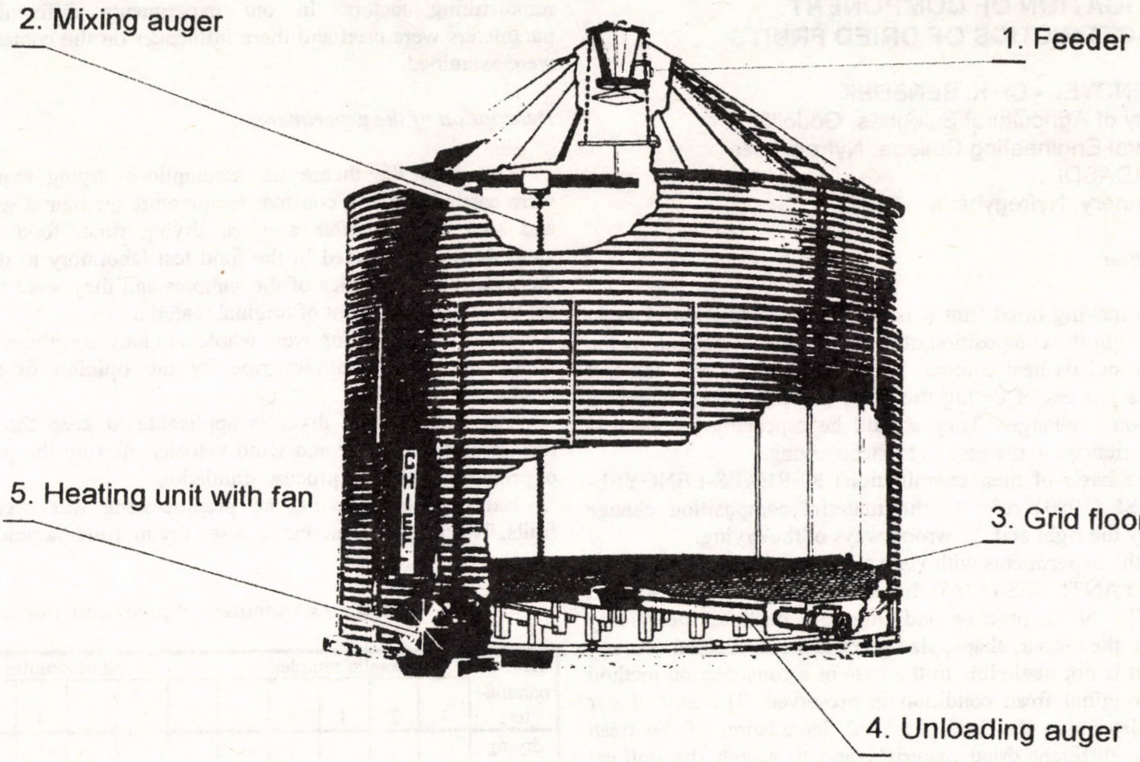

FIGURE 1.
Scheme of the drying tower

1. táblázat

Capacity and energetic characteristics of the CHIEF drying – storage plant (Maize drying) Selice, 1993.

No. of measures	Ambient air characteristics		Temperatute of the drying medium		Grain moisture content		Drying capacity	Evaporating capacity	Gas consump-tion	Specific heat energy consump-tion
	Air temperature (°C)	Air huminidity (%)	Adjusted (°C)	Measured (°C)	Before drying (%)	After drying (%)	(t/h)	(kg/h)	(m^3/h)*	(MJ/khg w)
1	21.8	41.8	60	60.7	20.2	13.3	11.5	915.2	114.7	4.2
2	22	39.3	56.8	57.7	18.9	13.6	14	858.8	110.2	4.3
3	21.6	45.8	51.6	53.8	18.2	12.8	13	805	103.5	4.3
4	23.2	46	47.8	51.9	18.8	12.4	10.5	827	-**	-
5	10.5	80.3	71.1	73.6	23.7	12.9	13	1,611.9	194.2	4
6	6.9	91.9	67.8	69.5	20.7	12.5	14	1,312	177.2	4.5
7	11.8	78.9	70	65.7	22	12.4	13.8	1,512.3	186.1	4.1
8	8	81.2	70	67.7	20.8	11.5	14	1,471.2	189.1	4.3

Notices: * Calorimetric value of the natural gas: 0.0334 GJ/m^3
** Owing of the adjustment of the gas burner it cannot be estimated

INVESTIGATION OF COMPONENT CHARACTERISTICS OF DRIED FRUITS

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Introduction

When making dried fruit it is not investigated what changes are resulted in the composition of the original raw material by the drying air and its heat content. Several articles refer to the fact that in the process of drying there are internal – food chemical composition – changes. They should be especially emphasised those experienced in the case of tobacco drying.

On the basis of their examinations KEREKES-LENGYEL-FENYVESI (1993) refer to the material composition change resulted by the right and the wrong ways of the drying.

With the experiments with vegetables and fruits by RAYNAL (1985) and ANTUNES (1985) the damages to cells are discussed mainly. The home practice and literature declares the quality focused on the colour, shape, size and the dried material content, although it is not negligible in the case of a conservation method how the original fresh condition is preserved. The aim of our work to determine the food chemical degradation of the fresh fruits with different dried materials and to search the optimal drying parameter. The experiments were carried out for sour cherry and plume.

Analysis of the drying process

The change of the material in the process of drying highly depends on the progression of the thermal and material transport. This can be well influenced in the case of convective drying technique. It has special significance at the colloid-capillar pore materials, when the free water leaves the surface first and the micells shrink. The changes are influenced not only by the material structure but the temperature conditions and first of all by the material warming up. At the drying behaviour of fruits and vegetables these questions are have not been answered clearly or at all. According to the investigations carried out with maize (NEMÉNYI and KACZ) one can state that surface temperature distribution is not uniform which influences the quality. As a results of the process the diffusion of some components solved in water starts in a certain extent.

Such a way in the case of cut and skiny fruits the higher sugar concentration and the acid oxidation cause a well observable getting brown and flavour decrease. According to the fruit production literature the temperature has a significant effect on the content of some components, namely acid, flavour, pectin, sugar. These factors change also in the drying process, since the metabolism, and the temperature have different effects. The biological process in the material during drying corresponds to the process taking place in the low temperature material but it is faster due to the high temperature of drying. According to the findings of BEKE and VAS (1985) the changes of the compositions are in relation to the diffusion processes inside material, to drying temperature and to the process rates. Thus in a drying process which corresponds to an accelerated storage a significant loss of water occurs causing a sugar transformation due to which the overall sugar content should increase. As an effect of the water motion and the temperature, a reduce of the pectin content should be considered. Taking into account all this it can be well recognised, that the drying process induces chemical reactions and it is not sufficient to examine the usual remoisturing factors. In our experiments different drying parameters were used and there influences on the content values were examined.

Description of the experiments

To verify the theoretical assumptions drying experiments were carried out in a constant temperature air tunnel with plum and sour cherry. After a given drying time, food chemical analysis was performed in the food test laboratory to determine the main characterestics of the samples and they were related to the dry material content of original material.

The fruits for drying were whole and halves without core and their state were optimum ripe by the opinion of the fruit producers.

The experimental dryer is applicable to keep thr constant temperature, humidity and wind velocity offering the possibility of properly controlled process simulation.

Except water washing no preprocessing was used to the fruits. The Table 1. contains the used drying fluid parameters.

Table 1.
Drying air parameters at plum and morello drying

Drying parameters	Morello samples					Plum samples					
	1	2	3	4	5	1	2	3	4	5	6
drying temperature °C	48	50	64	54	71	69	67	63	68	70	70
air velocity	2.4	2.9	3.0	2.6	2.8	3.2	2.3	4.8	2.6	4.7	2.3
relative humidity [%]	12.5	10.5	6.9	7.2	5.7	5.6	8.5	7.0	6.2	4.5	8.5
drying time [h]	11.5	24.0	12.5	14.0	12.0	19.5	22	24.5	23	11.5	22

Evaluation of the measurement results

In the evaluation of the measurement results a simple comparison method was used. The components of the dried material are related to the dry material content of the original material and such way a comparison is made.

The pre- and postdrying moisture states as well as the measured composition characteristics are included into the Table 2.

Table 2.
Moisture content and composition of fresh and dried samples

Characteristics %	Morello samples					
	fresh	1	2	3	4	5
Moisture	85	55	45	41	40	34
Sugar	15.5	14.6	10.4	13.9	12.7	11.8
Vitamine C	26.1	8.2	6.3	6.7	8.0	8.0
Acid	0.57	1.50	1.19	1.70	1.25	1.28
Pectin	-	-	-	-	-	-

Characteristics %	Plum samples						
	fresh	1	2	3	4	5	6
Moisture	83	37	34	33	32	27	26
Sugar	13.4	11.2	9.5	10.4	10.3	8.9	8.9
Vitamine C	12.1	7.75	6.6	2.3	3.7	3.26	2.7
Acid	0.45	0.38	0.33	0.28	0.37	0.43	0.36
Pectin	15.9	11.1	14.4	11.5	10.2	10.8	13.3

The data of sour cherries are shown as column diagram in the Fig.1. from which one can see that the increase of the drying time reduces the vitamine C content by 15 to 20 % which even reaches several times on fresh fruit base. It can be also stated that raising drying time is infavourable to the sugar content change. Compared to the drying with 11.5 to 14 hours time, the 24 hours drying results in 20 to 25 % decrease, which can be due to the possibility of diffusion. No correlation can be established between the acid content and the drying time. The acid content increase for dried fruit is significant. There were no possibility to measure pectin content change in sour cherry.

From the plum experiments the sugar content decrease can be concluded from Fig.2., as well, wich is influenced the wind velocity (see data in Table 1.).

The high air velocity increases the internal diffusion of the sugar toward the surface resulted in a loss with the water.

The vitamine C content is also influenced by the drying time and temperature. A long drying time and raised drying temperature results in a reducing effect. In the case of pectin the temperature and the drying time shows up an infavourable trend compared to fresh fruit.

The above data and their analysis prove that in the interaction of the material and drying fluid in the quality can not be discarded in the analysis of drying process. In order to assure the dried material quality one should find the technology parameters which results in the best composition. The experiments carried out give results of measuring series and refers to the possibilities of technology development, based on which the parameters to real plant conditions can be given.

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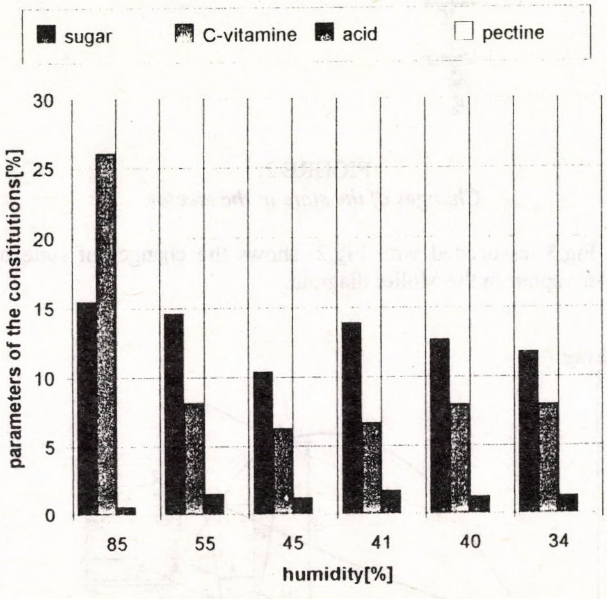

FIGURE 1.
Composition changes of dried sour cherry with different moisture content samples
Species: „Újfehértói fürtös meggy"
Measure date: 17. July 1993.

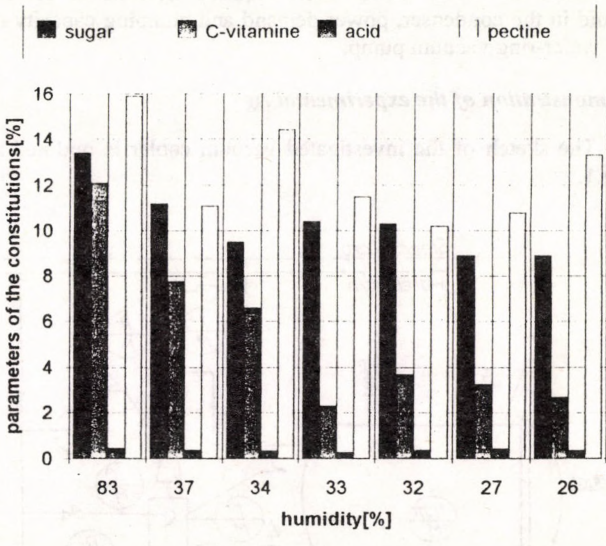

FIGURE 2.
Composition changes of prune with different moisture content samples
Measure date: 17. September 1993.

ENERGETIC MODELLING OF BATCH VACUUM COOLERS

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Introduction

To assure better food quality according to the recommendation of food quality guidelines, cooked products should be cooled down to 0-3 °C temperature within 90 minutes. It is not easy to achieve its requirement with the traditional cooling methods, refer to certain foods with solid or liquid-solid phases. Shelf-life of chilled product could be extended with application of vacuum cooling since it provides rapid temperature reduction. Batch vacuum coolers are needed for the cooling of cooked or baked products such as mashes, meat slurries, ready-meals and bakeries. Energetic analysis and calculation are presented on the basis experiments with a pilot plant vacuum cooler. The aim of the performed research was to find out the most relevant operating parameters and features which enable me to establish an energetic model for the introduced vacuum cooler. Experimental and computational results present a procedure of determining the time of evacuation, quantity of the formed water vapour, steam consumption, attainable counter pressure and efficiency of vapour compressor, required flowrate of service liquid in the condenser, power demand and pumping capacity of the water-ring vacuum pump.

Demonstration of the experimental rig

The sketch of the investigated vacuum cooler is outlined at Fig.1.

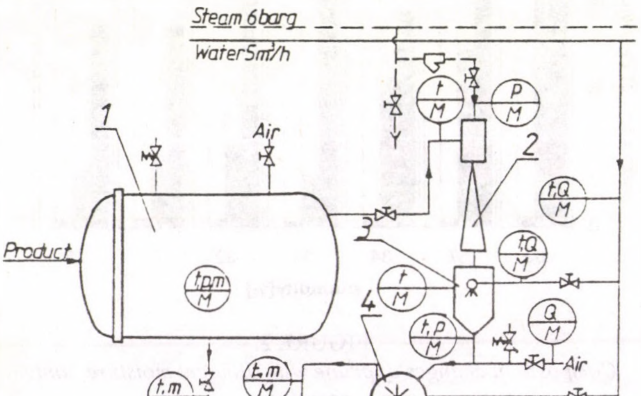

FIGURE 1.
The experimental rig
1 - vacuum chamber; 2 - vapour compressor;
3 - direct-spray condenser; 4 - water-ring vacuum pump;
(instrumentation for measuring the *t* - temperature; *p* - pressure;
Q - flowrate; *m* - weight)

Vapour compression vacuum coolers are particularly suitable for handling large quantity water vapour. The product is placed on trays into the vacuum chamber, which is a horizontal and cylindrical pressure vessel. The evacuation procedure is begin carried out in two steps. At the first stage the water-ring vacuum pump evacuates the retort below the flash point. Also, its duty is to remove the mixture of air and condensate from the condenser and assure fore-vacuum which is needed for starting the second stage. The steam jet ejector ensures the condensation to take place in the condenser. Because it compresses the absorbed vapour, the temperature of the discharged fluid will be above the level of service liquid temperature which is applied in the condenser. The following variables were logged: steam pressure, absolute pressure and temperature in the vessel, vapour inlet and discharge temperature at the ejector, temperature and flowrate of service liquid to the condenser and water-ring pump, suction pressure of the water-ring vacuum pump, air-flowrate regulating the condenser pressure, volume and temperature of condensate, discharged water flowrate and temperature at the drain, product temperature and weight.

Thermodynamics of vacuum cooler

The thermodynamic process which is occurred in the ejector can be seen at Fig.2.

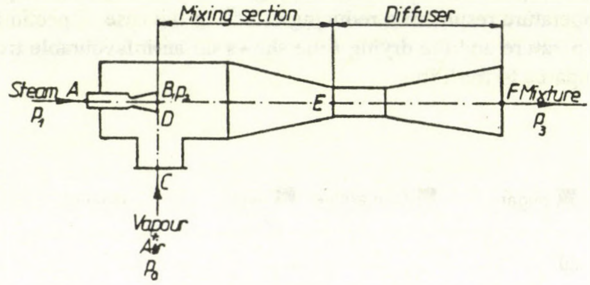

FIGURE 2.
Changes of the state in the ejector

Fig.3. associated with Fig.2. shows the changes of state of water vapour in the Molier diagram.

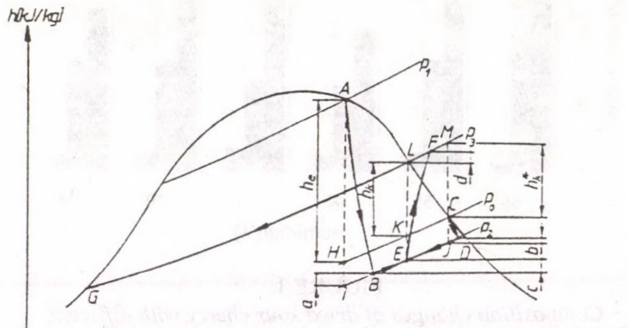

FIGURE 3.
Enthalpy against entropy diagram for vacuum cooling
Losses: *a* - nozzle; *b* - vapour expansion; *c* - mixing;
d - compression

The steam expands from p_1 (A) to p_2 (B) absolute pressure through the nozzle and passes its kinetic energy to the vapour, which was sucked and expanded from p_0 (A) to p_2 (B). The mixture of steam absorbed vapour and air is presented by p_2 pressure (E). It will be compressed to p_3 in the Venturi and discharged to the barometric condenser (F) where the condensation will take place (G). In the mixing chamber p_2 is smaller than p_0, because of the resistance of flow and effect of Venturi. Dotted line illustrated the adiabatic process. The real, politropic change of state AB, CD, EF are in continuous line. During the calculation $p_0 = p_2 = 10$ mbar, $p_1 = 5$ bar, $p_3 = 40$ mbar measured values were used.

Determination of the operation parameters

Calculation of the evacuation time

Fig.4. indicates a cooling curve of chilling of 20 kg batch 62 °C temperature water to 4 °C.

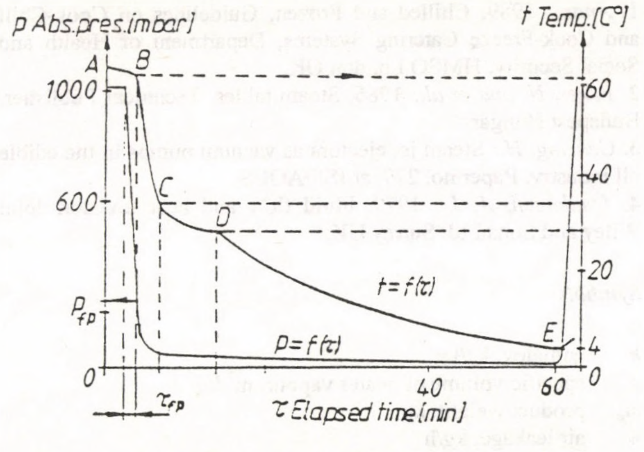

FIGURE 4.

Relationship between product temperature t = f(τ) and pressure of the vessel p = f(τ)

Vacuum cooling takes place when the residual pressure in the vessel reaches the saturated vapour pressure (p_{fp} = 230 mbar) which is determined by the initial product temperature of t_0 = 62 °C. This temperature is usually called flash point when the water content of the product begins to boil. The latent heat of evaporation comes from the product, therefore its temperature is lowering. The evacuation time to the flash point is given by equation (1).

$$\tau_{fp} = \frac{V}{S_n}\cdot\left(-ln\frac{P_{fp}}{P_k}\right)\cdot\varepsilon\cdot\frac{1}{\eta_{vol}}\ldots \qquad (1)$$

The τ_{fp} was calculated 1.17 min and measured 1.5 min. High pumping capacity gives little τ_{fp}, but fast pressure reduction could cause explosion of the product. It can be avoided by installing a regulating valve or air inlet pipe at the suction line.

Evaluation of the vapour load

The flowrate of released vapour w_p during the evaporation can be expressed from the heat balance equations.

$$w_p = \frac{c_p\cdot(m_p - \Delta m_p)\cdot v\cdot R}{r}\ldots \qquad (2)$$

The contains of Table 1. was worked out with the assistance of Fig.4.

Computation of the steam requirement

After the flash point rather than the vapour than the air has to be removed. The steam-jet ejector is ideal for transportating large quantity of water vapour which represents high specific volume at low pressure. The driven fluid is a mixture of water vapour and air, therefore steam requirement has to be calculated for both fluid respectively. The maximum air leakage values for commercially tight vacuum systems may be estimated from the following equation $v = V^{065}$ and it is equal to 1.4 kg/h. To be on the safe side this was chosen as the design value giving an air volume V_0 = 1,760 m³/h in front of the ejector. With the 200 kJ/h energy essential for V_0 compression the Δh_0 was 142 kJ/kg. For the enthalpy difference of primary steam Δh_1 = 838.5 kJ/kg was found. Thus the enthalpy ratio is $\Delta h_0/\Delta h_1$ = 0.16. Taking into consideration the ratio between the molecular weight of air and vapour and multiplied it with the value which is given by Fig.5. The steam consumption for pumping air will be equal to w_1 = 2.7 kg/h.

Table 1.
Vapour load during vacuum cooling

Distinctive feature of the curve	Temperature interval °C	Duration min	R °C/min	w_p m³/h	Comment on cooling process
B-C	62-33	3	11.2	2.6	flash
C-D	33-29	7	0.6	0.5	moderate
D-E	29-15	14	1	1.2	slow
	15-10	13	0.4	1.1	
	10-4	15	0.4	1.6	

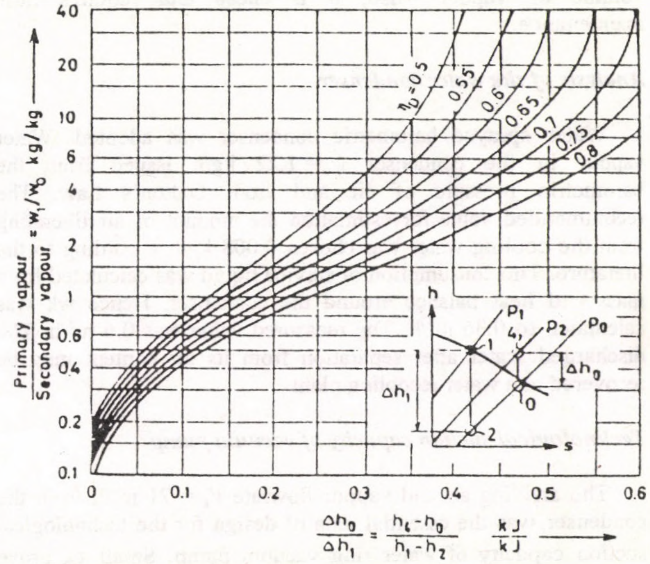

FIGURE 5.

The ratio between the motive steam and the amount of driven vapour against the enthalpy ratio

The first step of calculation the steam requirement for moving the vapour, was to figure out the Δh_0 = 190 kJlkg which is necessary to compress the absorbed vapour. The $\Delta h_0/\Delta h_1$ was equal to 0.226. Steam requirement to drive the vapour was calculated w_2 = 3.04 kg/h. Choosing the maximum vapour load from *DE* interval of Table 1. and employ Fig.5. the consumption is given as a sum of $w = w_1 + w_2$ = 5.74 kg/h. It gives an idea to estimate the steam supply. Furthermore I have to point out the importance of service liquid temperature applied in the condenser and steam condition as well. Steam should be saturated (see Fig.3.) or possibly superheated ahead of the nozzle, otherwise condensed droplets could blockage the throat. Lower service water temperature results in decreased pressure in the condenser and less steam consumption. This phenomena can be explained with existence of counter-pressure. Steam-jet pump could discharge to condenser against a certain pressure. The maximum value of this pressure, when the ejector just stop work is called limit counter-pressure p_{3h}. If the condenser pressure is above p_{3h}, than transmission coefficient given

$$\mu = \varphi \cdot \sqrt{\frac{h_e}{h_k^*} - 1} \ldots \quad (3)$$

equation will be equal to 0.

In my case the attainable p_{3h} can be expressed to 65 mbar with the assistance of initial conditions (see Point 2.) and the steam table. During the experiment pressure changes in the condenser were simulated by admitting air to the condenser. The effect of p_{3h} was that steam exhausted from the suction connection and backstreamed to the vessel. It was found that greater p_{3h} could be aspired with increased motive pressure, but it is certainly not economical. For example to reach p_{3h} = 80 mbar, the steam pressure should be twice as high as the preliminary value was, that is 10 bar. In spite of the fact that the ejector efficiency was only η_e = 1.2 %, defined by equation of

$$\eta_e = \frac{w \cdot h_k^*}{w_0 \cdot h_e} \cdot 100\,\% \ldots \quad (4)$$

its application may be a good solution in case of pumping large volume of vapour. Also, it is cheap and requires little maintenance.

Analysis of the water condenser

Water sprayed barometric condenser was adopted. Water vapour in the condenser w_0 = 1.22 kg/h issued from the barometric pressure of air and from Dalton's Law. The recommended value for estimation the amount of air liberating from the cooling water was chosen 0.008 kg/h according to the literature. The consumption of service liquid was calculated from mass and heat balance around the condenser. Hence wk was calculated to 0.36 m³/h. The measured value was 0.6 m³/h. The discharged water after separation from its air content may be recovered at a water recooling plant.

Technological suction capacity of vacuum pump

The arriving air and vapour flowrate V_k = 71 m³/h from the condenser was the essential data of design for the technological suction capacity of water ring vacuum pump. Small τ_{fp} prove greater 102 m³/h pumping size. For the isentropic compression of V_k, presuming η_{ad} = 0.5 the power consumption P_{vk} was 0.8 kW. Because the energy demand for evacuation of the vessel to flash point was greater P_0 = 1.34 kW than P_{vk}. Therefore the electric motor chosen should be made at P_0.

Summary

In connection with energetic analysis and computation, the most important parameters and features were determined of the vapour compression vacuum cooler. This equipment can be used for pressure cooking and vacuum cooling. In the case of lack of motive fluid (steam or compressed air) for the ejector, mechanical vacuum pump with refrigerator or absorption driven vacuum cooler may be recommended.

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Symbols

h	enthalpy, kJ/kg
v	specific volume of water vapour, m³/kg
m_p	product weight, kg
w	air leakage, kg/h
c_p	specific heat capacity of the product, kJ/kg °C
w_0	mass flowrate of the driven mixture, kg/h
p_0	absolute pressure in the vessel, mbar
w_1	steam consumption for transporting air, kg/h
p_1	steam pressure, bar
p_3	condenser pressure, mbar
w_2	steam consumption for transportating vapour, kg/h
p_k	barometric pressure, mbar
p_{fp}	p_0 at the flash point, mbar
w_3	total steam requirement of the ejector, kg/h
p_{3h}	counter pressure, mbar
w_p	evaporated vapour flowrate, m³/min
P_{vk}	power of delivery, kW
w_k	flowrate of service liquid, m³/h
P_0	power of evacuation, kW
τ_{fp}	evacuation time to the flash point, min
r	latent heat of evaporation, kJ/kg
ε	loss factor due to air leakage
R	cooling rate, °C/min
η_a	adiabatic efficiency
s	entropy, kJ/kg
η_D	diffuser efficiency
S_n	suction capacity, m³/min
η_e	ejector efficiency
t_0	product temperature, °C
η_{vol}	volumetric efficiency
V	volume of the vacuum vessel, m³
φ	delivery efficiency
V_0	air volume at the inlet of the ejector, m³/h
μ	delivery coefficient
V_k	air volume leaving the condenser, m³/h

CHANGES OF THE MACHINE AND IMPLEMENT TYPES IN THE COURSE OF THE TRANSIENT STATE OF THE AGRICULTURE

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In the tension accompanying the reformation of the agriculture in Hungary one can often hear about debates on recompense, privatisation, estate re-allocation as well as keeping and conformability of the laws and acts. Much less are spoken about the objects necessary for production including the technical background of the production. In the last year our institute undertook the job of examining and evaluating the changes having taken place so far, first of all concerning happenings to the former large scale machine stocks. The examinations started for almost the complete circle of firms existing before the transformation numbering 1,190 agricultural plants. Appreciable data could be collected only for 343 cooperative farms so that they were evaluated. The agricultural plants included into the evaluation represents a 25 % sample allowing general conclusions for the overall situation in this country.

Commonly known that the tranformation of the large scale cooperative farms are forced by law prescribing time limit. In the cooperative plants involved in the evaluation the transformation has been completed although in some cases it has not bee closed yet legally and the recompensation lands were not arranged everywhere.

As a result of the examination it can be stated that in the course of transformation the number of cooperative farms increased by some 63 % and the starting individul farmers sum up some 7 %. Among the new organisations after the transformation the 76 % new form cooperative farms were decisive. The number of cooperatives increased by 24 % and their land area decreased by 46 % and the number of their employees decreased by 32 %. These are important and significant changes toward racionality.

In addition to the cooperative farms a few share companies were formed which employ higher number people and operate considerable properties. They operates usually as property management holdings. One fourth of the new organisations are small economy groups withdrawn as groups. They produce as limited or deposit or other type companies. They own and handle only very small part of the land and properties: 1-3 % of that before transformation. They share the agricultural emloyment in similar rate while they own some more, 4-5 %, machines and implements.

The individual farmers are 6-7 % of the former employees having 3-4 ha land area from the cooperatives. They must have some more area because they got land in the course of recompensation.

A main point of our investigation is the collection of data on the state and motion data of machines and implements. 87 % of the machine and apparatus property remained in the use of the cooperatives. The smaller companies own 8 % and 5 % was taken by individuals. Considering the number of machines and the motion 86-90 of the power machines including tractors, combine harvesters, trucks and other selfpropelled machines are operated by the cooperative farms, while 10-14 % by small companies and individuals. The individuals were especially interested in getting tractors and trucks so they own 5-6 %. They type composition of power machines in cooperatives did not change significantly. The separated people in group and economy companies preferred the higher power machines (MTZ-80/82; RÁBA-250; CD-106) while the individuals preferred the smaller ones (MTZ-50; E-512/514). The changes in the use and the ownership of the machines are usually proportional to the motion of the land and the properties. The machine availability characteristic (value and number of machines specific to 100 ha agricultural land) has decreased a little.

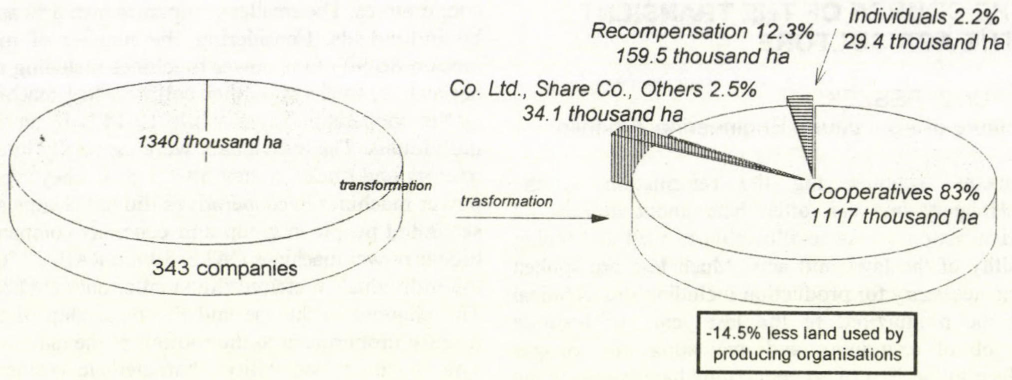
In the newly formed cooperatives and individual farmers has more favourable machine availability but quite worse than that value in the case of similar land area western farms. Perhaps that situation should not be achieved soon.

In the examination program the age of the machines were also recorded. The age of the machines are usually in relation with their performance and wearing out allowing to establish their applicability. It could be recognized that the average age of machines is around ten years. The wearing out degree of machines can be well characterised by the ration of their net and gros values, what is 70 % i.e. they are in last third of their life. The high age of tractors and selfpropelled combine harvesters are especially critical. The same is true for tillage, fertilizer spreader, plant protecting machines and trailers. The driers are also critically aged.

In the course of dividing of the former cooperative machine stock the average ages of the machines are also different. After the transformation the share companies have the lowest average age machines. It is not accidental as they are usually property handling holdings and they retained the better state machines. As light decrease can be also observed in the cooperative machine stocks, too. The other economy companies (co. Ltd, deposit co. etc.) have more aged machines and those of individual farmers are the most aged. This latter can be explained that the separated individuals got the older, smaller value machines as property share. In general, the machines and implements of the agriculture are worn out and overaged and need an urgent renewal. It can cause critical situation in the agricultural production even in the near future. In longer term it is unimaginable that this technical background could serve as basis of European level agriculture. The overaged mechanisation situation of the small scale farms is especially critical, and they should prove their competitiveness just now, in a difficult situation. The situation seems becoming slightly better as the small scale farms are investing in agricultural machines.

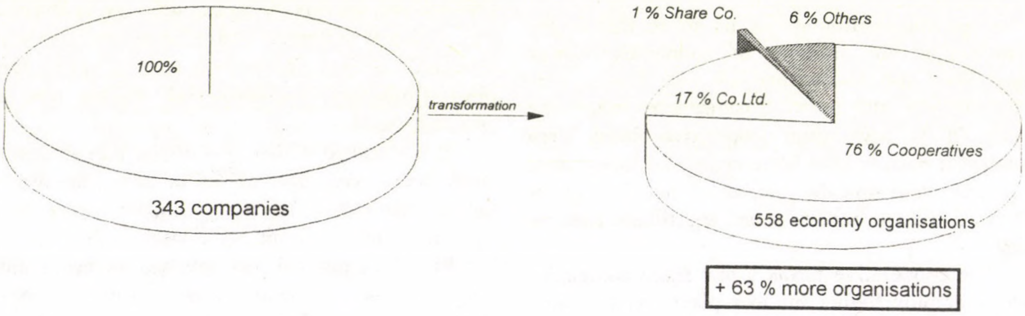
LAND AREA DISTRIBUTION CHANGES IN THE COURSE OF TRANSFORMATION

	Before transformation	After transformation in 1993					Recompensation
	Cooperatives	Cooperative	Co.Ltd.	Share Co.	Other Co.	Individual	
Examined	3,907	2,663	215	1,887	132	4	-
Estimated average area (ha)	3,818	2,602	-	-	-	-	-
Distribution of the land area	100.00 %	83.00 %	1.50 %	0.70 %	0.30 %	2.20 %	12.30 %



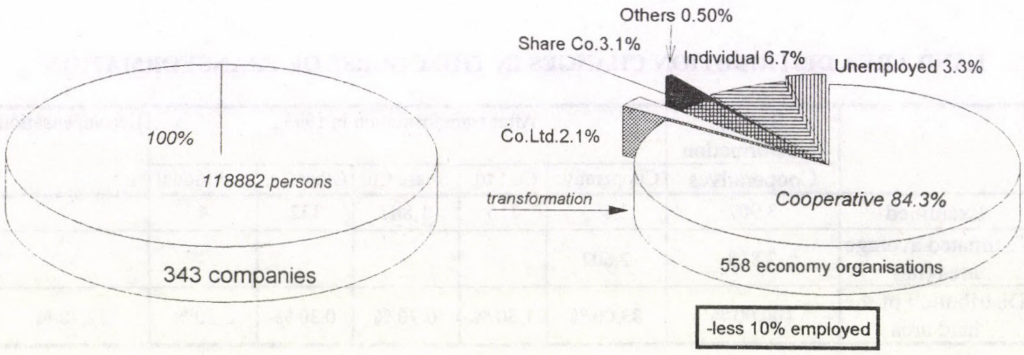
ORGANISATIONAL CHANGES IN THE COURSE OF TRANSFORMATION

	Before transformation	After tranformation in 1993				
	Cooperatives	Cooperative	Co. Ltd.	Share Co.	Other Co.	Individual
Examined (No.)	343	426	96	5	31	7,907
Country estimation	1,348	1,674	377	20	122	31,075
Distribution	100 %	76 %	17 %	1 %	6 %	-

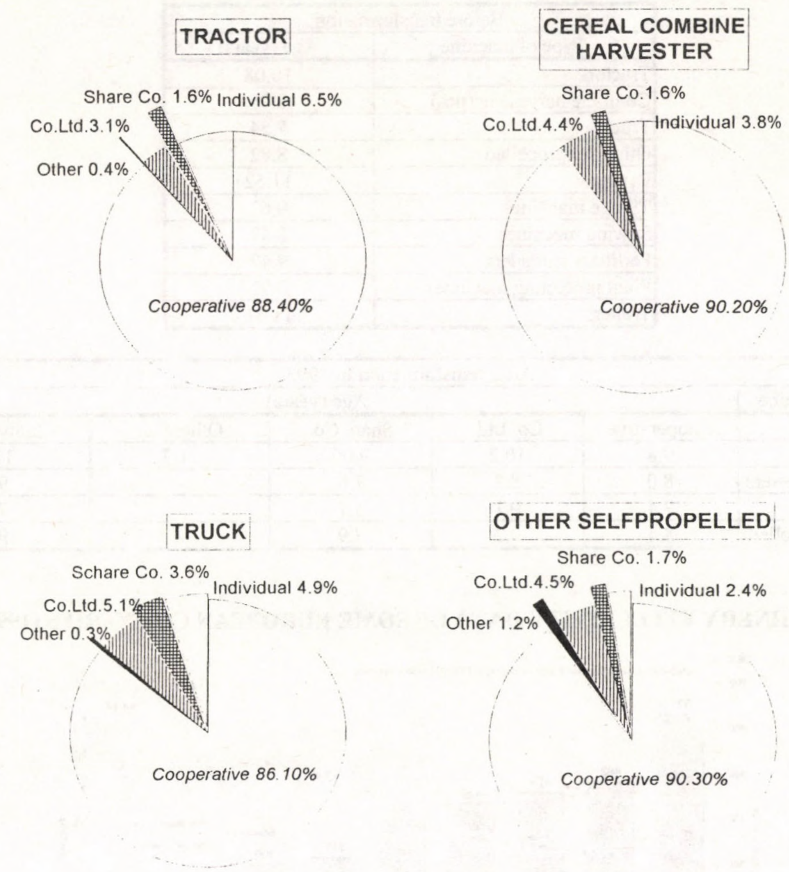


EMPLOYMENT CHANGES IN THE COURSE OF TRANSFORMATION

	Before transformation	After tranformation in 1993					
	Cooperatives	Cooperative	Co. Ltd.	Share Co.	Other Co.	Individual	Unemployed
Examined (persons/co.)	347	235	26	734	18	7,907	3,949
Country (persons/co.)	313	212	-	-	-	-	-
Distribution of employees	100.00 %	84.30 %	2.10 %	3.10 %	0.50 %	6.70 %	3.30 %



CHARACTERISTICS OF MACHINE PROPERTY AND MACHINE APPLICATION AFTER THE TRANSFORMATION (IN 1993)



SOME IMPORTANT FIGURES OF THE DEGREE OF SUPPLY FOR MACHINES

Before transformation		
For 100 ha	Examined	Country average
Value of machinery (thousand Ft)	988	598 (net)
Tractors (pcs)	0.61	0.62
Combine harvesters (pcs)	0.15	0.15
Truck (pcs)	0.26	0.29
Other selfpropelled (pcs)	0.09	0.11

After transformation					
For 100 ha	Cooperative	Co. Ltd.	Share Co.	Others	Individuals
Value of machinery (thousand Ft)	1,074	1,884	4,928	2,576	2,432
Tractors (pcs)	0.60	1.14	1.29	0.42	1.68
Combine harvesters (pcs)	0.15	0.40	0.18	-	0.24
Truck (pcs)	0.25	0.79	1.25	-	0.54
Other selfpropelled (pcs)	0.08	0.23	0.19	0.32	0.09

DATA OF MACHINE SUPPLY IN DEVELOPED EUROPEAN COUNTRIES (1991)

Description	Austria	Belgium	Denmark	France	Greece	Holland	Ireland	Luxemburg	UK	Germany	Italy	Portugal	Spain
Average estate (ha)	14.3	16.7	31	29.2	5.7	16.7	22.7	31.5	69.5	16.9	8.0	8.9	15.3
Tractor density (pcs/100ha)	13.8	8.2	5.8	4.7	2.7	9.1	2.6	7.1	2.8	12.4	7.0	-	-
Combine harvester (pcs/100ha cereal)	2.7	2.0	2.1	1.6	0.65	2.2	1.2	4.6	1.4	2.8	0.7	-	-

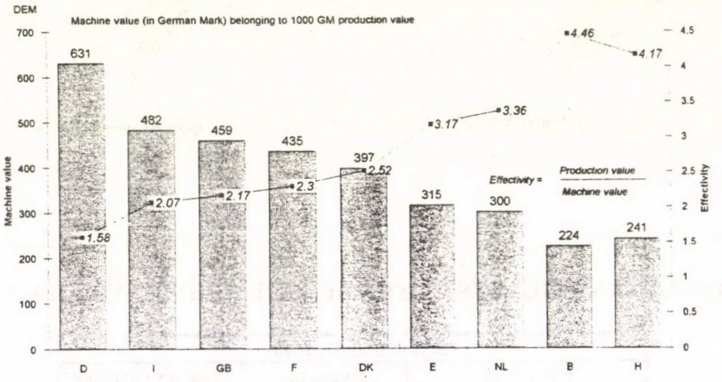
WEARING OUT STATE OF MACHINERY

Average time in usage

Before transformation	
Type of machine	Age (years)
Tractors	10.08
Combine harvesters (pcs)	8.05
Truck	7.54
Other selfpropelled	8.82
Dryers	11.52
Tillage machines	9.67
Sowing machines	8.47
Fertilizer spreaders	9.47
Plant protecting machines	8.97
Trailers	11.41

After transformation in 1993					
Type of machine	Age (years)				
	Cooperative	Co. Ltd.	Share Co.	Other Co.	Individuals
Tractors	9.8	10.2	9.06	11.7	11.6
Combine harvesters	8.0	8.7	7.8	-	9.2
Truck	7.4	9.1	5.7	-	7.5
Other selfpropelled	8.4	9.2	7.9	-	9.5

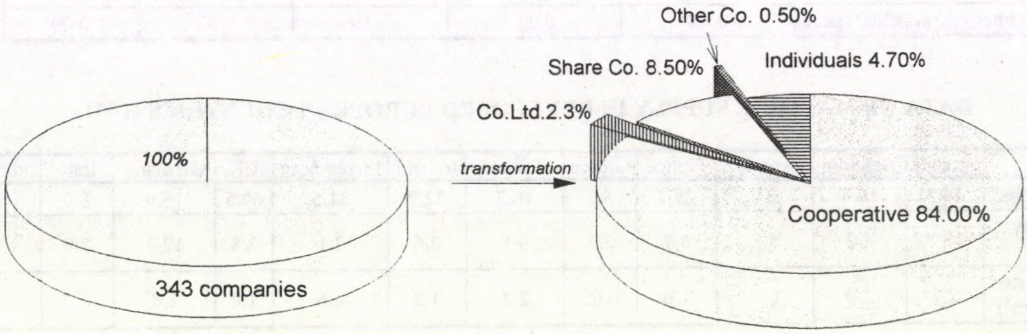
MACHINERY EFFECTIVITY DATA OF SOME EUROPEAN COUNTRIES (1993)



ESTATE DISTRIBUTION AFTER THE TRANSFORMATION

		Before transformation	After transformation in 1993				
		Cooperatives	Cooperative	Co. Ltd.	Share Co.	Other Co.	Individuals
Examined (thousand Ft)	Aver. property	284,600	197,300	24,200	1,702,400	13,200	597
	Machine	*38,600	*28,600	*4,050	*93,000	*3,400	*90
Country estimate (thousand Ft)	Aver. property	217,400	150,713	-	-	-	-
	Machine	22,850	16,930	-	-	-	-
Distribution (%)	Aver. property	100.00 %	84.00 %	2.30 %	8.50 %	0.50 %	4.70 %
	Machine	100.00 %	87.00 %	2.80 %	3.40 %	1.70 %	5.10 %

* = net value by evaluation



ECONOMY AND ENVIRONMENTAL IMPORTANCE OF ALTERNATIVE FUELS

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Due to the increase of the price of the traditional fuels, the supply problems and the higher significance of the environmental conservation – especially in the last 10-15 years – raised the interest in the alternative fuels. A great effort has been paid to their examination and application. As a result a great deal of experience has been accumulated so far. Despite the alternative fuels have not spreaded in a considerable extent, mostly for economy reasons.

A variety of alternative fuels are known. Among them only the PB gas, the compressed natural gas and the esterificated rape oil (RME) can be considered recently. The practical application of them are determined by the amount of tax. (In this country the petrol and diesel oil prices contain 72.2 % and 68.1 % tax, respectively.) The tax was determined by the government such a way which does not make the application impossible, but the spread would not be sudden. If they would be used too extentively, the income of the government budget would decrease significantly, as the production prices of the traditional fuels are the lowest so their tax is the highest.

The economy of alternative fuel application is influenced not only by the price of the fuel but by the additional investments neccesary to the operation. Therefore, for example the PB gas and compressed natural gas application is economical first of all in the case of higher specific fuel use and more significant yearly utilization. In the agricultural operation of diesel power machines neither the PB gas, nor the compressed natural gas can be used effectively, due to the possible tax refund for diesel oil. However the installation of gas containers would cause difficulties. Such a way the RME alone, could become an alternative fule used in greater extent. The calculated price of RME, without tax is between 34 and 87 Ft/l. Thus, even the minimal price is higher than that of the diesel oil after refund. These days, therefore, the reason for applying RME can be environmental.

Several people think that the company pressing and esterification can reduce the RME price, as the proccessing – in their opinion – is cheaper as there is no general cost and tax. This thinking is, however, wrong. The industrial pressing and esterification is usually less expensive than the company one. The general overhead cost will appear anyhow as higher one on the other products if not calculated to the rape. The tax will appear also, if the government will order, because tax must be paid for selfconsumed materials also (e.g. road building and maintenance fund).

The most important environment polluting materials emitted by power machines (vehicles) are the lead, sulphur dioxide, carbon monoxide, hydrocarbon, carbon dioxide and the particle. Diesel operated vehicles emit no lead pollution. The sulphur dioxide emission could be reduced drastically by the application of 0.05-0.01 % sulphur content fuel oil with some surplus cost. The CO and NO_x emission of RME – as an average of a great number of measuring results – is higher. The CH emission is lower while the particle emission is considerably lower than that of fuel oil. The important advantage of RME that it produces no surplus CO_2. The regular inspection of CO, CH, NO_x and CO_2 has not been solved in the case of diesel oil operated power machines. So that RME application can not be reasoned by their reduction. Recently, only particle emission could be the reason for promoting RME application.

The reduce of particle emission can be obtained in several ways. They are as follows:

- reduced operation by improved traffic organisation,
- improving maintainance and reparation level,
- use of additive agents,
- development of traditional fuels,
- mounting catalizers and smoke filters,
- operating engines meeting the new standard presciptions,
- using alternative fuels.

The government tries to achieve reducing environmental pollution by conviction, subsidisation, and force. Since the government budget has a considerable income from tax of traditional fuels, it favours rather the catalizers, the engines meeting the new standards and controls the particle emission of operating vehicles by environment protectional inspection.

To comply with the allowed particle emission of diesel operated vehicles is the duty of the operator. The particle emission can be reduced by using catalizers and smoke filters, engines meeting the new standards or by alternative fuels, if the normal maintenance and repair were nat be enough. According to the calculations the most economical way of particle emission reduction is the application of the vehicles meeting the new standards. They can be such kind of new or renewed vehicles. Some less economical the catalizer and smoke filter application, while RME application is the least economical.

As a result of the work it can be stated that considering the present prices, costs and tax system, etc., application of RME can not be favourized either economical or environment protectional reasons. To introduce RME into application it is necessary

- to modify the tax and subsidisation system of fuels,
- to determine allowed values of and measures against CO_2 pollution,
- to reduce the production cost of RME or to produce cheaper biofuel. The cost reduction can be solved by
  - an increase of production yield (from the present 1.5 ton/ha to 3.0 ton/ha),
  - a significant reduce in the specific cost rape production,
  - reducing rape processing cost including that of pressing, esterification, transport and storage or using cheap additive agent instead of esterification.

It can be concluded from the calculations that agricultural fields and workpower can be utilised more economically by bioheat producing plants (e.g. energy forest) than by rape, rape oil production.

PROBLEMS AND POSSIBILITIES OF MACHINERY DEVELOPMENT IN THE MIRROR OF LISA-PHILOSOPHY

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Introduction

The social and economic transformation which took place in Hungary in the last years has basically changed the earlier formed structure of agriculture. We do think that it will take a longer period of time to stabilize the conditions in agriculture again. We are in a period of transition when the old way of thinking has been not any more and the new one not yet really useful to develop the Hungarian agriculture.

Because of the large number of uncertainties besides the „great" conceptions of development it would be useful to think over how to develop the different partial areas. It is clear that we have to think about the development of agricultural production technologies besides the developing conception of the whole agricultural policy. It seems to be sure that the new private farms comparing to the co-operative ones will work on a different technological base. That's why it is important to take into consideration the new efforts besides the classical principles of production development. We have to lay stress on the machinery development as the subsystem of the production development because the efficiency and profitability of agricultural production basically depend on machinery.

Our paper deals with the LISA-philosophy and with the possibilities and problems of machinery development. LISA is one of the up-to-date tendencies of production development which was started in the USA in the last decade.

The main points of LISA-philosophy

LISA (Low Input / Sustainable Agriculture) was designed in the USA to help farmers reducing their inputs and to use partly or totally on-farm resources instead of purchased inputs. The goal is to deliver the scientific information to a wide range of farmers to improve profitability and to take natural and environmental aspects into consideration.

LISA includes :

- developing crop-rotation making the most of its potential possibilities,
- crop and livestock diversification,
- soil- and water conserving practices,
- developing mechanical cultivation and
- the different methods of biological pest controls.

The final goal of the complex efforts is to improve profitability while conserving natural resources and environment.

LISA program was started in 1985 and was subsidized in 1988 when the Congress of USA first appropriated $ 3.9 million for program research and education.

Many universities, research institues, farms and other organizations were joined to the program.

What can be important for us from LISA ?

The research work continued on the Department of Engineering Economics of Gödöllô University of Agricultural Sciences has determined three basic tendencies of the Hungarian production technologies development.

They are as follows :

- the continuation of the classical large scale farm approach, which emphasizes the increase of yields,
- the expansion of organic or bio-farming on the principle of total chemical free production, which emphasizes the natural and environmental aspects,
- the LISA-philosophy which emphasizes the profitability while totally mobilizing the on farm resources and protecting environment.

We have no reason to reconsider our earlier point of view. We do think that LISA gives a suitable base and can help us, Hungarians to determine the new way of development of our agriculture.

Why do we state this? First of all because there are several areas worked up and re-explained in LISA and most of them practically influence the short- and long-term development of agriculture.

We do believe that all the constructive elements of LISA have the reason for the existence in Hungary and Hungarian experts are able to systematize the knowledges and to work constructively on the base of it.

At the same time we consider that in the present situation of our agriculture these possibilities of development have to be taken into consideration.

Some accurate elements of the situation of the agricultural mechanization

Most of the Hungarian agricultural enterprises (all kinds of them) have serious problems on the field of mechanization. The difficulties have started in the 1980s when the earlier possibilities of development were narrowed and the machinery investments slowed down. As a consequence of it after several decades the balance of machinery investments and replacements tipped over at the enterprises.

The rate of depreciated but used means and their time of life increased nearly on all areas. (See: Table 1.)

Some other problems:

- the technically obsolete and used machines injure the environment very much,
- the maintaining and repairing basis were partly disintegrated and the remained part can hardly keep up with the wearing out of machines,
- the lack of infrastructure and the condition of the available one – e.g. the poor quality of agricultural roads – influences the technical state of the too heavy machines and at the same time increases the costs of repair and causes considerable losses at the transported products.

As other conditions were getting worse and because of the above mentioned facts the expected economic advantages of mechanisation were not realized efficiently. The lack of capital and the uncertainty of transformation worsened the problems. It wasn't really difficult to forecast the present situation of the Hungarian agriculture: one of the main limits of the international competitiveness is the stock of obsolete means. If our national economy wants to get a similar performance from agriculture in the future – as we used to it in the last decades – our agriculture would badly need a well planned course of development injections. The messages of LISA-philosophy have to be taken into consideration in this conception avoiding such a mechanisation which can be itself the limit of rational economic development in the future.

Nowadays several agricultural research teams deal with the questions of machinery development in Hungary. Most of the results fit the LISA-philosophy.

Some of the aspects which can motivate machinery development on the base of LISA-philosophy:

- protecting environment and nature, stressed the problems of soil conservation,
- energy-saving,
- enforcing rational aspects of ergonomy,
- machines usable for more aims to decrease the number of operations and to combine them rationally,
- developing machines which fit to the new technological solutions and provide cheap and energy-saving work.

We do think that the most important aspects of the above mentioned ones are the mechanisation of soil conservation, plant protection and the new technological methods. Decreasing the mass of agricultural machines and improving their safety of operation would mean general advantages.

Table 1.
Stock of main prime movers and machines (in economic organizations)
Source: Statistical Yearbook of Hungary, 1992.

		1980	1990*	1991	1992*
Tractor, number		55,452	49,400	44,840	40,300
of which:	21-40 kW	28,885	13,300	11,268	10,150
	41-75 kW	17,792	24,500	22,617	20,500
	76-110 kW	2,547	2,800	2,663	2,300
	111-150 kW	2,781	3,800	3,538	3,100
	over 150 kW	2,154	3,600	3,512	3,200
Engine capacity of tractors, 1,000 kW		3,031	3,370	3,107	2,791
of which:	21-40 kW	1,065	529	439	395
	41-75 kW	1,009	1,423	1,304	1,182
	76-110 kW	216	260	249	215
	111-150 kW	341	483	451	395
	over 150 kW	380	663	647	590
Truck, number:		28,704	32,000	24,293	23,600
Harvesters for cereals, number:		14,071	10,000	9,834	9,100
Engine capacity of mechanical traction power, 1,000 kW:		7,461	8,300	7,401	6,739
kW/1000 ha of agricultural area:		1,133	1,291	1,153	1,106
Distribution of mechanical traction power, %:					
	Tractor:	40.6	40.6	42.0	41.4
	Truck:	31.7	30.8	26.4	28.2
	Harvesters for cereals:	17.5	16.3	17.3	17.6

* Estimated data

REDUCTION OF THE NITROGEN AND PHOSPHORUS CONTENT IN LIQUID MANURE BY SEPARATION

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Problems and Aims

The sum of liquid manure (slurry sludge) being yearly produced in Germany amounts to just under 200 million tons. The nutrients of this manure could be profitably used as fertilizer on the whole agricultural acreage. Often however, these nutrients mean a load or even a danger for the groundwater and the atmosphere, since they are not available where and when they are needed. This factor can be avoided by applying a special treatment improving storability and handling and increasing its transportability.

The mechanical separation into a liquid and a solid phase turned out to be a first simple but very effective step. By this means an essential portion especially of the problematic nutrients nitrogen and phosphate can be divided out of the liquid manure. The application of the individual phases can be carried out more specifically. Furthermore a more extensive treatment is possible e.g. according to Fig.1. Laboratory experiments applying different methods like sedimentation, filtration, and pressing of liquid manure of pigs and cattle were not very promising. So marketable separators specifically developed for liquid manure were systematically investigated with regard to their applicability and separation efficiency.

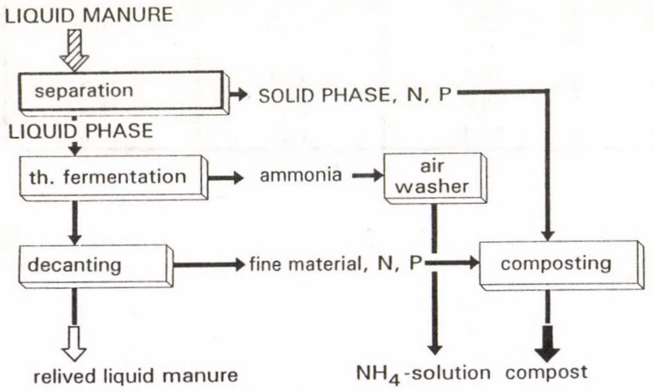

FIGURE 1.
Treatment of liquid manure – diagram of the FAL-process

Separators

Two physical differences, form and volumetric mass, are especially suitable as criteria to separate solid particles from this mixed substrate raw liquid manure:

I. By the difference of the geometric shape (size – *sieving, filtering, pressing*) the following devices separate: vibrating filter, arched filter as well as continuous pressure filter,

– press-drum separator, Fig.2., and
– press-screw separator, Fig.3.

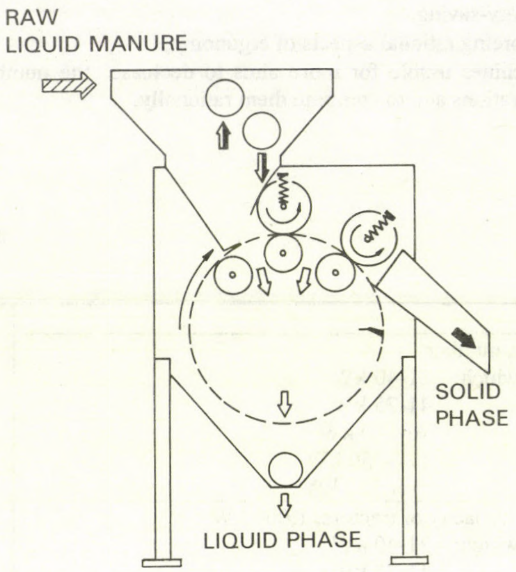

FIGURE 2.
Press-drum separator

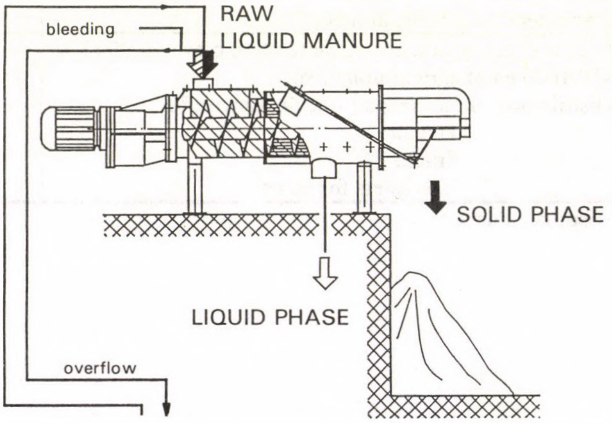

FIGURE 3.
Press-screw separator

II. The difference of the volumetric mass of the single particles (sedimentation and flotation, centrifuging or decanting) use some centrifuges and separators like the – decanting centrifuge, Fig.4.

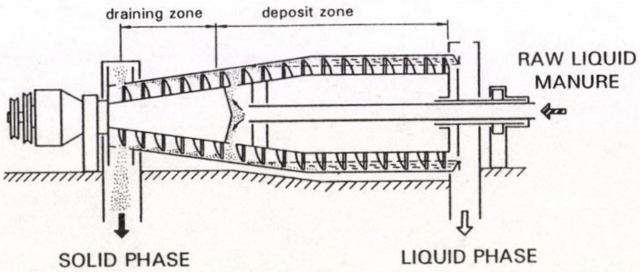

FIGURE 4.
Decanting centrifuge

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The above investigations have been effected at the local Institute of Technology within the scope of the research R&D-project „Semitechnical investigations for nutrient recovery and utilization of liquid manure by aerobic-thermophil treatment" (Cooperators: F. Schuchardt, H. Sonnenberg, J. Hahne and J. Janssen).

The above mentioned three devices were chosen for the investigations and were applied for raw liquid manure of pigs and cattle. The following determinations have been carried out: the mass portions to devide up the raw substrate, the contents respectively concentrations [% resp. g/kg] and thus achievably separated portions of the compounds (dry matter, organic dry matter, phosphate and nitrogen compounds), the pH value, the energy consumption, the function, safety in operation and handling as well as the general suitability for different substrates in practical operation.

Experiments

Practical experiments were effected at the research centre and in a large-scale plant out-of-town. The composition of the mixed liquid manure was approximately constant due to a collecting tank filled by several suppliers.

Results

N- and P-elimination

The separators working according to particle shape show a strong dependence on the diameter of strainer holes. The portions of some constituents divided out with the solid phase as well as the constituent amount are shown in Fig.5. A decreasing diameter of strainer holes increases the elimination of nitrogen (total N) and phosphate (PO_4-P), and also a larger portion of dry matter. But in the same way, the amount of the totally separated solid phase also increases. This means a decreasing diameter of the strainer holes increases the water content of the solid phase and lowers the dry matter content.

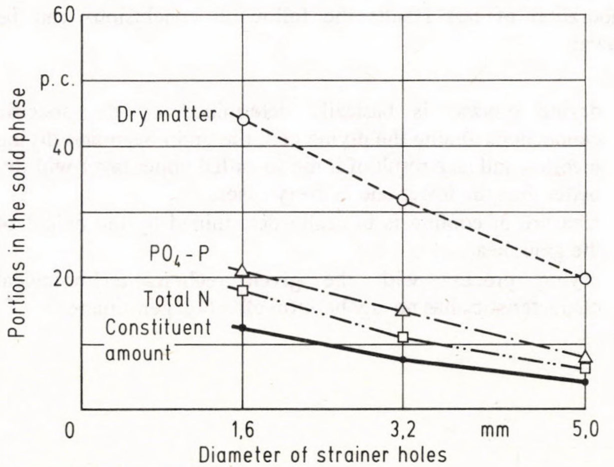

FIGURE 5.
Portions of contents in the solid phase, related to raw liquid manure (cattle) after separation by a press-drum separator

In comparable experiments with liquid manure of pigs and cattle regarding the nitrogen and phosphate relief of raw liquid manure, average values [p.c.], as shown in Fig.6., could be determined. In doing so a sufficiently high amount of dry matter for the respective solid phase was considered in order to keep its suitability for composting.

- A higher degree of separation can be achieved with a pasty or wet solid phase.
- Here the mass distribution solid: liquid amounted to ≈ (8-17) : (92-83). The pH-value was about 8.5 : 7.5.

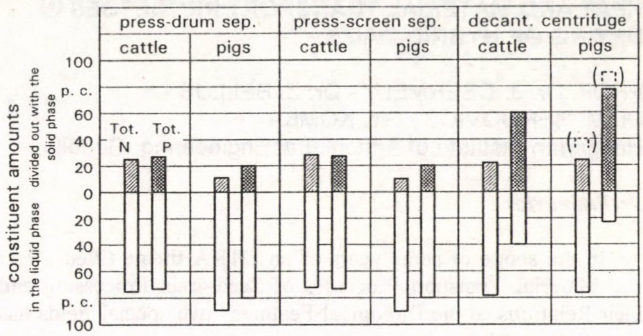

FIGURE 6.
Constituent amounts in p.c. of Nitrogen and Phosphate, divided out with the solid phase (cattle and pigs), when the solid phase is still dry enough for beeing composted.

Separators:
- Press-drum separator (SŰDTECH, hole-diameter = 3.2 mm),
- Press-screw separator (FAN, slit = 0.75 mm),
- Decanting centrifuge (WESTFALIA-SEPARATOR).

Dry matter content of liquid manure = 8 (6 to 9) % (cattle),
= 6 (4 to 7) % (pig).

Flow rates

For the preceding investigations, the through puts of raw liquid manure of the press-drum separator, the press-screw separator resp. decanting centrifuge amounted for cattle/pigs to mean values of

6.1/13.2, 6.7/10.2 resp. 0.6/1.6 m^3/h.

Energy consumption

According to the above investigations, the energy consumption regarding raw liquid manure amounts to

0.32/0.08, 0.31/0.18 resp. 5.00/4.70 kWh/m^3.

So the nearly equivalent press separators turn out to be energetically favoured as against the centrifuge.

Resume

The nutrients of the nearly 200 million tons of liquid manure (slurry sludge) being yearly produced in Germany could be profitably used as fertilizer on the agricultural acreage, if they were available in case of need on the right place at the right time, and all that without any burden of nitrate and danger for the groundwater and the atmosphere. These problems can be solved by a special treatment, eliminating the problematic nutrients nitrogen and phosphate from the liquid manure, improving the storability and handling and increasing the value for transportation.

The first and often already sufficient step is the mechanical separation into a liquid and a solid phase using marketable separators. Preserving the composting ability of the solid phase 24 p. c. of the nitrogen and 77 p. c. of the phosphate can be eliminated by a decanting centrifuge.

- 40 p.c. resp. 90 p.c. have been achieved by help of flocculation additives.
- Press-drum separators and press-screw separators attain a relief of about 28 p.c..

Thus, the simple mechanical separation can alredy be the answer to the problems of many farmers.

HEAT AND MATERIAL TRANSPORT PROCESSES IN DRYING OF HYBRID MAIZE

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Dr. M. HERDOVICS - GY. KOMKA
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Preliminaries

In the scope of some years of an OTKA theme titled „Heat and Material Transport Processes of Seed-grain Processing and their Relations to the Biological Features" two special fields has been elaborated.

Results of seed-pea drying in work conditions can be found in Hungarian Agricultural Engineering No 6/1993. In this Report the drying process was analysed in different heights along the radius of the tower. After this examinations a drying process of hybrid maize, by the help of a chamber type drier utilizing of primer and secunder drying air, was elaborated and evaluated in 1992. Results of this latest test is publishing as follows.

Method and circumstances of the elaboration

Drying test of hybrid maize was carried out at the seed processing plant of the district of Szenttamás of the Törökszentmiklós State Farm.

Material features during loading and unloading (W_o, t_o, φ_o), material and air technical features of the drying process ($W_{1,6,7,8}$, $t_{1,6,7,8}$) as well as heat technical ones (t_k, φ_4, $t_{1\text{-}5}$, $\varphi_{4\text{-}5,9}$) in primer and secunder running method were determined.

Measurings of moisture content were comprised grain, maize-ear, and maize-cob alike.

Location of sensors and samples of the chamber-type drier can be seen on Fig.1. Method of germination tests were elaborated parallel by the Institute for Agricultural Qualifying (MMI). Budapest and the Faculty of Genetic and Plant Improvement of the University of Agricultural Sciences, Gödöllő (GATE).

Elaboration of the gained data was carried out by the help of the method of function approaching.

Results and conclusions

In the course of the drying process of hybrid maize in chamber-type drier, 60 m^3 of maize-ear with a 36.0 % of average moisture content were dried. Dewatering took place under primer and secunder operative conditions of the upper and lower layers of the grain heap.

Characteristics of the primer drying air were 46.5 °C temperature and 12.5 % relative humidity while of the secunder one 38.5 °C temperature and 30.0 % relative humidity. The drying process was followed by shelling then 55 hours later the heap of corn was cooled from 33.5 °C and 11.5 % moisture content down to 16.0 °C temperature.

Typical reduction of moisture content in the lower layer measured in the sampling points of the chamber can be seen on Fig.2. while the changing of drying speed in the same places on Fig.3.

Drying processes related to cob, maize-ear and grain of maize are separately described plot against the running method by using of exponential equations.

As for dewatering beside 60/40 % ratio of primer/secunder running process there are no meaningful difference among the curves of the cob, maize-ear and grain of maize. It also can be observed that the drying intensity of the upper layer was higher than the lower one and the upper grain layer was also characterized by a lower final moisture content. Handling of grain maize after drying and shelling was carried out by using of a cooler type GRANIFRIGOR KK-70.

Cooling zones formed by the effect of the handling on a given level are shown on Fig.4.

As it can be seen on the figure, intensity and the speed of cooling in the measuring places and levels at lower heights of the heap were higher than in other points of the heap. The 15 °C nominal cooling temperature was measured on about the third day at the highest measuring points that were previously decided.

On the basis of years of research, development and elaboration of test results the following conclusions can be drawn:

- drying process is basically determined by the specific connections among the drying cell, the grain-heap and drying medium and as a result of it the so called upper layer will dry better than the lower one in every cases,
- measure of cooling is basically determined by the height of the grain heap,
- drying process with the given technical-technological characteristics has no any harmful effect on germination.

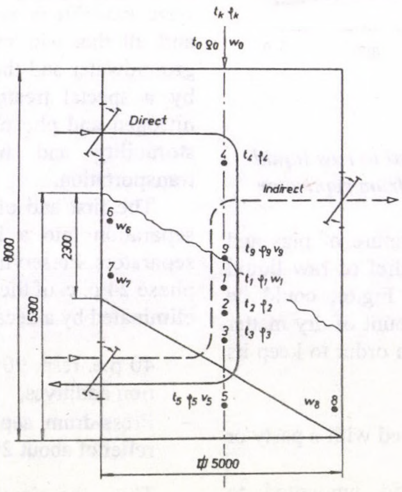

FIGURE 1.
Location of sensors and sampling points

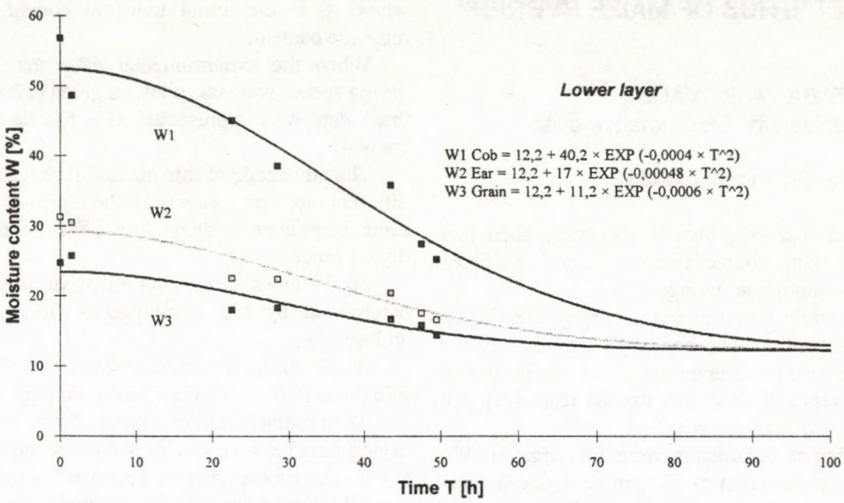

FIGURE 2.
Drying process (Hybrid maize, Törökszentmiklós, 1992.)

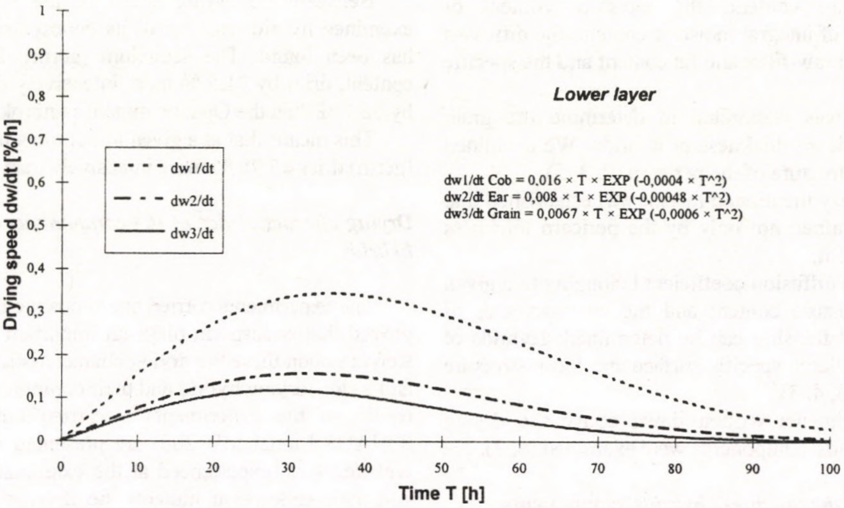

FIGURE 3.
Drying speed (Hybrid maize, Törökszentmiklós, 1992.)

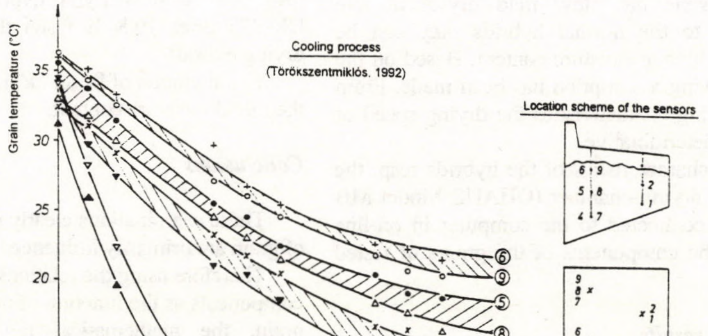

FIGURE 4.
Cooling process (Törökszentmiklós, 1992.)

DRYING CHARACTERISTICS OF MAIZE HYBRIDS' COMPONENTS

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As a result of several-year-long tests it was established that maize hybrids of different characteristics show significant differences in energy consumption at drying.

These differences at certain initial moisture content can run up to 50-60 %. These differences exist in laboratory conditions. At the same time, in accordance with the literature and our examinations, energy consumption difference at very slow drying, resp. very fast drying hybrids can be over 20 % in practice.

During our tests different parameters were investigated. We wanted to know which characteristics determine basically the mass- and heat transports in grain examining firstly the changes of material characteristics at artificial drying.

On the basis of our examinations the followings were described: the water diffusion coefficient as a function of temperature and moisture content; the moisture content of components as a function of integral moisture content; the diffusion coefficient as a function of raw-fibre and fat content and the specific surface.

Calculation method was elaborated to determine the grain surface area resp. the pericarp thickness of hybrids. We examined the permeability and the structure of the pericarp (2, 3, 5).

Based on the previously mentioned facts it was established that moisture release is determined not only by the pericarp thickness but also by the structure of it.

Between the moisture diffusion coefficient belonging to a given temperature and the moisture content and the characteristics of hybrids, the following relationship can be determined: Hybrids of low fat and fibre content, large specific surface and loose structure of pericarp dry fast (1, 2, 3, 4, 5).

Following the experiments written down above the drying characteristics of the hybrids' components were examined (6, 7).

Drying characteristics of the opaque-2 hybrids' components

Matter and method

Based on literature as well as on our experiences hybrids containing the Opaque-2 gene has slow field dry-down rate therefore, comparing them to the normal hybrids they can be harvested later, resp, with a higher moisture content. Based on the previously written the following assumption has been made. From the point of view of the drying characteristics the drying speed of the constituents is basically determinative.

To examine the drying characteristics of the hybrids resp. the components of the hybrid a drying-chamber (OHAUS Model MB 200) was used that can be connected to the computer in on-line system. Before measuring the components of the grains of tested hybrids were separated.

Evaluation of the measuring results

The moisture release can be approximated by the following function

$$\frac{X - X_e}{X_i - X_e} = e^{k \cdot \tau}$$

* Presented at the 9th International Drying Symposium (IDS'94) Gold Coast, Australia, August 1-4, 1994.

where X_i is the initial moisture conent, X_e is the equilibrium moisture content.

When the expermimental data were evaluated the average drying speeds were taken after a given (120 min.) drying period and these data were represented as a function of the initial moisture content.

The adventage of this method is that the drying processes with different moisture contents can be represented resp. compared in the same coordinate system. Any point of the lines represents one drying process.

Fig.1. shows clearly that intensive drying of Opaque hybrids is determined by the adventageous drying characteristics of the endosperm.

Based on the functions of Fig.1. the given drying curve to any initial moisture content can be drown resp. defined (Fig.2.).

At an initial moisture content of $X = 35$ %, the divergence of the drying time between the given hybrid and the endosperm mutant is 9.1 %. The endosperm of the normal hybrid dries 49.7 % faster than the unbroken grains. This rate between the unbroken grain and the endospermium of O_2 hybrid is 56.4 %.

The endosperm of the O_2 mutant dries 21.2 % faster than that of the normal one.

Between the drying speed of the scutellum (germ) of the examined hybrid and that of its endosperm mutant no divergence has been found. The scutellum (germ), in spite of its high fat content, dries by 71.5 % more intensively than the unbroken grain; by 68.7 % than the Opaque mutant's unbroken grain.

This means that at a given initial moisture content the scutellum (germ) dries 65-70 % more intensively than the unbroken grain.

Drying characteristics of the components of fast and slow drying hybrids

The experiments carried out in opaque endosperm mutants have proved that endosperm plays an important role at artificial drying. Relying upon these the drying characteristics of a fast drying hybrid and a slow drying hybrid and their components were examined. The results of the experiments – carried out in a drying-chamber (OHAUS Model MB 200) are presented in Fig.3. In compliance with the facts experienced at the examinations of normal hybrids and their endosperm mutants, no divergence has been perceived between the drying of scutella (germs). However, between the drying speed of endosperms the divergence has been 20.2 %. At the same time the divergence between the drying speed of the endosperm and the scutellum (germ) is 39.8 % (fast drying hybrid) resp. 52.0 % (slow drying hybrid). The unbroken grain of hybrid DK-323 dries 19.8 % faster than that of hybrid DK-300 (slow drying hybrid).

The alteration of factor „k" is shown in Figure 4 as a function of the initial moisture content.

Conclusions

These examinations clearly prove that the drying characteristics of grain are primarily influenced by the endosperm.

Therefore using the relations which give the moisture content of components as the function of the moisture content of the unbroken grain, the mathematical models describing the changes of characteristics (e.g. mass transports) in the grains can be controlled.

In connection with the investigations the function $k = f(X_i,T)$ and by this the drying functions of the unbroken grains and their components can be defined as well.

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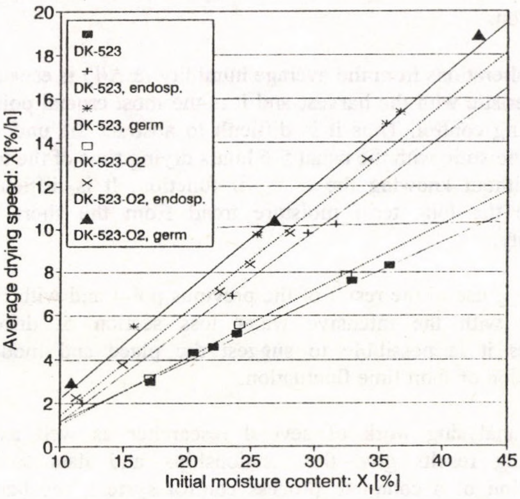

FIGURE 1.

Average drying speed of kernels and their constituents of tested norma (DK-523) hybrid and its Opaque 2 (DK-523-0₂) mutant as a function of the initial moisture content (Drying temperature: 70 °C, drying time: 120 min.)

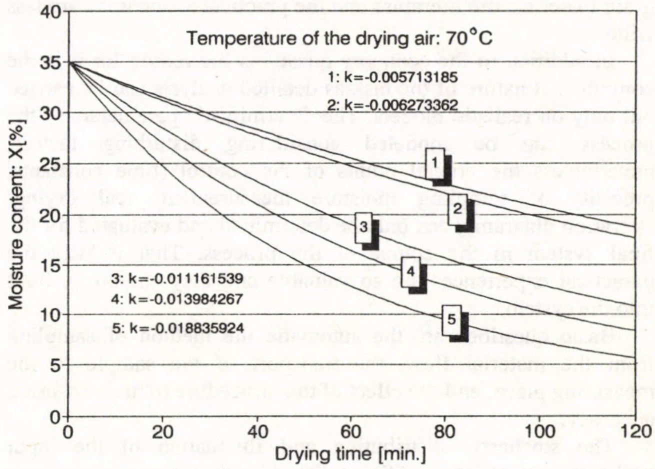

FIGURE 2.

Drying curves of kernels and their constituents of DK-523 hybrid and its endosperm mutant

(1- DK-523 unbroken grain; 2 - DK-523-O_2 unbroken grain; 3 - DK-523 endospermium; 4 - DK-523-O_2 endospermium; 5 - DK-523 and DK-523-O_2 scutellum (germ)

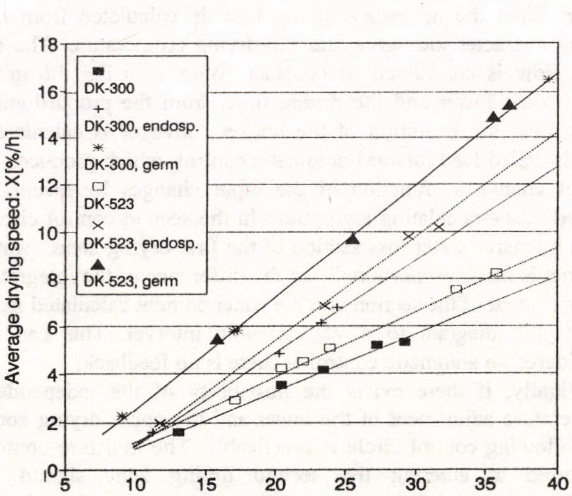

FIGURE 3.

Average drying speed of kernels and their constituents of a fast and slow-drying hybrids (DK-523 and DK-300) as a function of the initial moisture content (Drying air temperature: 70 °C, drying period: 120 minutes)

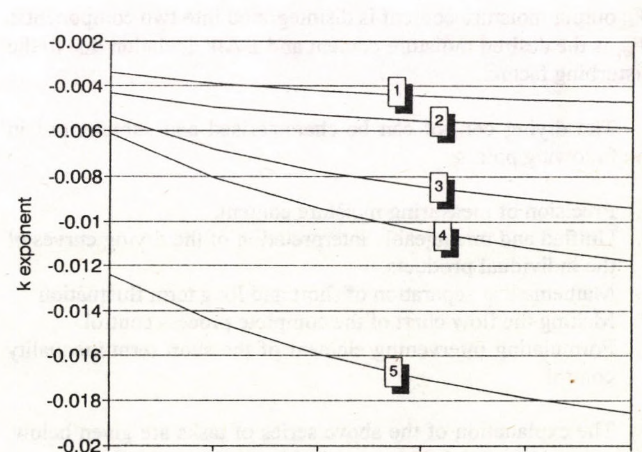

FIGURE 4.

K exponent of exponential equations describing drying curves of kernels an their constituents of a fast and a slow-drying hybrids as a function of the initial moisture content

QUESTIONS OF CORN DRYING DYNAMICS WITH TOWER DRIERS

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The literature of drying is rich and wide, especially in the case of different disciplines. Methods of moisture measurements, modeling drying, quantitative analysis of drying properties of produces, the comparison of the measurement and model samples are deeply elaborated.

Concerning quality questions of process control of drying grain materials the literature and the practical adaptations are less wide.

In addition to the economy questions the reason for it is the complicated nature of the task as detailed analysis can be carried out only on realistic models. The deterministic parameters of the process can be modeled considering disturbing factors, nevertheless the crucial points of the control (time constants, precisity of sampling moisture measurement, real drying/ operation diagrams) can only be determined and evaluated for the final system in the course of the process. That is why the paractical experiences are so valuable and they should be built into the system.

Basic questions are the automatic the method of sampling from the material flow, the transport of the sample to the measuring place, end the effect of this procedure to the measuring accuracy.

The stochastic distribution and fluctuation of the input moisture content is a significant disturbing factor.

Considering above mentioned facts it is resonable to examine the quality parameters of the drying control in an analysing and synthetising work.

$$W_{ki} = W_{kiv} \pm \Delta W$$

where:

W_{ki} output moisture content is disintegrated into two components: W_{kiv} is the desired moisture content and $\pm \Delta W$ deviation due to the disturbing factors.

The drying control can be characterised and summarised in the following points:

1. Precision of measuring moisture content.
2. Unified and manageable interpretation of the drying curves of the individual products.
3. Mathematical separation of short and long term fluctuation
4. Making the flow chart of the complete process control.
5. Formulating intervening element of the short term inequality control.

The explanation of the above series of tasks are given below, through the unsolved problems resulting a value of ΔW.

1. The preciseness of humidity measuring instruments built into the technology process and using the principle of dielectrical property evaluation of sample. The origin of the inaccuracy is rather the physical parameters of the material in the sampling space than the long and short term instability of the electronic devices. Such physical parameters are the alterations in the spherical shape, sample density, quickness of the sample getting the measurement space, the effect of the temperature on the dielectric property. Further disturbing factors are the pollution, ripeness and the species of the material during sampling. Their complex resultant is the actual moisture measurement error.

2. The other deterministic error source is the lack of the drying characteristic curves which are manageable and algorythmizable unified. Well known that the moisture loss process of grain materials is initially linear then exponential with different exponent multipliers correlating closely to the water binding modes. The figures of them for different produces as nuclear physical haracteristics are missing. These data are inevitable to determine time constants of the controland to the energetic evaluation.

3. The alterations from the average humidity *($\pm \Delta W$)* is especially characteristic with the harvest and it is the most crucial point of the drying control. Thus it is difficult to abstract the undesired excess moisture with the usual 5-6 hours drying time of the tower drier without knowing the $w = f(t)$ function. It is difficult to separate the long term moisture trend from the short term inequality.

4. Making use of the result of the previous point and with being familiar with the intensive water loss section of different produces it is possibble to suggest the place and mode of elimination of short time fluctuation.

5. The analysing work of several researcher as well as the measuring results give the relationships and data for the elaboration of a complete process control system, the hardver scheme fitting the technology processes and the system specifications.

On the basis of the technology flow chart (Fig.1.) the control algorythm can be proposed as given below. The average values of the input moisture content *(w_{be})* of the preheated grain flow and the output moisture content *(w_{ki})* are produced for the whole tower. Then the necessary drying time is calculated from the drying characteristic curve and the drying temperature. The air mass flow is considered as constant. With knowing the grain mass in the tower and the drying time, from the proportioning mass flow the revolution of the bucket conveyor is calculated. This is called feed forward automatic control, which produces an output change as function of the input changes by means of shifted mean calculating algorythm. In the second control circle, in an intensive water loss section of the first drying zone, water abstract is made proportionally to the difference of the integrated water content of the section and the water content calculated from the drying diagram to a v_{max} sizeable interval. This can be considered an automatic control as there is no feedback.

Finally, if there exists the possibility of the independent temperature adjustment of the lower and the upper drying zone, the following control circle is practicable. The moisture content measured at entering the second drying zone should be considered as an input parameter of the other controlled section with restriction that the proportioning revolution can not be changed. The temperature of the second zone in relation to difference of the desired and the measured moisture content will be the intervening target.

The effect of the interveners as a function of time is shown in Fig.2.

The hardware scheme of the process control is shown in Fig.3.

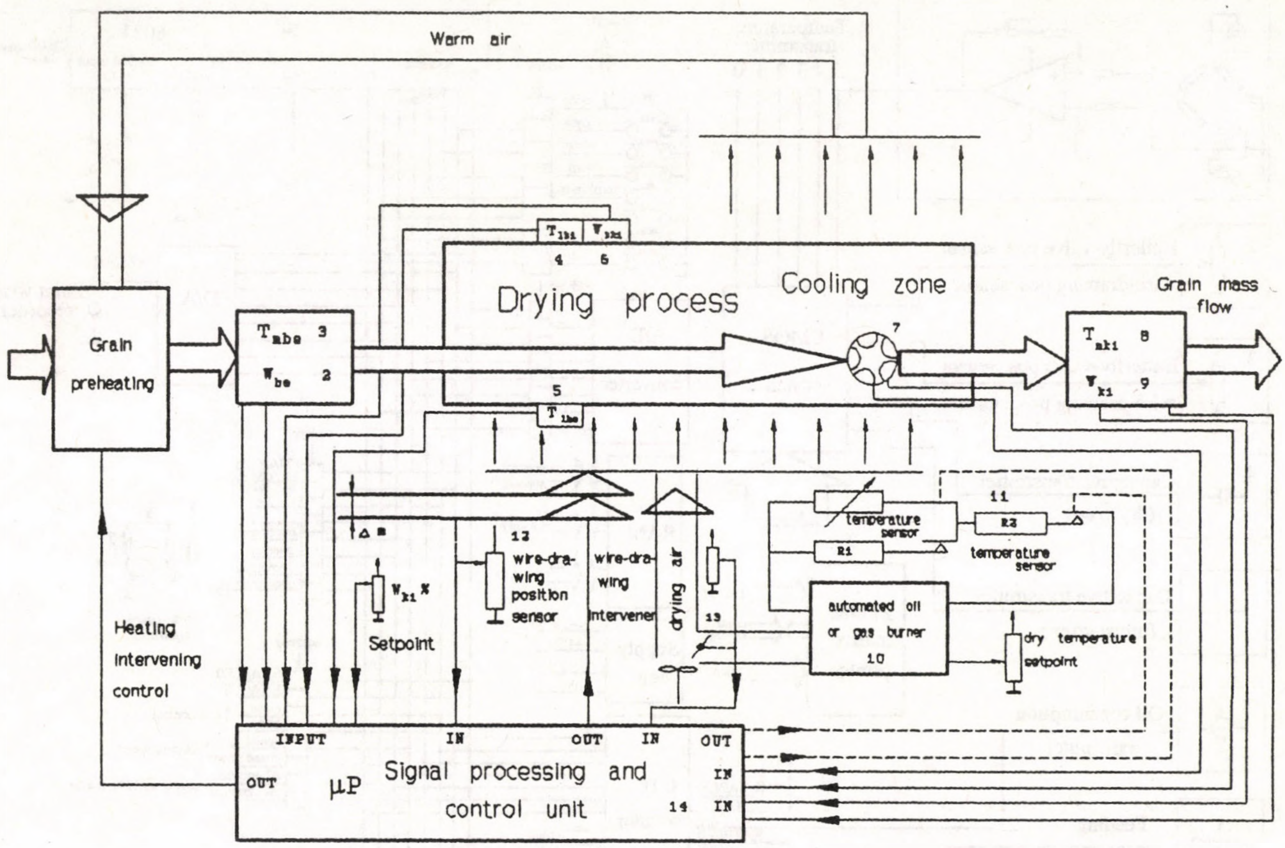

FIGURE 1.

Technology flow chart of produce drying

1 - Grain preheating unit; 2 - w_{be} input moisture sensor transmitter; 3 - T_{Mbe} input grain temperature sensor; 4 - T_{Lki} output air temperature sensor; 5 - T_{Lbe} input drying air temperature transmitter; 6 - In-process moisture measurement, w_{ki}; 7 - $T'av_5$ Bucket conveyor revolution transmitter; 7.a. - Feader intervening; 8 - T_{Mki} output grain temp. transmitter; 9 - w_{ki} output dried material moisture sensor transmitter; 10 - Oil burning control unit; 11 - T drying air temperature correction in the lower zone; 12 - L_f drying air wire-drawing intervener; 13 - Ventilator unit; 14 - μP unit with I/O perpherials (PIO, SIO, CTC); 15 - R_{pill} butterfly-valve position potentiometer

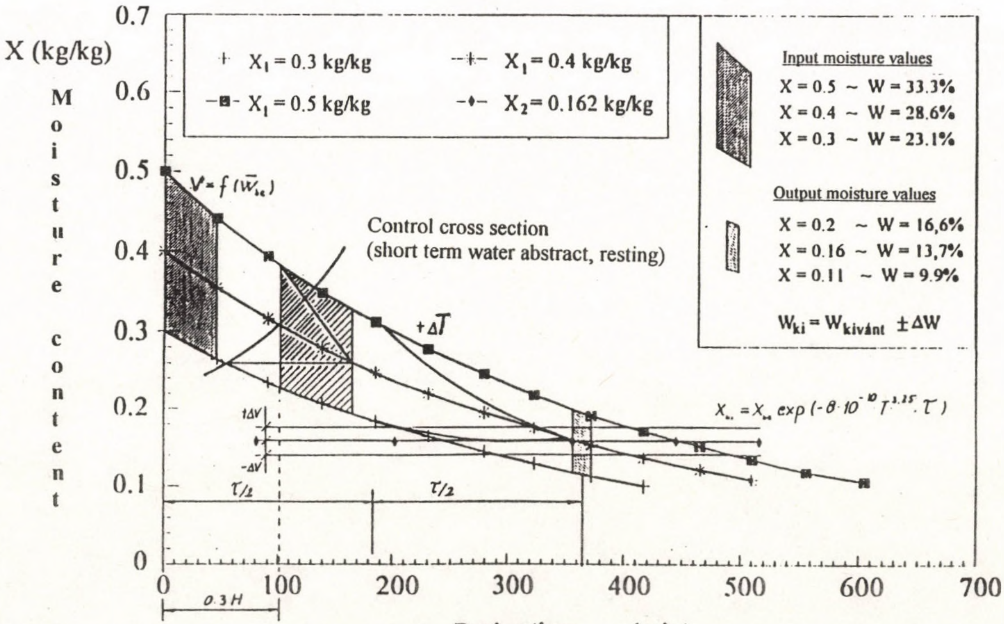

FIGURE 2.

Effect of interveners versus time diagram

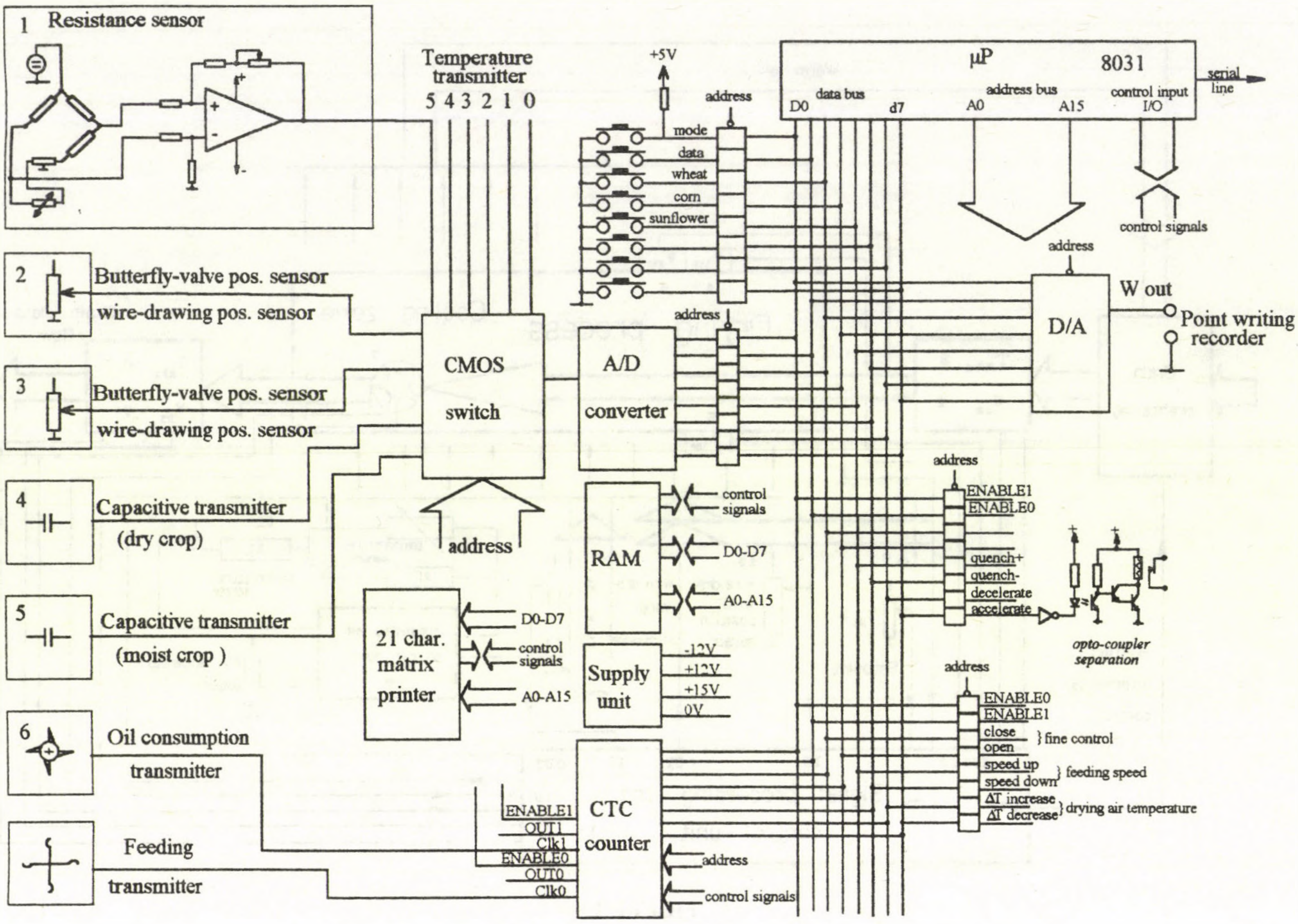

FIGURE 3.
Hardware scheme of process control

QUICK ENDURANCE EXAMINATION OF THE INTERNAL COMBUSTION ENGINES

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The reliability and endurance evaluation of internal combustion piston engines takes a significant part of the construction development time. The endurance and the reliability test require 2-3 thousands hours running time in real operational conditions.

A great shortening of the test time offers significant economy advantages. If the wearing out time acceleration is successfully determined for a given engine type then the endurance effect of any design, material and technical modification can be tested unambigously and precisely.

As a consequence of discovering the advantages of realisation of the accelerated endurance examination method, research is carried on the methods of the accelerated reliability and endurance tests of internal combustion piston engines both in Hungary and abroad.

The aim of the accelerated test method development is to elaborate such methods that incorporate same wearing out process as taking place in the engines under real operation conditions but with highly increased intensity.

To determine the most important external factors causing the wearing out process let us take into account all the effects influencing the durability of the internal combustion piston engines. (Fig.1.)

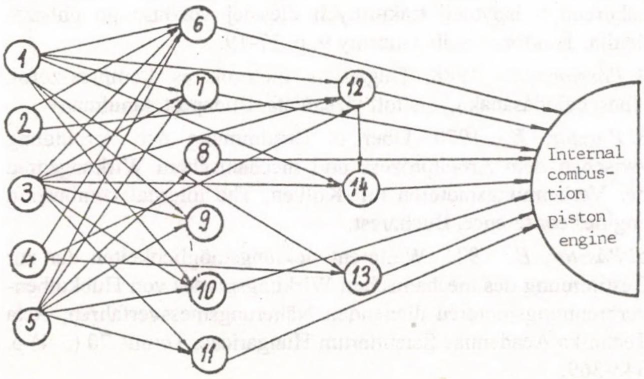

FIGURE 1.
Graph model of the external factors affecting the reliability and durability of the internal combustion piston engines

The numbered factors are:

1. The properties of the vehicle (or tractor) incorporating the engine.
2. The type of the work to perform.
3. Climate conditions.
4. Soil and road conditions.
5. The operational care level to the vehicle (or tractor).
6. The air pollution.
7. The conditions of the engine storage.
8. Fuel quality.
9. Engine quality.
10. Maintenance quality.
11. Engine handling care level.
12. Mechanical load on the engine crankshaft.
13. Low frequency vibrations to the engine.
14. Thermal loads on the engine

As the graph model shows through a few output factors (6-14) 5 input factors have influence on the reliability characteristics of the engines. It exhibits the input external factors as the primer sources of the complex effects acting on the reliability characteristics of the engines.

In order to simlify the graph modell several less significant external factors are neglected. The graph modell simlified such way contains only those factors directly influencing the engine reliability. (Fig.2.)

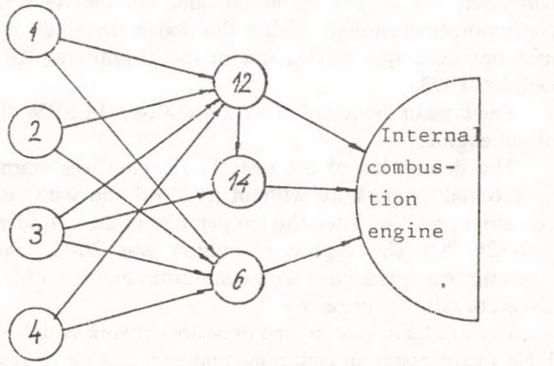

FIGURE 2.
Simplified graph model

As it can be seen in the figure, the modell contains only three direct input factors:

1. Mechanical load (12).
2. Thermal load (14).
3. Air pollution (6).

The accelerated endurance tests can be classified into three main groups on the basis of increased intensity, which are:

1. Raising air pollution.
2. Increasing the mechanical load.
3. Enhancing the mechanical and thermal engine load in a thermal way resulting in accelerated wearing out process.

The theoretical and practical method of the load increase in a thermal way was elaborated by Dr.Endre Pásztor, professor in the Vehicle Machinery Institute of the Budapest Technical University. The testing apparatus in the Mezőtúr College of Agricultural Engineering of the Gödöllő University of Agricultural Sciences was installed under his instructions. The equipment is applicable to practical measurements. (Fig.3.)

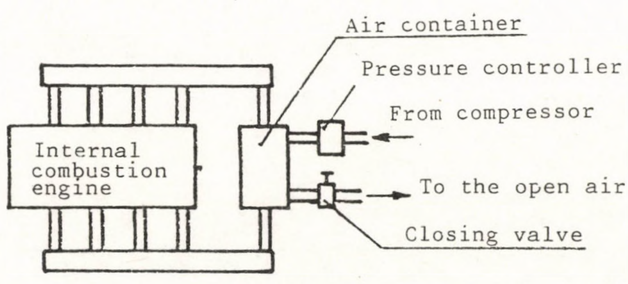

FIGURE 3.
Outline of the testing equipment

The description of the equipment:

The suction and the exhaust systems of the engine are connected to a common air container. The air container is connected to the compressed air network through pressure control valve supplying overpressure resulting raised mechanical load. The output pipe stub can be gradually opened and closed by a closing valve. Starting the engine with open valves and the pressure is raised in the air container gradually by opening the output valve, while the necessary amount of air is supplied from the air network to keep the engine in rotation. Thus the engine operates under significant overload (with raised average pressure) resulting in accelerated wearing out. The pressure in the container, the engine revolution and the fuel consumption is continuously measured. Using the above described method the measurements was carried out in the „Multiterra Kft." seat in October 1993.

The type of the tested engine: 4VD 14,5/12 SRW (IFA W50) diesel engine.

The description of the test: The engine was warmed up to operational temperature without any load and with atmospheric container pressure. Then the temperature of the cylinder wall was 117-120 °C. The engine revolution was 2000 1/min. After reaching the operational temperature the exhaust pipe stub was closed to raise the pressure.

The available compressed pressure network could supply 0.8-1 bar overpressure in continuous operation. As a consequence of the increased container pressure the compression endpressure and the burning peak pressure were raised resulting in considerably higher mechanical (friction) losses. The cylinder wall temperature increase(134-135 °C) proved it.

The engine was operated continuously under those conditions, however the smoking was extremely high due to the high pollution of the suction air.

A further raise of the container pressure by valve closing caused the cooling water to boiled and further increase of the cylinder wall temperature.

At 4 bar container pressure the seal at the first cylinder broke down.

It can be concluded from the performed examinations that the described method is applicable to increase the load of the in ternal combustion engines in a thermal way. Having sufficient number of measurement data the optimum container pressure with which the measurements results the desired wearing out increase but does not lead to the immediate breaking down of the engine.

After performed the measurements the examined engine and the equipment was reformed according to the method nuber II. (Fig.4.)

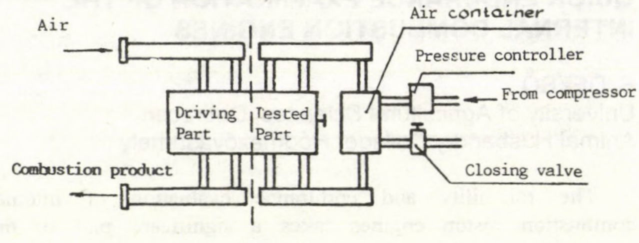

FIGURE 4.

In this method the engine is separated and the first two cylinders operates as engine and the compression ratio in the third and fourth cylinder is significantly reduced (from $\varepsilon = 18$ to $\varepsilon = 10$) and the further accelerated wearing out is examinede with the help of circulation without combustion.

By the conduction of the examination the practical applicability of the ideas of the accelerated wearing out is intended to prove. The achieved measurement data and results are thought to serve as a basis of further tests.

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GRAPHOANALITIC METHOD TO HELP THE COMPARATIVE EXAMINATION OF ENGINE CHARACTERISTICS

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Introduction

The demand for comparative examination of internal combustion engines can rise not only for the purpose of engine qualification or for seeking the adjustment parameters of an unknown engine but for comparing a given type engine when operated with different fuels or at changed operational conditions to find out of the effects.

In the last decades extensive research started in connection with alternative energy resources [1]. The favourable properties of the effective energetic parameters is an important criterium of the applicability. The evaluation and the exact comparison of the braking bench measurements themselves are serious professional job so that great care should be taken of the proper preparation. The complex engine setting up and adjustment for the given fuel type and for the predetermined optimum criteria is important and work expensive phase of the preparation. In our opinion the technology used at adjustment of an unknown engine is well applicable for this purpose. However, the method require a great number of measurements for the precise setting up, which is rather expensive these days.

This can be compensated by the graphoanalitic method being introduced here which does not substitute the previous but rather completes that, i.e. a part of the test bench measurements can be economised by the benefits of the computer methods.

In principal a technique of mathematical statistics is used to compare the engine characteristic diagrams, what seems novel because they are considered deterministic ones. Nevertheless it is not denied that stochastic phenomena can be found with the differences of the most parameters. The deviations and the shape of the curves encumbered the comparison. Another rule is applied here, i.e. the sections of the regulator characterictics before the controlled section and the deviation of the revolution characteristic curves depend on the optimum adjustment values (e.g. angle of injection before dead point.

Logical orger of the comparative examination based on characteristic curve analysis at the examination of alternative fuel [2]

1. Recording revolution and regulator characteristic curves with fuel oil and the tested alternative fuel. The adjustment values correspond to the factory values (dose, injection angle, injector opening pressure) supplied for diesel oil optimum. (Fig.1.)

2. The analysis of the curves taken with two different fuels includes the examination of the shape, relative position, extrem values and first of all the deviations at same rpm (ΔM, Δb_t). In the Fig.1. first of all the deviation of moment and the specific consumption is shown.

2.1. First statement is wether the still unknown behaviour fuel is applicable to the engine. It is obtained from the global comparison of the curves, the engine behaving on the braking bench, and from the additional informations (cooling liquid temperature, exhaust gas, noise, etc.). A preliminary opinion can be made for the further examinations.

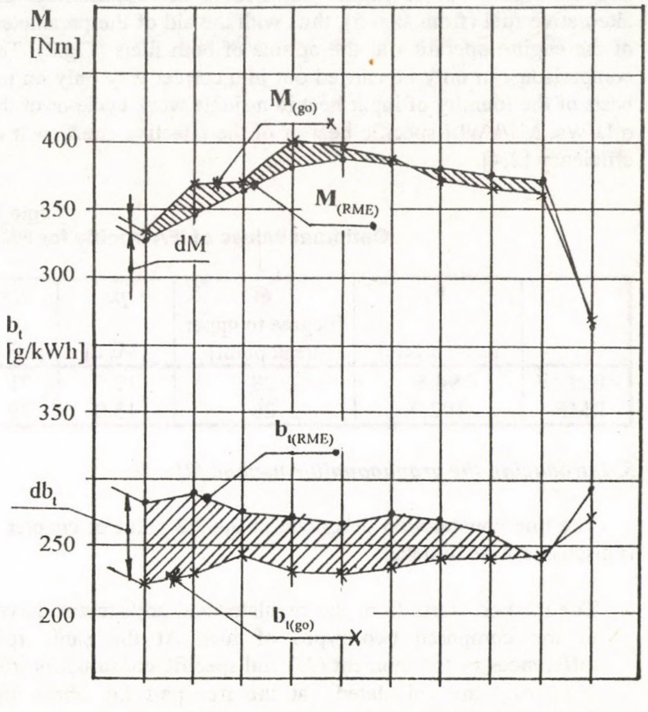

FIGURE 1.
Factory adjustment IFA engine. The curves of the engine torque (M) and specific consumption (b_t) with fuel oil (go) and rape methil ester (RME)

2.2. If the differences in the moment and the specific consumption values are higher than those of the measuring error, regression lines ($\Delta M = f(n)$ and $\Delta b_t = f(n)$) can be constructed by means of the method of least squares. Regarding the direction and the intersection point of the lines, the direction of measurement series continuation and the practical measurement sections of the curves can be decided. The position of the lines should not be examined as routine but rather based on thorough professional considerations. In general, it can be stated that the slope direction of the curves shows the deviating of the curves. In addition it should be taken into account which original curve is positioned at the bottom.

2.3. The feeding pump charecteristic is also included in the scope of the examination which is obtained from records of the changes as funcions of the cicle dose revolution. Such way the deviations of the physical properties (density, viscosity) of the new fuel is taken into account in the determination of the dose.

3. Based on the analysis the simplifications to the traditional method of the optimum adjustment of the engine parameters (dose, injection timing, injector opening pressure) can be made. Also it can be found out which characteristics are not necessary and which domains are advisable to examine.

4. Recording the adjustment curves is carried out and the optimum values for the alternative fuel are established (Table 1.) [3].

5. At the engine adjusted to the values determined in step 4, the revolution and regulator curves are recorded while using the tested fuel.

6. The comparative examination is carried out based on the optimum adjustment to fuel oil measurements (recorded in step 1) and the values of the engine adjusted to the optimum of the alternative fuel (from step 5), thus with the aid of the parameters of the engine operating at the optima of both fuels (Fig.2). The comparison can only be carried out in a correct way only on the basis of the identity of input heat in a single work cycle or of the q [J/Ws, MJ/kWh] specific heat or of the effective coefficient of efficiency [2,4].

Table 1.
Optimum values of IFA engine for RME

	V_d [mm^3/cycle]	Θ [degree to upper dead point]	p_D [MPa]	P_{eff} [kW]
- fuel oil	94.5	28	17.5	71
- RME	102.0	26	15.0	70

3. *Introducing the graphoanalitic method [2]*

The line consturction described in the 2.2 point of chapter 2 is discussed here in detail:

- The method starts from the regulator and adjustment curves of the compared two types of fuel. At the same rpm differences of the moment (M) and specific consumption (b_t) (ΔM, Δb_t) are calculated at the free part i.e. ahead the beginning of the control part.
- Regression lines are fitted to them as $\Delta M = f(n)$ and $\Delta b_t = f(n)$ functions.
- To construct the regression lines variables are interpreted and processed as follows:

$$Y = a + b \cdot X$$

for $\Delta M = f(n)$:

$$b_M = \frac{\sum(n \cdot \Delta M) - z \cdot n_x \cdot \Delta M_y}{\sum n^2 - z \cdot n_x^2}$$

$$a_M = \Delta M_y - b_M \cdot n_x$$

for $\Delta b_t = f(n)$:

$$b_b = \frac{\sum(n \cdot \Delta b_t) - z \cdot n_x \cdot \Delta b_y}{\sum n^2 - z \cdot n_x^2}$$

$$a_b = \Delta b_y - b_b \cdot n_x$$

- The direction in wich the optimum should be sought was established from the positions of the lines relative to each other and to the axises.
- The closeness of line fitting was not examined as the processes of the internal combustion engines and parameters reflecting them are determionistic ones. This method was applied in addition to the known techniques of the characteristic curve analysis (examining tangents, extrema).

Results

It can be seen in Fig.3. (detail *a*) that the original factory adjustment for fuel oil results deviation at the RME, therefore the lines makes a definite angle. In the case of a higher deviation they intersect each other within the operation domain. In the detail *b* of Fig.3. when the parameters of the engine found for both fuel with optimal adjustment values, the lines are near parallel. This meams that the engine behaved similarly with the two fuels at different rpm-s.

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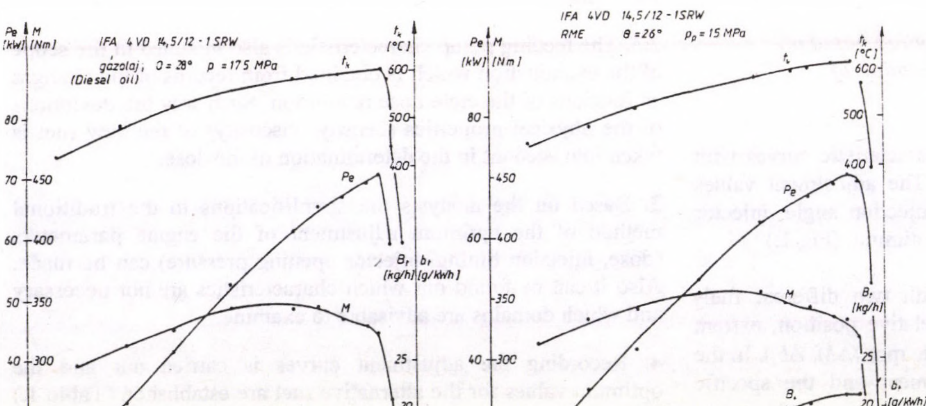

FIGURE 2.
Engine characteristics adjusted to the optima of both fuels

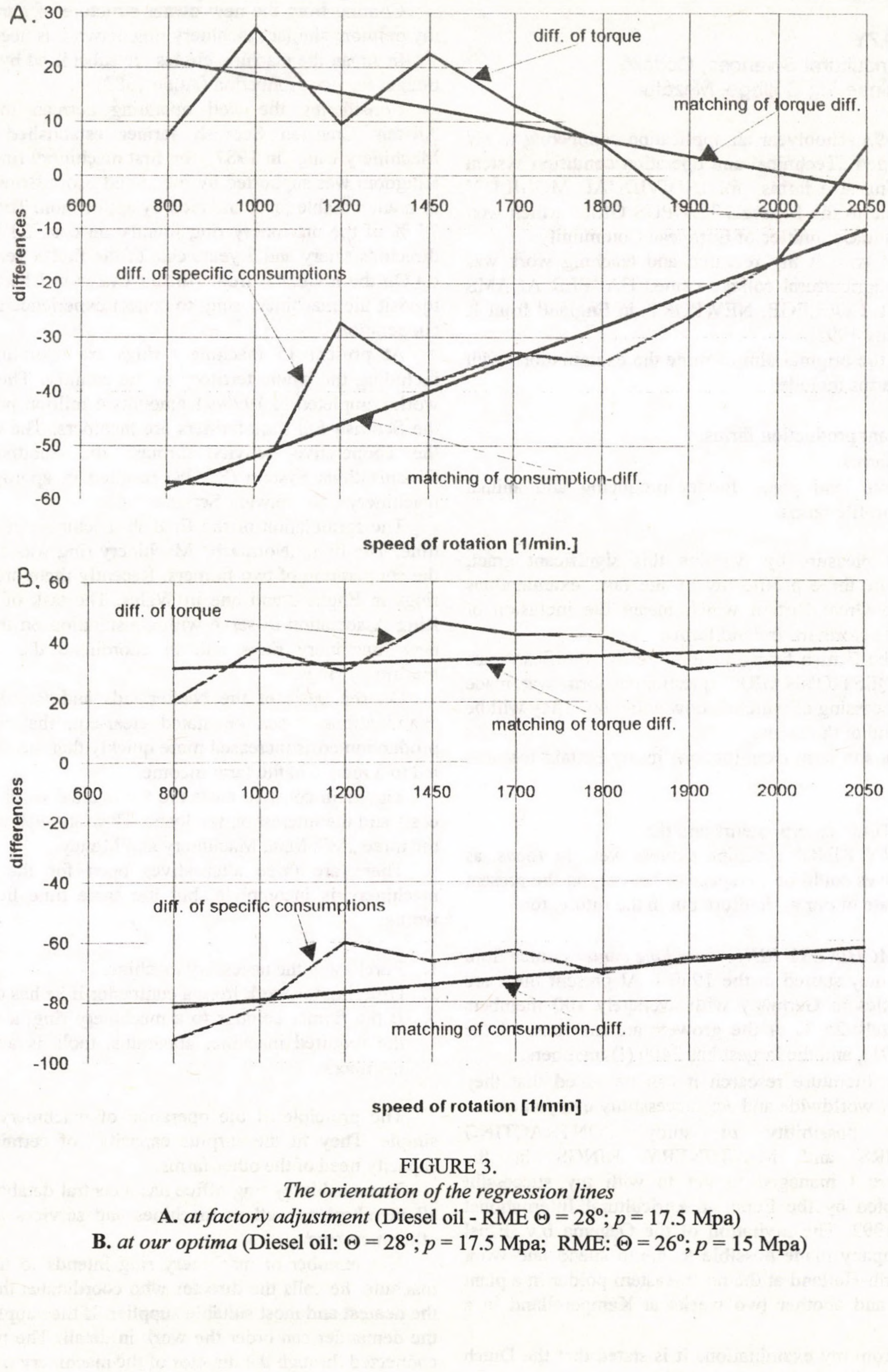

FIGURE 3.

The orientation of the regression lines

A. *at factory adjustment* (Diesel oil - RME $\Theta = 28^o$; $p = 17.5$ Mpa)

B. *at our optima* (Diesel oil: $\Theta = 28^o$; $p = 17.5$ Mpa; RME: $\Theta = 26^o$; $p = 15$ Mpa)

HOME AND ABROAD EXAMINATION OF FAMILY FARMS OPERATION

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For the 1992/93 schoolyear an application connecting to my research theme titled „Technical and operation condition system of new undertaking size farms" for INDIVIDUAL MOBILITY GRANT was made to the Brussels TEMPUS Office which won the support from the Committee of European Community.

In accordance with it my research and teaching work was conducted at the agricultural collage named HARPER ADAMS AGRICULTURAL COLLEGE, NEWPORT, in England from 1. February to 31. July 1993.

According to the original aim of mine the examinations with studying family farms include:

- arable land plant production farms,
- milking cow farms,
- mixed – arable land plant, fodder producing and animal husbandry – profile farms.

To my great pleasure by winning this significant grant, complying with the three profile my in site farm examinations were extended to Great Britain which meant the inclusion of Scottish Wales and Northern Ireland farms.

To examine the British farms having already significant past an appropriate „QESTIONNAIRE" questioning form was made the computer proccessing of which is now going on. They will be evaluated at the end of the theme.

Beyond the in site farm examinations in my Britain research the

- „CONTRACTOR" enterpreneurs and the
- „MACHINERY RING" machine centers were in focus, as these alternatives could be perspective not only in the present transitional state of our agriculture but in the future, too.

The term *„MACHINERY RING" machine center* comes from Germany, where they started in the 1950-s. At present there are 260 machine circles in Germany with averagely 100 members each. Approximately 25 % of the growers are members of the circle (Cargill 1991), and the largest has 2400 (!) members.

Based on my literature research it can be stated that they spreaded suddenly worldwide and act successfully everywhere.

I had the possibility to study CONTRACTING ENTERPRENEURS and MACHINERY RINGS in the Netherlands where I managed to get to with my successful application accepted by the Fund of Agricultural International Connections in 1992. The invitation of the Oegema b.v. Espel Agricultural Company made possible to me to spend and work two weeks in North-Holland at the north-eastern polder in a plant cultivating farm and another two weeks at Kampereiland in a milking farm.

Clonçluded from my examinations it is stated that the Dutch machinery rings are large with appr. 1000 members.

Differently from that, in France in the case of „CUMA" only 5-6 neighbours make circle for joint machinery purchase, like syndicate.

It can be stated based on my examination that the nature of same purpose, similar function MACHINERY RINGS is different country by country.

Japanese farmers investigated the operation of machine circles in Germany in 1974 and a modified machinery network was established in Japan to help the great number but small scale farms.

Coming from the new owner structure of our agriculture, in my opinion, similar machinery ring network is needed.

In Japan the machine circles are subsidised by the goverment budget for rice production (Anon 1989).

Considering the well operating german machinery rings Alistair Cranston Scottish farmer established the „Borders Machinery Ring" in 1987. The first machinery ring of the United Kingdom was supported by the „Food From Britain" in the form of grant winable for foundation by application. This contained the 75 % of the machinery ring foundation cost, 33 % of the circle director's salary and 3 years cost of the first 5 years (Anon 1992 c.) On the invitation from Alistair Cranston I had the possibility to visit the machinery ring, to collect experience and to agree on cooperation.

At present 15 machinery rings are operating in Scotland including the whole territory of the country. The value of their work completed in 1990/91 amounts 4 million pounds. 12 % of the Scottish full time farmers are members. The coordination of the cooperative activity through the Scottish Agricultural Organisations System (SAOS) resulted in appropriate structure machinery ring network Scotland-wide.

The formulation of the English machinery rings took longer time. The first, „Normach" Machinery ring was established with the cooperation of two farmers. Recently there are 16 machinery rings in England and one in Wales. The task of the Machinery Ring Association to serve with consultation on the forms of the new machinery rings and to coordinate the activity of the machinery rings.

On the basis of the Netherlands and Britain in site farm examinations it can be stated clear-cut, that the past period production costs increased more quickly that the farm yields. This led to a reduce in the farm income.

The main constant costs are the manual work, the machinery costs and the interest on the loans. They are well characterised by the three „M": Man, Machinery and Money.

There are three alternatives open for the farmer whose machinery is incomplete, but the same time he needs certain works:

1. Purchasing the necessary machine.
2. Ordering the work from a contractor if he has capacity to do.
3. If the farmer belongs to a machinery ring, a wide variety of the required machine, apparatus, tools is available for the members.

The principle of the operation of machinery rings is quite simple. They fit the surplus capacity of certain farms to the capacity need of the other farms.

The machinery ring office has a central database of the list of all members as well as machines and services available to the other members.

If a member of machinery ring intends to use a service or machine, he calls the director who coordinates the demand with the nearest and most suitable supplier. If the supplier is available, the demander can order the work in detail. The two partners are connected through the director of the machinery ring.

The „CONTRACTORS" have advantage as they can answer directly whether they can perform the demanded work or not.

In the „MACHINERY RINGS" the full time director is present as an extra connection who has to be in connection to the supplier. Before answering the demander, first he should examine if the supplier can perform the work in fact. Thus the personal contact has a great importance.

The most machinery ring has 40 pounds joining fee and 50 pounds yearly dues for the members. After performed the work the supplier fill in a three copies job sheet which is signed by the demander as proving the work. One copy is given both to the supplier and to the demander and to the director.

The value of the work is transferred from the demander's bank account to that of the supplier within 14-28 days after finishing the work. For each businness 2 % is given as commission to the supplier and to the demander by the machinery ring.

In the most works the members of the machinery ring available for the work take care of the machine operators, too. Nevertheless the machines and the operators can be borrowed separately, as well, depending on the intention of the partners.

The larger the machinery ring in size the more services and machines are available and the more demander can use them. The most machinery rings have professionals, skilled workers, drivers, mechanicians, breeders.

By collecting the requests from the members and keeping the members together on interest many machinery rings are highly competitive in offering power machines and implements and at the same time capable to perform a complete scale of agricultural service.

In the most machinery rings members has the same costs. They are non-profit organizations with own rights and with similar operation way.

The machinery ring issues „price information list" covering all work offered. This is elaborated by the leadership on the basis of the local contractor prices. This prices are used flexibly and are rather informative than compulsory.

In connection with the operation of the machinery rings the frollowing simple but important elements are emphasised:

- Every member is the owner and operator of his machine.
- He is free to offer to the machinery ring as much or as little as he want.
- He can prefer one person to the other in supplying the service and he can refuse the work.
- Anybody is entitled to deny the work offered by the director.

Some contractor was afraid of the machinery rings thinking them serious competitors. The practice proved that the contractor and the machinery ring system do not exclude each other. This is verified by the fact that among the machinery ring members a great increase of contracting enterpreneurs, machine salesmen, and different agricultural salesmen is observed.

The advantages of the machinery rings:

1. Offering possibility to the farmers to better utilisation of their machines, and to let them.

2. The machine ring offers one alternative never. The farmer is free to employ the same contractor continously, too after joining the machinery ring.

3. The machinery ring membership is advantegous in the case of changeng a machine by a new one. In the case of a new, higher output machine the machinery ring can get surplus work to utilise that with increased efficiency. The machinery ring can give advice if it is worth to change the machine or not, as there is always a member in side the machinery ring who offers the given work less expensively.

4. Ensuring temporary worker helps the farmer family in case of illness.

5. First of all the organised contracting helps to control the costs.

6. The machinery ring eliminates the disadvantages coming from the occassional and sometimes less reliable work of some contractors.

7. The Managing Board surveys the machinery ring prices. These informative prices are usually below those of the contractors. According to the equivocal opinion of the several machinery ring directors and members the organisation offers good possibilities to reduce the manual and machine work costs by extending the scope of their activity. The data in the *Table 1* given by Muir in 1992 proves the competitiveness and the cost reducing effect of the machinery rings clear cut.

Table 1.
Machine work costs of different operations
(Muir I. 1992., Arable Farming)

(1 ha = 2.471 acres)

Operation	Land area	Cost (pounds/acre)		Notes
	(acres)	Private machine	Machinery ring price	
Plowing	100	16.67	10.50	Rate:
	200	12.93		1.5 acres/h
	300	11.60		
	400	11.05		
Rape harvest	200	23.88	12.00	Rate:
	300	17.22		4.5 acres/h
	400	13.80		
	500	11.90		
Operation	**Number of bale**	**Cost (pounds/bale)**		**Notes**
	(Pieces/year)	Private machine	Machinery ring price	
Cylindric	1,000	2.34	1.15	
bale making	1,500	1.77		
	2,000	1.48		
	2,500	1.31		
	3,000	1.20		

Based on the foreign practice and experience and the home need the Association of Contractors has been formed in this country, so that the application of contracted work is given in several places (even if not in all fields).

After these initial steps by finishing my research I intend to find and elaborate the possibilities to introduce the machinery rings in Hungary.

SOIL CULTIVATION CONDITIONS FOR ADAPTIVE PLANT PRODUCTION

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Characteristics of the traditional soil cultivation

The traditional tillage can be characterised by the different depth cultivation of the whole surface and by the high number of passes. Formulation of its is a result of the several century development. In the lack of effective cultivation tools the soil state suitable to production can only be ensured only by several different time actions. Even recently the traditional tillage uses simple tools with low learning need (plough, disc, combinator, harrow, ring cylinder, smoothing) and few connecting solutions compared to the possibilities.

The traditional tillage can be criticised for the high time and energy need as well as the for its infavourable effects to the soil.

The high time need is a cultivation risk as the changing weather conditions can influence disadvantageously the soil tillability. However, the followers of the traditional tillage think that the more operation leads to a better based plant production. This is the explanation to the popularity of the traditional cultivation.

The high number of passes means 8-10 action from the stubble to the sowing and consumes as high as 60 l/ha fuel or more. The higher number of passes results not only in higher cost but the soil damage, too. The frequent moving of the soil is a reason for the decrease of the organic material content. The soil is also compacted by the several passes. The compacted soil tends to form clods what results in the need for additional works to achieve the suitable state for sowing.

The plants need the suitable soil state for their growing and not the many passes.

The advantages of the traditional tillage is characterised by the little need to learn, relatively low herbicide dependency, the effectivity of the mechanical control of pests and diseases and the low sensitivity to stubble remains. This stands against the increased damage of soil and the high operation cost.

The characteristics of the adaptive tillage

The adaptivity includes adaptivity to the soil, the soil state and the economy conditions. The method, tool and the depth of the cultivation are chosen in the given instance, considering a longer period in the interest of the improving and saving the physical and biological conditions of the soil.

Any tillage act can utilise the favourable effects of the soil state resulted from the previous operation.

The aspect of the adaptivity does not allow the excessive compaction of the soil, as its correction leads to increased expenses and damaging the structure.

The stubble remains are are not considered as ineludible harm, but rather as a chance to be used for improving the biological condition and for reducing the moisture loss of soil.

The conformity to the soil state with the reducible tillage risk results in fewer passes. The decreased compaction harm from wheels exempts the soil cultivation from the forced actions. At the same time the adaptive tillage uses regular loosening to save and improve the soil condition.

The advantages of the reduced number of passes can be shown in the expended tillage time, energy and cost reduction. The time demand can be decreased by 30-50 % while the fuel and other cost can be reduced 25-35 %.

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The tools of the adaptive soil tillage

Power machines. Soil preserving movement wheels, belts and tracks (e.g. TERRA types) can not be used in the near future due to the high prices and the lack of the company capital. The decrease of the soil destruction can be reached by controlled tillage traffic.

Tools of stalk cutting and stubble-stripping. To reduce soil destruction it is more favourable to make the stalk cutting in a single pass with the harvest. From the aspect of other agronomy considerations the remains spreaded out after stalk cutting keep on the moisture content saved by the shading before harvest.

To mix stubble remains partly in the soil the cultivator combined with surface closing roller (e.g. CONSER TILL, AGRIKON-FNR, AGRIKON KL-Kulti, AGRIKON SZL) is more applicable to take care of the subble than the stubble stipping disc. Using disc can not be excluded but it needs more attention. If the first disc operation is shallow, in the next pass (e.g. when taking care of the stripped stubble) the previously compacted layer can be worked through.

The principal function of the stubble stripping is to reduce the soil moisture content and to help the soil restructuring. Those soils with restructured shallow upper layer after stripping can be taken care of with less energy and higher quality. The favourable effect can be utilized at the loosening or deep plowing of the deeper compacted soils.

Principal tillage. The only applicable **tool to loosen the** – upto now almost common – **compacted state soils is the chisel plow**. The home choice of moderately deep chisel plows is good: the KÜHNE produces the VFK-5 type and the Scythe Factory Szentgotthárd makes the RÁBA-CASE-IH-10-14-3, 5, 7 and 9 blades versions. After the VIBROLAZ-80 type has gone the KÜHNE-ML-700 is the only deep chisel plow but due to the moderate demand, it is enough. The KÜHNE factory produces finishing rollers for all chisel plow (and for the 10-770 heavy disc harrow and for the CONSER TILL heavy cultivator, too).

The multioperational heavy cultivators are indispensable implements of the soil preserving adaptive tillage systems. The new generation heavy cultivators the „stubble buster" have usually wing blades (e.g. FNR, KL-KULTI and the KSZL) and there are soil surface closing elements, such as roller harrow (with pins, framing, and rods), after the breaker-mixer elements.

To rotate the soil occasionaly the less soil destructing combined plows are advised. In the lack of them the plows (KÜHNE-CASE-IH and KÜHNE-RABEWERK) mounted with soil preserving rotating elements (AGRIKON-SZE) meet the adaptivity conditions.

The soil cultivation in single pass with ploughing is important in the adaptive tillage systems.

Surface culvation and seedbed making implements. According to the adaptivity principles the single pass cultivation is desirable together with the basic tillage.

The soil after not finished autumn basic tillage or the spring ploughing should be cultivated by a combination of smoothing, loosening tools in a single pass. (AGRIKON KRM, FMG).

The starshaped soil driven rotors (rotary hoe) are the most important elements of the AGRIKON surface cultivators which loosens well and is self-cleaning at proper working speed (8-10 km/h) in moisten soil, and mixes the stubble remains from the surface in the cultivated layer.

The combined cultivating-sowing and seed-bed preparing sowing machines (AMAZONE, HASSIA, DUTZI, RAU) which are popular in Western Europe give the possibility better cost saving and soil preserving and reliable sowing in certain soil conditions and situations (e.g. spring ploughing, and at longer sowing period due to the wet soil.).

In the choice of adaptive cultivation tools the soil preserving elements, such as soil conditioning looseners, cultivators for indulgent upper layer tillage which makes no compact upper closing layer and not tending to make dust, driven by soil. Nevertheless the plow and ploughing are not completely neglected in this system.

Considering these how can the machine development match the principles of the adaptive soil tillage. If there are more possibility in the choice of the new products to accomodate to the soil state than that offered by plough, disc and ring roller the solution is one step closer. In the offer of our Factories several good solution can be found.

ENVIRONMENTAL POLLUTING EFFECT OF DIESEL ENGINES AND THE EXPERIENCES WITH THEIR EXAMINATIONS

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The diesel engines, due to their efficiency are used exclusively for several purposes. In Europe their spread as useful vehicles, construction industrial mobile machines, agricultural tractors and selfpropelled implements were supported even by governmental projects. In the past fifteen years diesel engine applications in passenger cars has increased significantly.

As a result of the permanent bad tension in the car to environment relation the diesel engine has been getting into a position loss due to the judgement of the air polluting effect. Their pushing back in the case of cars were contributed by the general application of the controlled catalizers to four stroke petrol engines which reduced the harmful gas emission considerably. The Swiss get rid of even only 1 to 2 year old diesel engine cars as a consequence of the severe environmental prescriptions and the public aversion formed.

In useful vehicles, construction industrial and agricultural machines the diesel engine application is continued due to the more economical and efficient operation. Nevertheless it is necessary to reduce the environment polluting effect in this field, too.

The manufacturers tend to understand the environment protectional questions and the first regulation suggestions were made by the West German car industry in the end of the sixties. The first limitations to harmful material emission of exhaust gases were respected voluntarily. From the principle of voluntariness the highly industrialised state changed to the law regulation soon.

In the burning process of the diesel engine, due to the large excess air, the overwhelming part of products are not toxic. Such kind of products are water vapour (H_2O), carbon dioxide (CO_2), which together with the air constituents, such as nitgogen (N_2), oxigen (O_2) and inert gases make approximately 99 % of the exhaust gases. Unfortunately there are approximately 0.3 mass percentage deleterious gases, too, including gas state mitrogen oxids (NO_x), carbon hydrogens (C_nH_m), carbon monoxide (CO) and particle form soot (amorphous carbon) with adhered carbon hydrogen compounds. There are additional solid particles such as ash, sulphates, wearing particles and dust from the suction air.

Among the deleterious materials the sulphur dioxide (SO_2) should be mentioned the quantity of which depends only on the sulphur content of the fuel. More recently CO_2 should be considered as a harmful material. The application of fossile origin fuels makes the carbon dioxid content of the air to increase influencing the climate change negatively through generating the greenhouse effect.

In the GFR, according to the data of the 1987 year report of the German Federal Office of Environment Protection the vehicles contributed the whole deleterious gas emission of the industry, power plants, housekeeping, transport, etc. as follows: 1.5 % CO, 6.1 % C_nH_m, 16.7 % NO_x and 6.4 % dust or particle. The car industry disputes these figures. Despite it can be stated that the vehicles pollute our environment significantly. In addition to reducing the nitrogen dioxed emission it is principally resonable to decrease particle emission since particles especially the adhered components have cancerogenic effect.

Limit values have been elaborated for the harmful material components of vehicle exhaust gas content by the legislators. The European presciptions valid in the near past and currently are summarised in Table 1. The USA regulations are perharps less severe than the European ones. Due to the different test methods the comparison is rather cumbersome and inaccurate.

Table 1.
European specifications to exhaust gas of diesel engine driven vehicles

Prescription	ECE R49	EG	EG EURO I	EG EURO II
CO	14	11.2	4.5(4.9)*	4.0
CH	3.5	2.45	1.1(1.23)	1.1
NO	18	14.4	8.0(9.0)	7.0
Particle	-	-	0.36(0.4)	0.15
Applied from	01.01.1988	01.10.1990	01.10.1993	01.10.1996

Figures in g/kWh *(If P>85kW)
The measuring method is ECE R49 13 point tests

The prescription made by the European Economy Committee are significant aggravation from 1. October 1993 and the new element is the limit values of the particle emission. Formerly the particles in the diesel engine exhaust gas were judged by the absolute light absorption coefficient of the visible soot (diesel smoke). According to the ECE R24 prescription of the European Economy Committee the figure of the absolute light absorption coefficient must not be higher than the values given as a function of the theoretical air volume flow (Fig.1.).

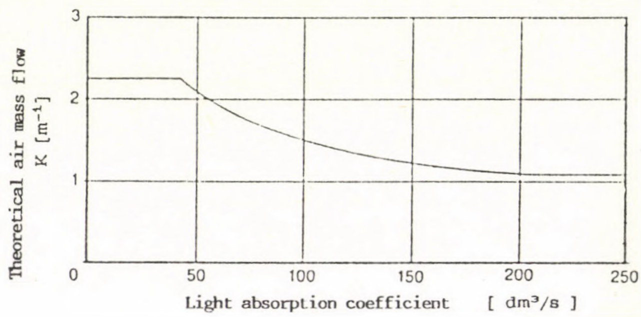

FIGURE 1.
ECE R24 prescriptions of limits of the diesel engine smoke measurement

The home regulations are the same as the European ones and their introduction follow them only with a short delay. In all type tests of vehicles the prescriptions are demanded. The vehicle prescriptions are applied to agricultural tractors running on public roads.

The ECE R49 does not test an adjustment state. The method selects 13 points of the engine operation to sample. The substance of the 13 point examination method is demonstrated in Fig.2. The examination is carried out on a usual test bench.

The regulator characteristic of the engine are followed by the determination of measuring points marked by circles, then in the order of the numbers written in the circles, corresponding to the prescribed load percentages the exhast gas component determination is carried out. The measured emission values are taken into account with the weighing factors written next to the circles together with the performance supplied in the measuring point and the figure of the deleterious material emission characteristic to the 13 points is given in g/kWh. The harmful material amount in the measuring points shows up rather changing values. This is demonstrated by the examination results of the emission data of a new JAMZ 238-D2 type turbocharger diesel engine in the Fig.3. and of the RÁBA MAN D2356 type, no turbocharger diesel engine in the Fig.4.

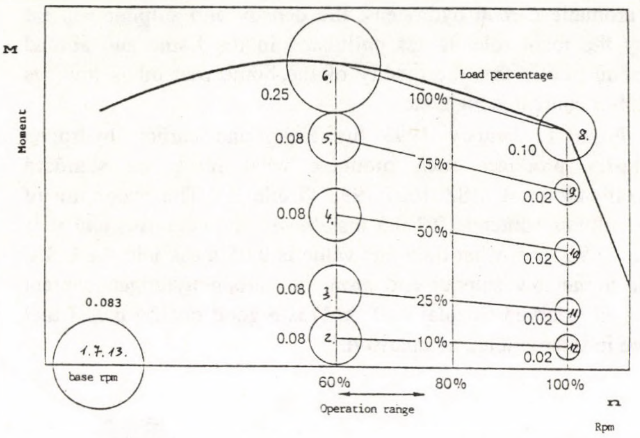

FIGURE 2.
Measuring points and weighing factors in the ECE R49 13 point test

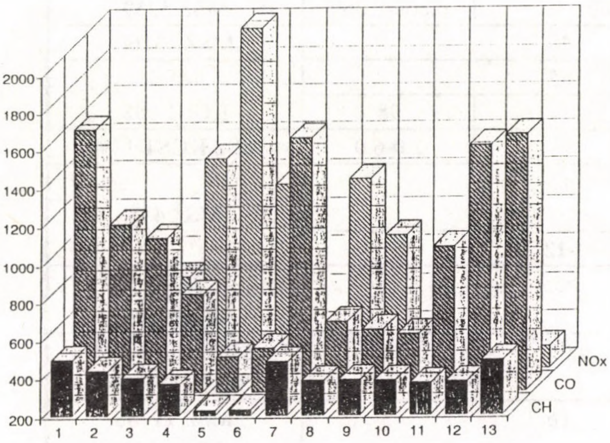

FIGURE 3.
Examination of JAMZ 238-D2 type diesel engine according to ECE R49 13 point test

The summarised figures characteristic to the emission measured and calculated on the basis of ECE R49 method are as follow:

- for JAMZ 238-D2 engine:
  CO = 6.396 g/kWh
  C_nH_m = 1.312 g/kWh
  NO_x = 13.476 g/kWh
- for RÁBA MAN D2356 engine:
  CO = 9.251 g/kWh
  C_nH_m = 2.684 g/kWh
  NO_x = 22.033 g/kWh

The operator has also tasks to keep his/her vehicle in a suitable state in the course of usage. The periodical technical inspections and the public road controls serve to supervise such kind of tasks. In the interest of reducing air pollution in Hungary all the diesel engine vehicles running on public roads are demanded to emit smoke below the prescribed limit. The prescription on the exhaust gas light absorption coefficient is contained by the Table 2. based on the KHMV (Ministry of Transport, Communication and Urban Development) order number 18/1991. (18. December). The vehicles should be taken to yearly environment protectional inspection and the result is certificated by the so called green card.

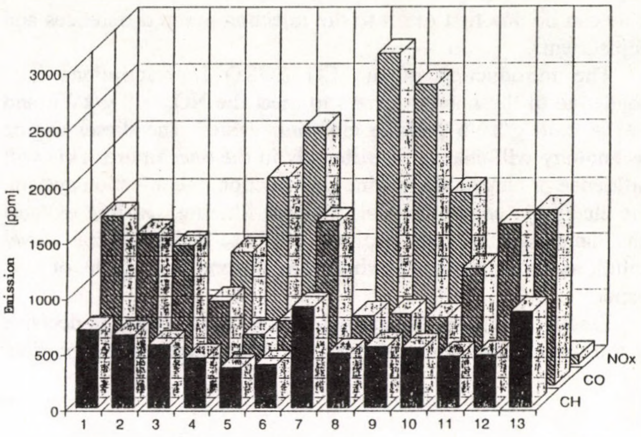

FIGURE 4.
Examination of RÁBA MAN D2356 HM6U type diesel engine according to ECE R49 13 point test

Table 2.
The allowed smoke of exhaust gas of diesel engine driven vehicles (a part of the KHVM {Ministry of Transport, Communication and Urban Development} order numbered 18/1991. [18 December])

Vehicle category	Type of engine	K1 [1/m]	K2 [1/m]
Less than 3500 kg total mass		2.5	1.5
More than 3500 kg total mass	suction charged	3.5 3.5	1.5 2.5
Agricultural tractor and slow vehicle		3.5	1.5

Absolute light absorption coefficient of exhaust gas K [1/m]
– K1 free accelation on base rpm
– K2 free accelation on raised base rpm

In the last year several renewed high performance Mercedes-Benz OM 422 A 11/5 type turbocharger diesel engines were tested. The smoking values of the exhaust gas were also measured. They are shown in Fig.5.

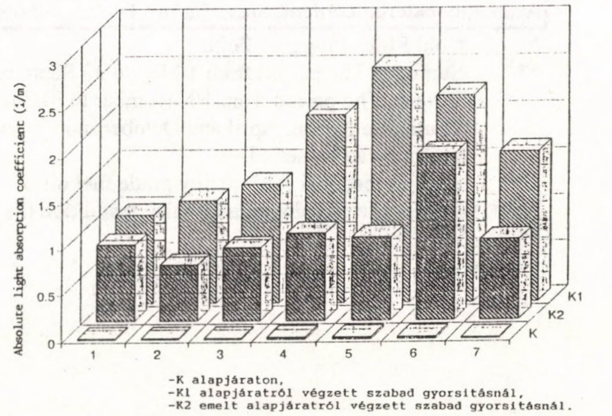

FIGURE 5.
Smoke component values of Mercedes-Benz OM 422 A 11/5 type diesel engines

The OM 422 A 11/5 type engines of the camions with total weight higher than 3,500 kg meet the requirements (K1= 3.5 and K2 = 2.5 [1/m]). From the Figure 5 one can conclude also, that the smoking is quite different even within the same type group.

This can be due first of all to the injection pump differences and adjustments.

The introduction of the EG EURO I prescriptions is a challenge to the manufacturers to meet the NO_x = 8 g/kWh and PM = 0.36 g/kWh particle emission values. The diesel engine technology will change significantly in the near future. This will influence or change the engine construction, the injection system, the electronic engine control, the soot filtering, catalitic exhaust gas handling, the fuel applied. In these fields several novel solutions have appeared which are beyond the scope of this paper.

Finally the fuel is mentioned, the quality of which is decisive in the solid particle emission and the cetane number, the portion of aromatic carbon hydrogens, the density and sulphur content play the main role. It has pullulated in the home and abroad general public that the quality of the home fuel oil is low, its sulphur content is high, etc.

From 1. January 1993 the Hungarian carbon hydrogen industry produces such products what meet the standard specifications of MSZ 1627:1993 (Table 3.). The maximum of the sulphur contentis 0.2-0.3 mass% in EC countries and it is only 1993 from what time this value is 0.05 mass% in the USA. The home low sulphur and aromatic carbon hydrogen content fuel oil (marked Gázolaj 0.01 AM) is a good quality diesel fuel even in international comparison.

Table 3.

Fuel oils, MSZ 1627: 1993 (section)

Quality grades		Fuel oil 0.2	Fuel oil 0.05	Fuel oil 0.01 AM	Specification to the test method
Characteristics		Prescriptions			
Density at 15 °C, g/cm³		0.820-0.860		0.800-0.860	MSZ 3259
Cetane index, at least		48			MSZ 13166
Distilled amount % (V/V)	to 250 °C, max.	65			MSZ KGST 758
	to 350 °C, min.	85		98	
Kinematic viscosity at 20 °C, mm²s⁻¹		3.0-8.0		2.0-6.0	MSZ KGST 1494
Cold filtering limit temperature (CFPP)*, °C max.	in summer**	+5			MSZ 458
	in witer	-12			
Flashpoint, in closed space, Pensky-Martens, °C		>55			MSZ KGST 1495
Sulphur content % (m/m), max.		0.2	0.05	0.01	MSZ 11733 and MSZ 11744***
Corrosion effect on copper plate, max. corrosion grade		1*b*			MSZ 11788 Method *A*
Conradson number 10 % (V/V) distillation remainds, max., % (m/m)		0.1			MSZ 3260
Water content, max.		trifling			MSZ KGST 2382
Oxide ash, max., % (m/m)		0.01****			MSZ 11727
Aromatic material content, max., (m/m)		no specification		5.0	to be ordered

* Cold Filter Plugging Point

** Summer: The period from 1 May to 30 September
Winter: The period from 1 November to 31 March
Transition period: April and October months, when products for both winter and summer can be selled.

*** Only to test 0.01 AM quality grade fuel oil

**** In the case of using quality raising additive the allowed value for oxide ash is maximum 0.03% (m/m)

RECOGNITION AND CORRECTION OF MACHINE DESIGN WEAK POINTS

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Agricultural machines are required principally to operate reliable during the planned time of usage being serviceable to meet their function. Thus fault and damage prevention is aspired to achieve that have two different basic tools i.e. preventive maintenance and weak point analysis and correction.

The fault analysis and its methods

The fault analysis (damage analysis) processes the type, reason, frequency, consequences and cost of the defects making use of fault and misoperational data in order to determine the necessary measures.

The mechanism of the faults describes the process of occuring a fault (damage) in the order

fault reason ⇒ fault type ⇒ fault appearence

while the fault analysis has a reverse order as it starts from the fault appearence and aims to define the fault reason (1).

The practical application of the fault analysis were carried out with a hydraulic, pulled type, rotating loading machine used in Hungary. In the given period 145 of the 329 machine put in working broke down during warranty time and 354 faults occured in the 304 breakdown.

In the fault analysis several methods could be used. Some of them are as follows:

a) The *practical function of the accumulating damage* (3) gives information about the machine stock defect behaviour. The absciss and the ordinate refer to the number of faults per machine and the number of machines with the given number of faults, respectively. Also similar representation can be used with total fault number of machine, the fault reason and so on. The discrete practical distributions are Poisson type ones and the mean values are their parameters. They are used in the maintenance planning and evaluation.

b) *Pareto analysis* is a generally used method by which the fault locations can be evaluated in accordance with the fault reasons, the types of faults and the fixing technologies. They serve information for weak point determination and for different measures.

c) The *analysis of faults and their expenses* is practicable in terms with machine performance. It is not always possible, and during our investigations it was made in terms with operational hours. The result can offer motives for modifying the maintenance system. For instance, it can support the determination of the technical supervision time and content.

Terminology of weak point analysis and the process of correction

The weak point is a structural part of a machine or equipment which compared to other parts has lower waering out reserve, or the wearing out reserve can be restored with higher expense. The concept has been standardised in several country (4) (5).

A simplified process scheme of weak point correction is shown in Fig.1.

The weak point localisation can be considered as a part of the fault analysis. The source of the information necessary to carry out it is the fault analysis anyhow.

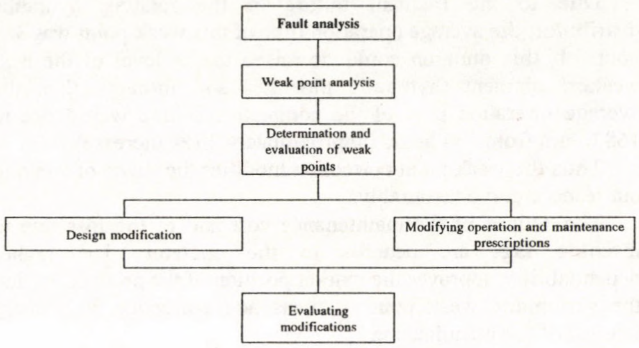

FIGURE 1.
The process of weak point correction simplified

The selection of the weak point from the faulty parts can be made by evaluating several interrelating viewpoints, so that it is a typical multifactor decision problem.

Known methods of weak point localisation:

a) Several methods of *complex system examination* are known (6). Their application and spread are limited by their complication.

b) The *practical value analysis* (7) is well applicable due to its matchability to the methods of product planning and other advantages.
The technique can be modified for weak point selection (2).

The main steps are:

- determining hierachic order of evaluation factors by means of relevancy tree method,
- determining the importance of evaluation factors using weighing coefficients,
- determining characteristic figures of srtucture parts as evaluation factors (evaluation list),
- evaluation of structure parts using scores and weighted practical value,
- determining end evaluating the total value of structure parts making use of value profile,
- further analysis to select weak points.

c) If the evaluation aspects are limited to two weakpoint factors, the frequency and the cost, the weak points can be selected by means of Pareto-diagram. This is shown for the case of loading machine in Fig.2.

The technical, organisation and economy conclusions can be used in weak point correction which is possible in three ways, in principle:

- modifying the design,
- modifying the operation and maintenance specifications,
- applying both of them.

The benefits of weak point correction

Besides the operator and the maintainer the fault information is needed first of all by the manufacturer in order to modernise the product and to raise its reliability. First of all the customer's service can supply these informations systematised to the development.

The gain of weak point correction based on the results of the mentioned examination (2) is demonstrated in Fig.3. The wearing out reserve (8) using up in time is characterised the average operation time. The weak point correction increases the average operation time evidently.

Due to the frequent failure of the rotating hydraulic distributor, the average operation time of this weak point was 339 hours. If this duration could be raised to the level of the next weakest element (hydraulic pipelines and fittings), then the average operation time of the complete machine would rise to 168 hours from 134 hours (approximately 25 % increase).

Thus the weak point correction modifies the shape of wearing out reserve curve favourably.

The reduce of the maintenance cost and of the loss due to machine lags are benefits to the operator. The higher dependability improves the market position of the product, so that the systematic weak point analysis and correction is primary interest of the manufacturer.

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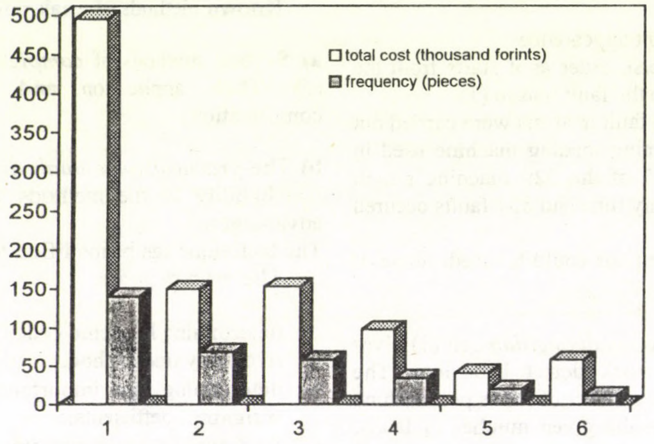

FIGURE 2.
Frequency and costs of fault locations
1 - rotating hydraulic distributor; 2 - hydraulic pipelines and fittings;
3 - control block and distributor; 4 - revolving column;
5 - hydraulic working cylinders; 6 - hydraulic pump

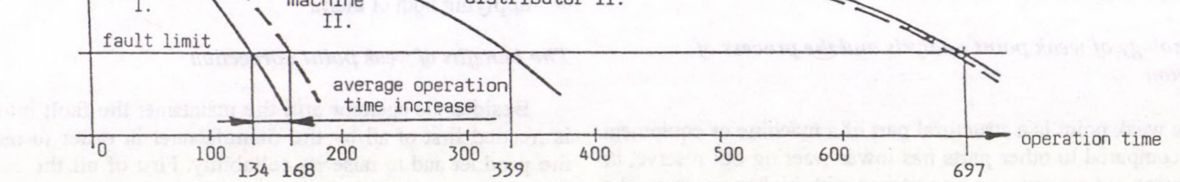

FIGURE 3.
The effect of weak point reparation on the average operation time of the machine

INFLUENCING MILKING FACTORS CONCERNING THE FREEZING POINT OF THE RAW MILK

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Preliminaries

Owing to the malfunction and unworkmanlike operation of the milking machine foreign water can get in the milk. Depending on its water volume, freezing point of the milk comes near to the 0 °C temperature.

Recently there was an increase in frequency of presence of the foreing water content among the milk samples taking in ten days intervals. In August of 1993 more than 25 % of the milk samples examined in raw milk qualifying laboratories contained foreign water. All these facts back up of the necessity of the examinations concerning the influencing factors of the freezing point of the raw milk.

Aim of the research was to explore connections among the factors that influence remaining and emptying of the foreign materials during the operation of the washing and rinsing systems, adding water of washing udder in the milk and quality of the milk.

Results of the examinations

Following a recirculating cleaning and rinsing milking system is adjuted for milk. During the milking process remained water in the cleaned spaces is mixed with milk and increase the water content of it.

In the course of examinations under operation following the cleaning and before milking remained water in units of the milking system was checked and measured.

Examined units were: milking unit, milk hose, milk line, receiver, milk pump, trap, and plate cooler.

In the case of omission of udder wiping, that should have to follow the washing, water from teats gets in the milking machine where it get mixed up the milk. According to our examinations volume of such kind of water from the four teats is about 1 cm^3.

Remained water in the milking system is an average of 30 litres after recycling washing. Most of the water can be found in the milk lines. It can be stored about 9 litres of water.

Volume and distribution of the remained water in milking units can be seen on Fig.1.

Conclusions

As it proved explicitly during the examinations of the milking and milk transporting processes that, apart from the intentional watering, the foreign water content of the raw milk consisted of the water coming from the inner spaces of the milking system (units) and the water from the surface of the udder.

In terms of formula:

$$y = m \cdot A + b$$

where:

y - volume of the total foreign water, in litre;
m - number of cows milked;
A - volume of water remained on the surface of the udder, in litre/cow;
b - volume of water remained in the inner spaces of the milking units, in litre

Amount of the total remained water (See Fig.2.) is basically determined by the water in the units (b), because the value of it is about 15-60 litres while at the same time in the case of 600 cows no more than 600 ml of water derives from the surfaces of their udders $(m \cdot A)$.

Remained water (b) consists of two parts. One part of the water could be let down (b_1), the other part could not be let down (b_2). The first (b_1) kind of water can be found for example in the receiver with pump, the second (b_2) is the water that can be found in the trap and milk line above the flap valve. Water of b_1 goes off in the case of careful operation or all of it remains in the unit for lack of skill.

Remained water in units in terms of formula is as follows:

$$b = K \cdot (b_1 + b_2)$$

where:

K - is a so called 'carefulness' factor

Foreign water content of the raw milk $(V_i, \%)$ can calculate in the knowledge of the total volume of foreign water (y) and the total amount of milk (Q):

$$V_i = \frac{y}{Q} \cdot 100 = \frac{m \cdot A + b}{m \cdot F} \cdot 100 = \left[\frac{A}{F} + \frac{b}{Q} \right] \cdot 100$$

where:

V_i - foreign water content (%);
y - volume of the total foreign water (litre);
Q - total amount of milk in one shift (litre)

$$Q = F \cdot m$$

where:

F - average milk production per cow (litre/cow);
m - number of cows milked

Foreign water content (V_i) is influenced by the following factors: – volume of milk water remained on the surface of the udder (A), average milk production (F), volume of water remained in the inner spaces of the milking unit (b), and the total amount of milk per shift (Q).

Remained water on the surface of the udder (A) increases the foreig water content of milk produced per shift by only hundreds of percents taking into consideration the 3-15 litre/cow average occasional milk production.

Table 1.
Volume and distribution of the remained technological water in the examined milking systems

Denomitation	Unit	Average volume	Distribution
Milking machines	cm^3	200	0.6
Receiver with pump	cm^3	3,970	11.8
Releaser milk pump	cm^3	1,200	3.5
Milk trap and milk line	cm^3	6,250	18.5
Milk tank	cm^3	6,075	18.0
Milk pump	cm^3	1,635	4.8
Plastic house milk trap	cm^3	2,700	8.0
Milk line	cm^3	8,750	25.9
Plate cooler	cm^3	3,000	8.9
Total	cm^3	33,780	100

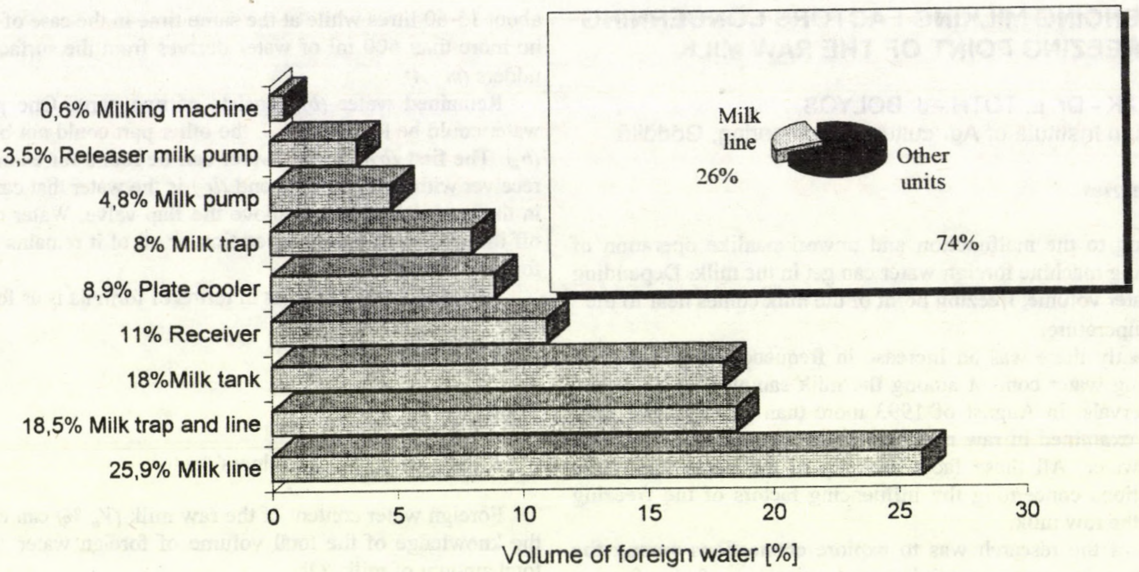

FIGURE 1.
Distribution of the foreign water in the milking units

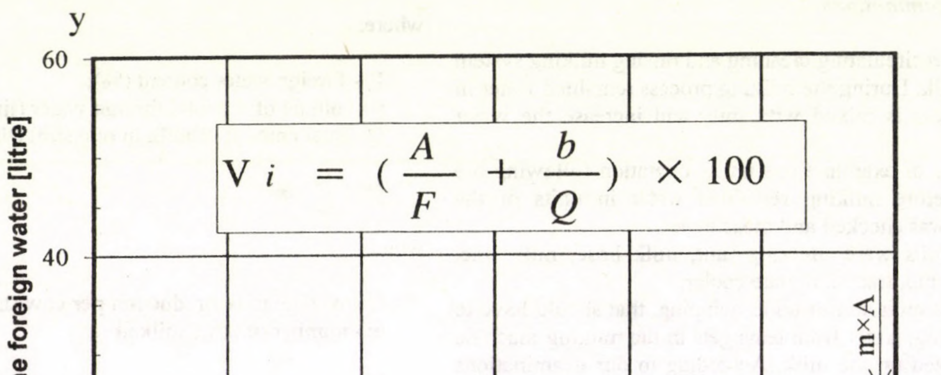

FIGURE 2.
Influencing factors concerning the foreign water content of the raw milk

SLIP/PULL RELATIONSHIP

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Introduction

The relationship between the slip and the pull has a principal influence on the tractive characteristics and the efficiency of the tractor and tillage implement combination. Generally this relationship is determined from the results of the measurement of the tractive characteristics of the tractor. During such a measurement a constant pull, or a relatively constant pull is set and the different characteristics are measured. However, during the tillage both the slip and the pull vary at a higher extent [1,2], than with the tractor drawbar test (Fig.1.).

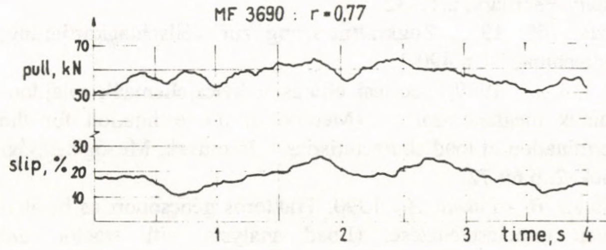

FIGURE 1.
Measured signals of the slip and the pull versus the time

The variations in the pull depend on the mode of the depth control, the variability of the soil resistance, the construction of the implement and on other factors mainly of stochastic character.

Objective

The objective of the paper reported herein is to determine the relationship between the slip and the pull and the variations in the relationship in the time domain when the slip and the pull are tested with tractor and plough combination under actual operating conditions.

Method and test conditions

Usually the slip and the pull were analysed separately, however the simultaneous analysis of the two variables provide with more information, than the sum of two separate analysis. This is especially true, if the variables are analysed as stochastic vector variables with respect to their momentary values, instead of the analysis of the usual average values.

Tests were performed on two different fields with two different tractor and implement combinations. With the test no. 1 a four wheel drive tractor (type: Rába 250) and semimounted plough (type: Rabewerk) were operated on a 300 m long field of loamy clay soil (moisture content: 23 %). The depth control mode used was position control.

With test no.2 a four wheel drive tractor (type: Massey Ferguson 3690) and semi-mounted plough (type: Agro Master 2804) were operated on a 1800m long field of sandy clay soil (moisture content: 18 %).

Results

The correlation analysis of the slip function and that of the pull function showed that the sampling period needed for the estimation of the expected values for confidence level of 95 % were as folows:

test no. 1:	for slip 2.08 s;	for pull 2.80 s;
test no. 2:	for slip 3.14 s;	for pull 4.46 s.

On this basis the sampling period and/or the sampling distance can be determined for the confidence estimation of the two components.

The correlation coefficients of the momentary values of the two components refer to a poor, or a medium close correlation ($r = 0.2\text{-}0.7$). Therefore occurs the question that a time delay can be found for the maximum of the connection, or not? In case of a sudden pull increase the system cannot response by a simultaneous slip increase. There is a definite moment of inertia of the tractor and implement combination and the drive line between the engine and the soil is a sophisticated vibrational system.

From the results and the analysis two possibilites can be assumed:

- the increase of the pull does not cause a considerable increase of the slip. This is shown by the phase displacement of approximatelly 0.1 s and a peak occurs in the cross correlation function.
- the increase of the pull does cause a considerable increase of the slip and therefore a relative reduction occurs in the pull. This phenomena is the result of the difference between cofficients of friction for sliding and rolling frictions (similar to the ABS with cars). In this case the correlation is negative.

The results show that the slip/pull relationship is definitely influenced by a stochastic character, since the correlation for the momentary values is poor (Fig.2.).

Therefore occurs the question how coulld be this correlation improved? To solve this problem, the average values were determined for different periods of integration. The well known and accepted exponential relationship between the slip and the pull was determined for different periods of integration. The result is: the longer is the period of integration, the closer is the correlation.

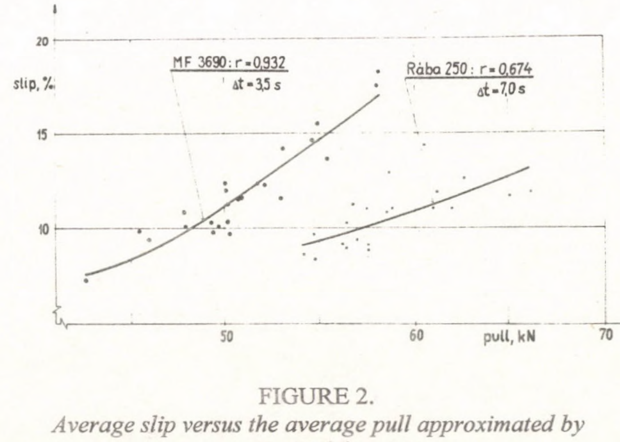

FIGURE 2.
Average slip versus the average pull approximated by exponential function

For $r = 0.8$ correlation coefficient the period of integration with the no. 1 test is 7.5 s and with the no. 2 test it is 0.5 s (Fig.3.). From these data one could conclude that the „noise" caused by the test conditions results in the poor coefficient of correlation. Consequently the period of integration can be calculated for a definite slip/pull process. The results show that the dynamic relationship gives a higher value of the slip [4] relative to the static relationship [3] where the variations in the pull are lower.

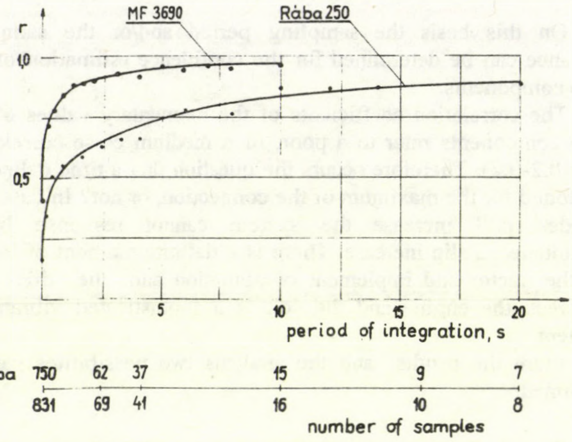

FIGURE 3.

Coefficient of correlation for slip and pull (average values) versus the period of integration and the number of samples

Conclusions

The conclusions are as follows:

- there is a similarity betwen the slip and the pull as correlated stochastic processes for the period of integration,
- the correlation of the slip/pull relationship is poor on the basis of the momentary values, and the maximum of the correlation occurs when the time displacement is not equal to zero,
- the time delay is not the same for the two tests, the reason can be originated in the soil conditions, running gears of the tractor, the control mode of the hitch, etc.,
- the longer is the period of integration for the two variables. The better is the correlation betwen them and therefore there is a difference between the static and dynamic relationships.

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THE DETERMINATION OF PHYSICAL CHARACTERISTICS OF SEEDS FOR THE CONSTRUCTION OF SEEDING MACHINES

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Modern cultivation technology means stricter and stricter requirements for sowing machines. Precise portioning are of special importance among work quality indecies for these machines. Thus physical charactereistics of seeds must be taken into consideration in the design and development of sowing devices. This study summarizes our initial results in this field.

Introduction

As the physical characteristics of seeds can strongly influence their movements in the seeding machine as well as in the air, it is essential to study them when constructing seeding machines. In this respect the size, shape, coefficient of friction and aerodynamic resistance of the grains are of great importance (1). Our objective in the first phase of the research was to determine phisical characteristics of wheat grains.

Due to their irregular shape, determining the size of wheat grains is a troublesome process. a precise description of grains has to include several sizes (length, width, thickness) and can be obtained from the screen size of the corns (2-5).

Several methods have been used to measure the coefficient of friction for particles (6-7). It can be obtained by using an inclined plate. The tangent of the angle of inclination, where the particles start to slide, is equal to the coefficient of friction (8). Another device is the shear apparatus, a box which is open at the bottom. It is loaded with grains and placed on a friction surface. The force required for the motion of the box is the friction force (9-12). The friction surface can be placed on the top of the box as well (12). Another device is the roating plate, where the force required to keep the sample in the same position on the plate is equal to the friction force (11). If using another technique, we can move the sample on the friction surface forwards and backwards (13-15). The coefficient of friction is strongly influenced by the type and surface characteristics of the grain and the friction material, environmental conditions and the velocity relative to the friction surface layer.

The shape, mass and surface of the grains have a significant influence on their movements in the air. Coarser particles have higher aerodynamic resistance. To determine the coefficient of aerodynamic resistance we have to study the density of air as well as particle density. The density of air can be obtained from the temperature, pressure and humidity of the air (16). Particle density can be determined by using a dry pycnometer (17-19), measuring the porous space (6-7). We can use the fall time (11) to calculate the aerodynamic resistance. By increasing the falling distance of particles we can reach the constant velocity which can be used to determine the aerodynamic resistance (20). Critical air velocity can be determined by air moving in a vertical tube (21). To insure the constant velocity we can use a tube narrowing upwards (17).

Measurement method

We have chosen six-either presently used or potential- wheat types for the experiment *(Alföld 90 [A-90], Matonvásári 18 [M-18], Martonvásári 22 [M-22], Öthalom [Öth], Zombor [Zom], Zugoly [Zug]),* with samples of 50 g each (1000-1800 grains). 3 grain characteristics (length, width, thickness) were determined with an accuracy of 0.01 mm. We have analyzed and represented collected data by computer.

We have measured critical air velocity of the grains between 7.93 and11.21 m/s, and divided them into 7-17 groups, according to their critical air velocity. For the experiment we have used a wind channel with adjustable air velocity. We have analyzed and represented collected data by computer.

We have determined the frictional coefficient of the grains. After randomly choosing 20 grains from each group, we have placed them on our measuring device, an ungraduated adjustable-angle plate. The sliding surface was stainless steel, and we could change the angle between 0°-90°. By gradually changing the angle of the plate -repeating the process five times- we have determined the angle where the particles have started to slide. The tangent of this angle was the coefficient of friction between the grain and the friction surface.

Measurement results

Grain size distribution

We have found significant size deviations among different wheat types. Within each type both width, length and thickness of grains have shown large size variance. Let us list the data of the *M-18* wheat grains, as an example (Fig.1.). Average *width* 3.39 mm; median width 3.44 mm; mean width 3.54 mm; variance 0.30 mm; minimum width 2.26 mm; maximum width 4.03 mm. Average *length* 7.25 mm; median length 7.29 mm; mean length 7.3 mm; variance 0.60 mm; minimum length 5.27 mm; maximum length 8.97 mm. Average thickness 2.89 mm; median thickness 2.9 mm; mean thickness 2.92 mm; variance 0.23 mm; minimum thickness 2.01 mm; maximum thickness 3.89 mm.

The width, length and thickness distribution of grains are asymmetrical to the median value, and the asymmetry is not significally unidirectional (Fig.2.). From Fig.2, we can see that 85 % of the grains fall into the ± 0.5 mm interval of the average width value. Respective figures for the length and thickness values are 77 % and 95 %.

Based on our experiments we can say that there is a significant deviation among sizes of the difference wheat types, as the conducted variance analysis has shown that there is a significant difference among the mean values of the examined wheat types at a $P = 0.1$ % level.

Critical air velocity

In our experiment we have tried to identify the factors influencing the movement of grains in the air. Thousand seed mass and grain sizes have differed significantly among the groups formed on the basis of critical air velocity.

- Relation between critical air velocity and thousand seed mass

In the case of *A-90* , thousand seed mass has changed between 27.00 g and 52.94 g. Respective figures for *M-18* were 33.33 g and 55.44 g; for *M-22* 12.49 g and 39.99 g; for *Öth.* 23.8 g and 50 g; for *Zom.* 19.23 g and 49.99 g; and for *ZUG.* 20 g and 45.45 g. So the thousand seed mass, generally used in practice, is an average figure representing grains with significantly different masses. Fig.3. shows the relation between critical air velocity and thousand seed mass for the six examined wheat types. We have to note that for the various wheat types we have measured different thousand seed masses for the same critical air velocity. Hence we can conclude that critical air velocity is influenced by factors other than thousand seed mass.

• Relation between the critical velocity and grain size

By measuring grain size in each group we have determined the relation between critical air velocity and grain size. We have found that for the various wheat types we measured different grain sizes for the same critical air velocity. As extremes we show the *M-18* (Fig.4.) and *M-22* (Fig.5.). Based on the figures we can conclude that the grain,s movement in the air is influenced by the grain size, however, there are factors, influencing the grain,s critical air velocity, others that thousand seed mass and grain size. According to our analysis we can say that the closest relationship among the examined factors is between the critical air velocity and the thousand seed mass. The relationship can be most accurately described with a parabolical function. In the case of *M-18* the function between the critical air velocity and the thousand seed mass shows Eq. (1):

$$Y = 10.2941 - 0.641667 \cdot X + 0.103760 \cdot X^2$$

In this case the *coefficient of correlation is 0.9964,* the *coefficient of determination is 0.99,* and the *F-value is 344.089 (0.001).*

Measurement of the coefficient of friction

During the experiments we have found no significant difference among the coefficient of friction of the different wheat types on a stainless steel surface. We haven,t found any significant deviation among the coefficients of friction for the grain groups formed by the critical air velocity measurement, either. The value of the coefficient of friction varied between 0.3 and 0.4 in both cases.

Conclusion

1. We have found significant grain size differences both within one type and among several types of wheates. In the case of the *M-22* the width, length and thickness size was 2.15/4.6/2.05 mm in the group with the smollest grain size; and 3.35/5.85/3.0 mm in the group with the largest grain size. Respective figures for the *A-90* were 2.8/6.3/2.8 mm and 3.3/7.15/3.25 mm.

2. The thousand seed mass differs significantly in the case of wheat grains. In the case of the *M-22* the thousand seed masses of the different groups varied between 12.49 g and 39.99 g. Respective figures for the *M-18* were 33.33 g and 55.40 g.

3. According to our experiments the most important characteristic is the grain,s critical air velocity. In our case it has varied between 7.93 m/s and 11.21 m/s.

4. We have measured different grain sizes for the same critical air velocity for different wheat types.

5. We have measured different thousand seed masses for the same critical air velocity for different wheat types.

6. The relationship between the critical air velocity and the thousand seed mass is of special interest.

7. As we have measured different grain sizes an thousand seed masses for the same critical air velocity in the case of various wheat types, we have concluded that the movement of grains through the air is influenced by factors other than the afore mentioned ones.

8. There was no significant difference among the coefficients of friction for grains of various types, grain sizes and thousand seed masses on stainless steel surface. Its value has varied between 0.3 and 0.4.

9. The relationship between the critical air velocity, the grain size and the thoiusand seed mass can be most accurately described by a parabolic function.

10. According to the result of our experiments further measurements are required to determine other grain characteristics.

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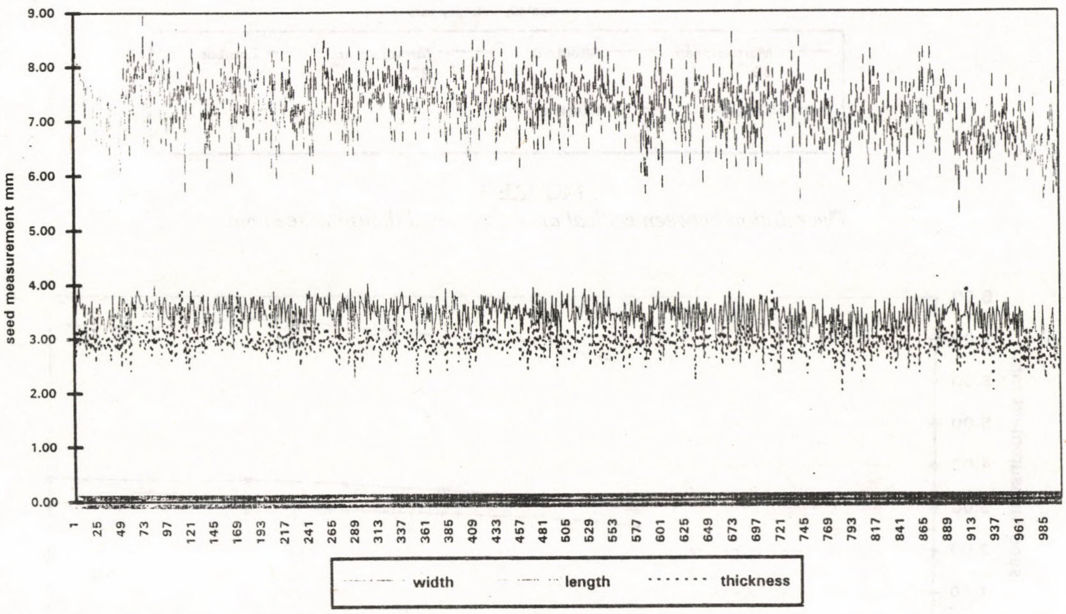

FIGURE 1.
Survey datas of the wheat , Martonvásári 18

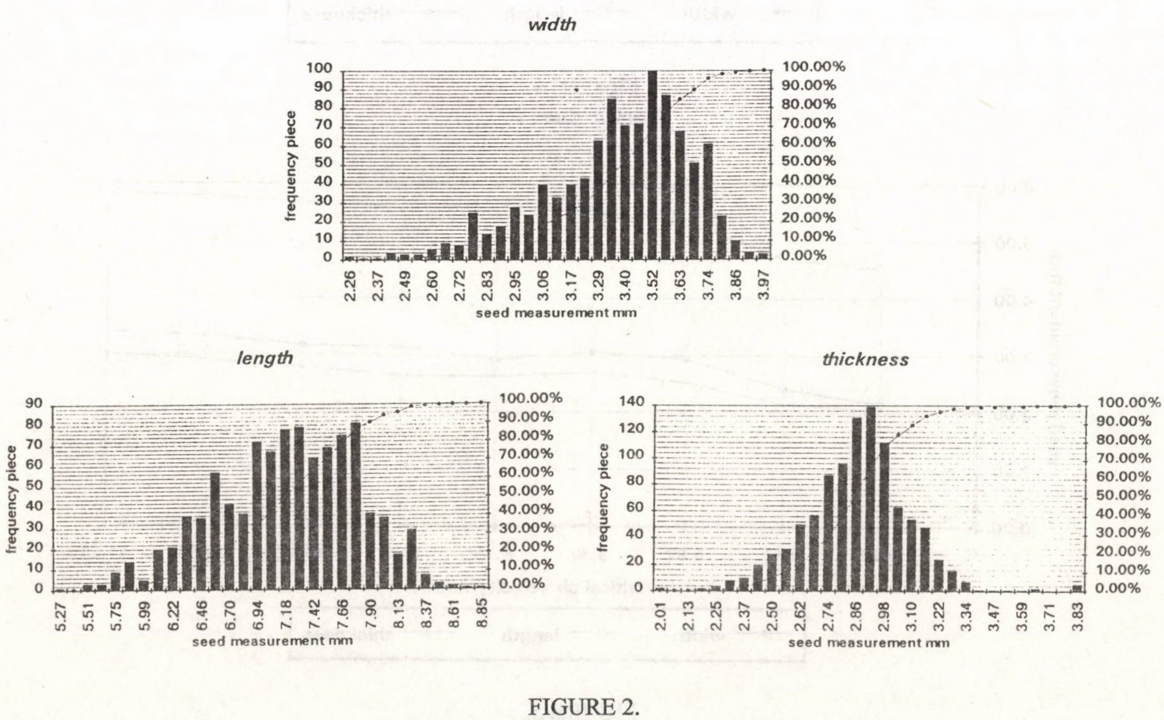

FIGURE 2.
Distribution of the wheat , Martonvásári 18

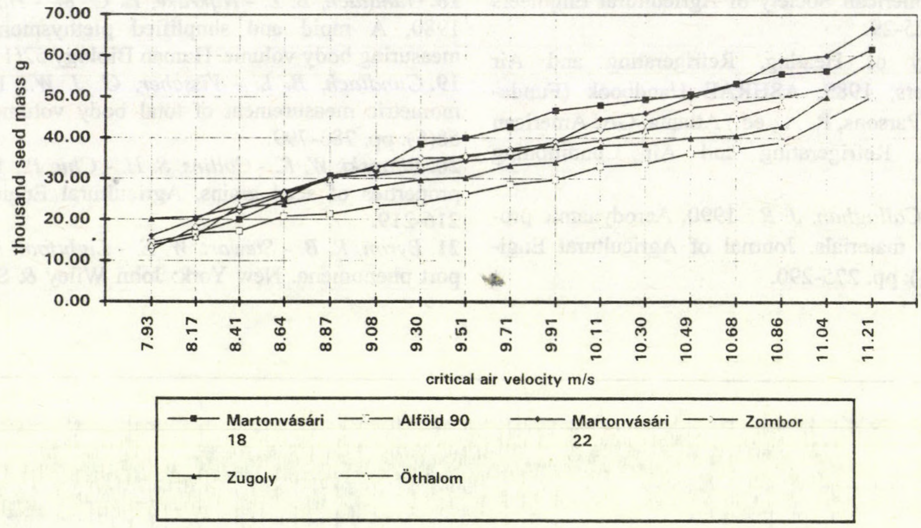

FIGURE 3.
The relation between critical air velocity and thousand seed mass

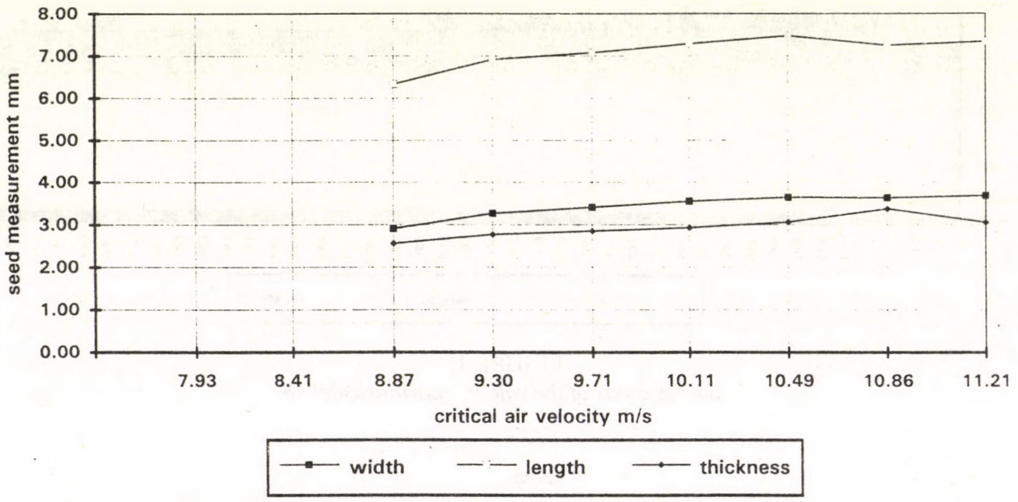

FIGURE 4.
Martonvásári 18

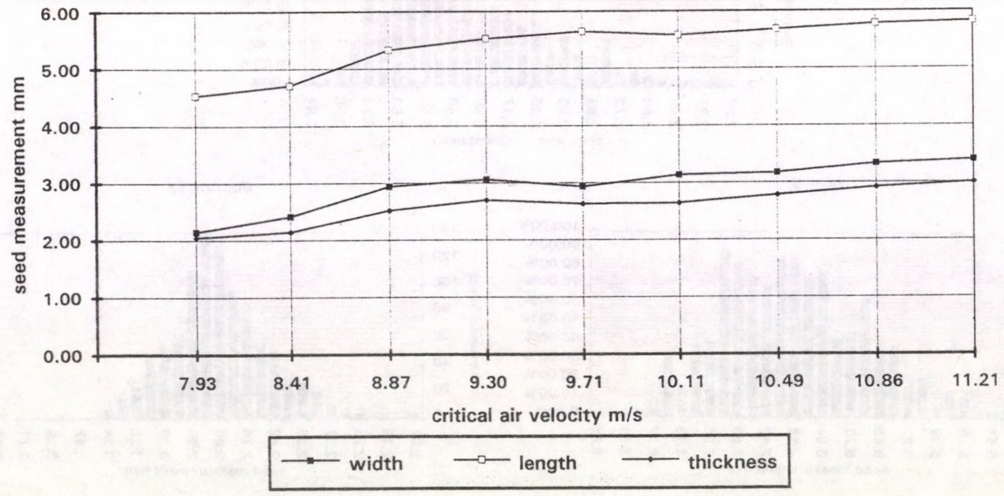

FIGURE 5.
Martonvásári 22

VACUUM COOLING OF VEGETABLES

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Refrigerated vacumm cooler

The scheme of vacuum cooler is illustrated in Fig.1.

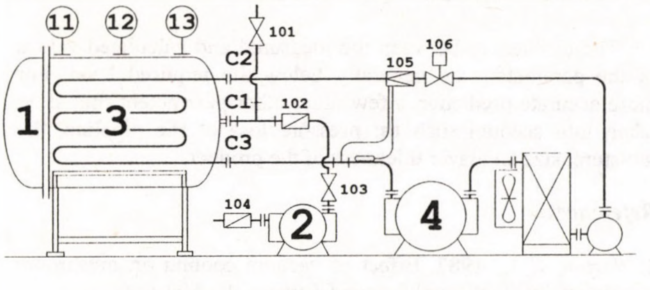

FIGURE 1.
1 - Vacuum chamber; 2 - Oil-ring vacuum pump;
3 - Ice condenser coil; 4 - Refrigerator;
11 - Thermocouples; 12 - Pressure gauge;
13 - Scales; 101-106 - Control elements

For vacuum cooling the product on tray is placed into the vacuum chamber (1). Having closed the door of the chamber the evacuation is started by the vacuum pump (2). As a result of this procedure the pressure has to be dropped down to the level of 7 mbar inside the vessel.Having reached the vapour tension corresponding to the actual temperature of the product that begins to evaporate. The latent heat of evaporation is extracted from the product itself so the product temperature is reduced. The vater vapour released from the products is removed by the ice condenser coil (3). The coolant for ice condenser is provided by the refrigerator (4).

For vacuum cooling of mushroom the temperature was measured by coper – constantan thermocouples. The pressure was shown by an Edwards pressure gauge. The weight loss of the product during the vacuum cooling procedure was checked by an electronical scales with accuracy of one gram. All the results were recorded by data logger system.

Calculation method for refrigerated vacuum cooler

For energetical optimization of a refrigerated vacuum cooler three aspects of the total procedure is to be investigated and is to be harmonized with each others such as:

- heat and mass transfer properties of the product,
- evacuation speed of vacuum pump used, and
- cooling capacity of the ice condenser and refrigerator.

As for the first aspect the product is considered to be suitable for vacuum cooling and just the other two factors are taking into account for the calculation of vacuum cooler.

The Fig.2. shows the changing of product surface temperature as a function of the pressure inside the vacuum chamber.

In the term of this figure the cooling procedure can be devided into three sections such as:

- evacuation of vacuum chamber to reduce the pressure down to the level of the water vapour tension corresponding to the initial temperature of the product *(p_{fp})*, that is called as „flash point" *(τ_{f1})*,
- evacuation of vacuum chamber further on down to the level of the so called remainder pressure *(p_v)* cerresponding to the final temperature of the product wanted *(τ_{f2})*,
- cooling of the product starting by the flash point from the initial temnperature *(t_0)* down to the final temperature of the product *(t_v), (τ_h)*.

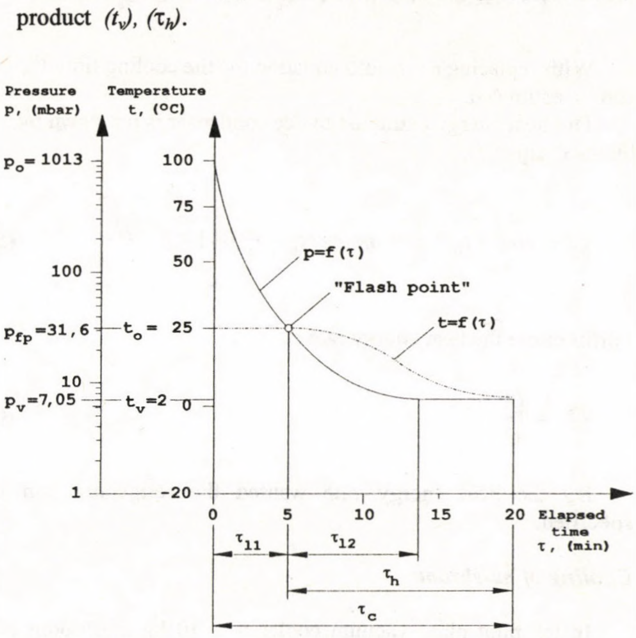

FIGURE 2.

In the first section of evacuation the flash point has to be reached as fast as possible. The sunction (evacuation) speed of the vacuum pump can be calculated by the following equation:

$$S = \frac{V}{\tau_{f1}} \cdot ln\frac{p_0}{p_{fp}} \cdot \varepsilon \cdot \frac{1}{\eta} \quad (m^3/s) \tag{1}$$

Having reached the flash point the evaporation of the product water content as well as the cooling of the product begins. The heat energy balance of the procedure can be presented as it follows:

$$\frac{dt}{d\tau} \cdot \left[(m - \frac{dm_p}{d\tau} \cdot d\tau) \cdot c \right] = r \cdot \frac{dm_p}{d\tau} \tag{2}$$

In the second section of the vacuum cooling the vapour is removed by the ice condenser still the vacuum pump is to eliminate the remainder air and the air leaked into the vessel. The heat energy balance for this sections can be put down by the following formula:

$$k \cdot A \cdot (t - t_e) = c \cdot m \cdot \frac{dt}{d\tau} + c \cdot m \cdot \frac{dt}{d\tau} \cdot \frac{c_v \cdot t}{r} +$$

$$+ c \cdot m \cdot \frac{dt}{d\tau} \cdot \frac{L}{r} \tag{3}$$

In the equation (3) the first part of the right side is for the condensation heat of the vapour, the second one is for the undercooling heat of the liquid down to the freezing point finally the third one is for the freezing heat of the condensed liquid. Eliminating the second part and solving the differential eguation a formula can be set up between the cooling time and the surface temperature of the product:

$$\tau = \left[\frac{c \cdot m}{k \cdot A} \cdot \left(1 + \frac{L}{r}\right)\right] \cdot ln\frac{t_0 - t_e}{t - t_e} = H \cdot ln\frac{t_0 - t_e}{t - t_e} \quad (4)$$

With replacing $t = t_v$ into equation (4) the cooling time (τ_h) can be estimated.

The heat energy extracted by ice condenser is put down by the next equation:

$$Q = m \cdot c \cdot (t_0 - t) = m \cdot c \cdot (t_0 - t_c) \cdot \left[1 - e^{-\left(\frac{\tau}{H}\right)}\right] \quad (5)$$

Furthermore the heat energy rate :

$$Q_0 = \frac{Q}{\tau} \quad (6)$$

By the heat energy rate wanted the refigerator can be specified.

Cooling of mushroom

In teh pilot plant vacuum cooler m = 10 kg mushroom was cooled for test the work of the equpment as well as the accuracy of calculation methon to predict the the time of the total procedure. The cooling time measured for mushroom is shown in Fig.3.

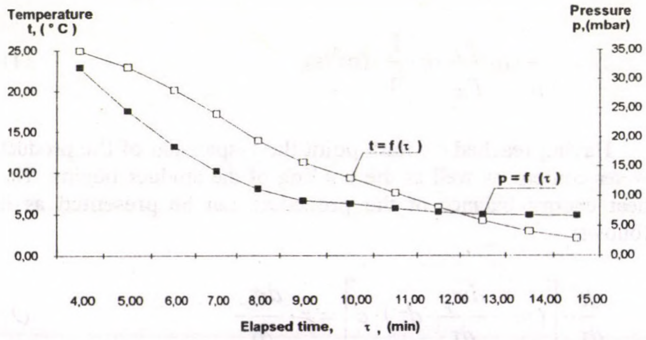

FIGURE 3.

The graph verifies that the vacuum cooling is a real rapid cooling method in the case mushroom as well.

Comparison of the measured and the calculated parameters

In the equation of (1) - (6) the following data were taking into account to calculate the time of the different sections of vacuum cooling procedure:

m = 10 kg; V = 0.5 m^3; p_0 = 1.013 mbar; t_0 = 25 °C;
p_{fp} = 31.6 mbar; t_v = 2 °C; p_v = 7 mbar; c = 3.8 kJ/kg K;
r = 2,460 kJ/kg; L = 334 kJ/kg K; A = 5.5 m^2;
k = 0.017 kW/m^2 K; t_e = -15 °C

The calculated and measured parameters are:

Evacuation time:	τ_{l1c} = 3.48 min	τ_{l1m} = 4.1 min
Cooling time:	τ_{hc} = 6.56 min	τ_{hm} = 9.8 min
Cooling energy rate:	Q_{0c} = 2.22 kW	Q_{0n} = 3.0 kW

The differences between the measured and calculated values of the parameters are generally below the required level. For more accurate prediction a few more other parameters sholud be taken into account such as: pressure loss of the pipeline, the moisture, size and layer thickness of the product.

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List of symbols

τ	time, s
ε	leakage coefficient of vacuum pump, 1.1
η	volometrical efficiency of vacuum pump, 0.8
τ_h	cooling time, s
τ_c	total time, s
τ_{l1}	evacuation time untill flash point, s
τ_{l2}	evacuation time between flash point and remeinder pressure point, mbar
A	area of ice condenser, m^2
c	specific heat coefficient of product, kJ/kg K
k	heat transfer coefficient of ice condenser, kW/m^2 K
L	freezing heat of water, kJ/kg
m	mass of product, kg
m_p	mass of vapour, kg
p_{fp}	vapour pressure on product input temperature, t_0, (flash point), mbar
p_o	atmospheric pressure, mbar
p_v	remainder pressure, mbar
Q	heat energy, kJ
Q_0	heat energy rate, kW
r	latent heat of evaporation, kJ/kg
S	sunction speed of vacuum pump, m^3/s
t	temperature, °C
t_e	evaporation temperature of ice condenser, °C
t_0	inlet temperature of product , °C
t_v	outlet temperature of product , °C
V	volume, m^3

PARAMETER ESTIMATIMATION OF SZENDRŐ CHAFF LENGTH DISTRIBUTION

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The chaff length distribution is an important characteristics of the chaff chopped by machines. It is known that the histograms taken from representative samples are dissymmetrical and similarly to the logaritmic normal distribution are stretched along *x* axis. such a way the homogenity of the chaff are described only approximately by the empiric expectable (mean) value and the deviation. At the same time these parameters of chaff length distribution are hardly applicable to characterise chopping machines. Such research is induced by these problems which try to explain the distribution characteristics starting from the physical phenomenon, the nature of the chopping. In this aspect the analysis of P. Szendrő (1976) is claimed as a most successful one.

According to the Szendrő's assumption the shape of empiric density function depends basicly on three factors, such as the alterations and orientation of the maize plant and the processes taking place in the machine. The Szendrő frequency function is a complex function composed from the mix of three distributions:

$$\hat{h}(x) = \hat{P} \cdot f(x) + \hat{Q} \cdot g(x) + \hat{R} \cdot e(x) \qquad (1)$$

The frequency functions of component distributions are

$$f(x) = \frac{1}{\sqrt{2\pi} \cdot S_1} \cdot e^{-\frac{(x-M_1)^2}{2 \cdot S_1}} \qquad 0 < x \le M_2 \qquad (2)$$

which are the frequency function of normal distribution (ξ) probability variable with S_1 and M_1 parameters.

$$g(x) = \begin{cases} \frac{1}{M_1} & \text{if } 0 < x \le M_1 \\ 0 & \text{if } x > M_1 \end{cases} \qquad (3)$$

is the density function of uniform distribution probability variable (η) with M_1 parameter.

$$e(x) = a \cdot (x - M_2)^2 \qquad M_1 < x \le M_2 \qquad (4)$$

is the density function of parabolic distribution probability variable (ρ) with M_2 and a parameters.

The first distribution relates to the properties of of the chopping equipment, namely to the inaccuracy of blade positions and to the fluctuation of drum revolution and the material flow. Thus the M_0 theoretical chuff length (which is set at the machine) can be considered as an estimation of M_1 parameter, ie. the length of a certain part of the chuff bulk is a normal distribution probability variable with M_0 mean. This heap is called purely cut part.

The other component distribution is explained that the L_i size maize plant parts are not exactly the multiple of the chuff length. Such a way in the course of cutting process L_i-nM_0 size so called fragment part is produced. The length of the fragments are between 0 and M_0. According to the hypothesis the probability of the occurance of any length is the same, therefore this component probability variable is interpreted as uniform distribution one.

The oversized chuff can not be considered normal distribution ones but rather they shows up quadratic distribution. This is characterised by the third component of the frequency function. The reasons for occuring oversized chuff are that the axis of plant parts are not always oriented perpendicularly to the blades of the chopping drum. It can be proven that offperpendicularly fed plants produce quadratic distribution. (Szendrő, 1976).

Due to the spatial settling, the distribution density function for alfalfa chuff – differently from maize chuff – is a mix of two distribution types as follows:

$$\hat{h}(x) = \hat{P} \cdot f(x) + \hat{R} \cdot e(x) \qquad (5)$$

where *f(x)* normal and *e(x)* parabolic distribution functions are interpreted in the interval 0-M_2.

In order to make conclusions from the histogram of the representative samples for the chopping machine properties and to qualify the chuff bulk, the distribution parameters should be produced. In the first approximation seven parameters are to face in the case of maize:

$$(S_1, M_1, M_2, a, \hat{P}, \hat{Q}, \hat{R}) \qquad (6)$$

and six parameters for alfalfa:

$$(S_1, M_1, M_2, a, \hat{P}, \hat{R}) \qquad (7)$$

In both cases the parameter estimations are non-linear. Fortunately the parameters are not independent on each other. Furtherly the possibilities of reducing the number of parameters are searched.

First *a* parameter of maize chuff distribution is considered. As

$$\int_{M_1}^{M_2} e(x)dx = a \cdot \int_{M_1}^{M_2} (x - M_2)^2 dx =$$

$$= a \cdot \left[\frac{(x - M_2)^3}{3} \right]_{M_1}^{M_2} = -a \cdot \frac{(M_1 - M_2)^3}{3} = 1 \qquad (8)$$

the parameter is expressed

$$a = \frac{3}{(M_2 - M_1)^3} \qquad (9)$$

Thus *a* parameter can be written as function of M_1 and M_2, with which:

$$e(x) = \frac{a \cdot (x - M_2)^2}{(M_2 - M_1)^3}; \qquad M_1 < x \le M_2 \qquad (10)$$

In the chuff mix the sum of the parts gives

$$\hat{P} + \hat{Q} + \hat{R} = 1 \qquad (11)$$

so that each part can be expressed with the remaining twos.

The number of parameter can be reduced further if M_e average chuff length is assumed to be the undistorted estimation of the $\hat{M}(\mu)$ expectable value of $\hat{h}(x)$ density function. First the expectable value of $\hat{h}(x)$ is determined:

$$M(\hat{\mu}) = \hat{P}\cdot\int_{-\infty}^{\infty} x\cdot f(x)dx + \hat{Q}\cdot\int_{0}^{M_1} x\cdot g(x)dx + \hat{R}\cdot\int_{M_1}^{M_2} x\cdot e(x)dx\,; \quad M(\hat{\mu}) = M_1 + \hat{Q}\cdot\int_{0}^{M_1}\frac{x}{M_1}dx + \hat{R}\cdot\int_{M_1}^{M_2} x\cdot\frac{3\cdot(x-M_2)^2}{(M_2-M_1)^3}dx \qquad (12)$$

After integration we have

$$M(\hat{\mu}) = \hat{P}\cdot M_1 + \hat{Q}\cdot\frac{M_1}{2} + \hat{R}\cdot\frac{M_2+3\cdot M_1}{4} \qquad (13)$$

Making use of $\hat{Q} = 1-\hat{P}-\hat{R}$ relationship the mean expectable value of the complex distribution is

$$M(\hat{\mu}) = \frac{M_1}{2} + \hat{P}\cdot\frac{M_1}{2} + \frac{\hat{R}}{4}\cdot(M_1+M_2) \qquad (14)$$

Expressing the oversized part and substituting $M(\hat{\mu}) = M_e$ gives

$$\hat{R} = \frac{4\cdot M_e - 2\cdot M_1 - 2\cdot\hat{P}\cdot M_1}{M_1+M_2} \qquad (15)$$

The number of parameters can be reduced to four $(S_1, M_1, M_2, \hat{P})$.

Note that the last hypothesis is advantageous not only from the aspect of the number of parameters, but the deviation between the expectable values of the histogram and the fitted density function will be small. One will be able to see that the hypothesis decrease the risk of finding a local optimum instead of the actual one.

The fitting of the $g(x)$ and $e(x)$ functions is ensured in the point M_1 by determining the density function of uniform distribution from the condition

$$\hat{Q}\cdot g(x) = \hat{R}\cdot[e(x=M_1)] = \hat{R}\cdot\left[\frac{3\cdot(x-M_2)^2}{(M_2-M_1)^3}\right]_{x=M_1} = \hat{R}\cdot\left[\frac{3\cdot(M_1-M_2)^2}{(M_2-M_1)^3}\right] \qquad (16)$$

The alfalfa length distribution parameters are reduced in a similar way. First a parameter is determined:

$$\int_{0}^{M_2} e(x)dx = a\cdot\int_{0}^{M_2}(x-M_2)^2 = a\cdot\left[\frac{(x-M_2)^3}{3}\right]_{0}^{M_2} = a\cdot\frac{M_2^3}{3} = 1 \qquad (17)$$

from which

$$a = \frac{3}{M_2^3} \qquad (18)$$

and

$$e(x) = \frac{a\cdot(x-M_2)^2}{M_2^3}\,; \quad 0 < x \le M_2 \qquad (19)$$

The sum of components ratios is unit, thus

$$\hat{P} = 1-\hat{R} \qquad (20)$$

Here it is assumed that the M_e chuff length calculated from the histogram is an undistorted estimation of the $M(\hat{\mu})$ expectable value of $\hat{h}(x)$ density function.

So that

$$M(\hat{\mu}) = \hat{P}\cdot\int_{-\infty}^{\infty} x\cdot f(x)dx + \hat{R}\cdot\int_{0}^{M_2} x\cdot e(x)dx\,;$$

$$M(\hat{\mu}) = M_1 + \hat{R}\cdot\int x\cdot\frac{3\cdot(x-M_2)^2}{M_2^3}dx \qquad (21)$$

After integration

$$M(\hat{\mu}) = \hat{P}\cdot M_1 + \hat{R}\cdot\frac{M_2}{4} \qquad (22)$$

Making use $\hat{R} = 1-\hat{P}$ and $M(\hat{\mu}) = M_e$ we obtain

$$\hat{P} = \frac{4\cdot M_e - M_2}{4\cdot M_1 - M_2} \qquad (23)$$

The nuber of parameters in the case of alfalfa is reduced three (S_1, M_1, M_2).

The aim of the parameter estimation is to minimise the deviations of the measured $\tilde{y}_i$ and the calculated $f(\mathbf{x}_i, \mathbf{p})$ values with the suitable selection of **p** parameters. One criterium of this can be the minimisation of the function

$$Q(\mathbf{p}) = \sum_{i=1}^{n}\left[\tilde{y}_i - f(\mathbf{x}_i,\mathbf{p})\right]^2\cdot w_i \qquad (24)$$

characteristic to the deviation. In the formula w_i is the weight of ith measurement in the square sum. The method is called least square method.

The minimising procedure is included into the flow chart of Fig.1. The heuristic method lays upon the the assumption that that the sign of the optimum parameter values are known and there is only one existing value. A further principal condition that the fitted function is writeable in the $y = f(\mathbf{x}, \mathbf{p})$ form. The method itself is very simple.The basic conception: when the estimation is improving the division steps are inreased, when getting away from the optimum, the division steps are decreased to the half and the direction is changed. In the approximation one time only one parameter value is changed, but in one iteration all the parameters are varied.

In the algorythm one convergence factor $(0 < e_i < 1)$ is ordered to each parameter and the parameter value is changed by the formula

$$p_i = p_i \cdot (1 - e_i) \tag{25}$$

Following this the effect of the change to the goal function is examined. If its value is increasing the value of e_i is reduced to half of the previous value and the sign is changed and the p_i parameter value is modified according to the above formula and the change of the goal fuction is recomputed. It the value of the goal function is decreasing e_i is increased and the next parameter is taken. According to the experience 1.2 times value increase can be offered. The procedure finishes when the relative change in the goal function is below the given small ε value, i.e.

$$\frac{Q(p)^j - Q(p)^{j+1}}{Q(p)^{j+1}} \leq \varepsilon \tag{26}$$

where $j = 1, 2, ..., m$ the number of iterations.

In Fig.2. and 3. computer fitted density functions and and parameters as examples.

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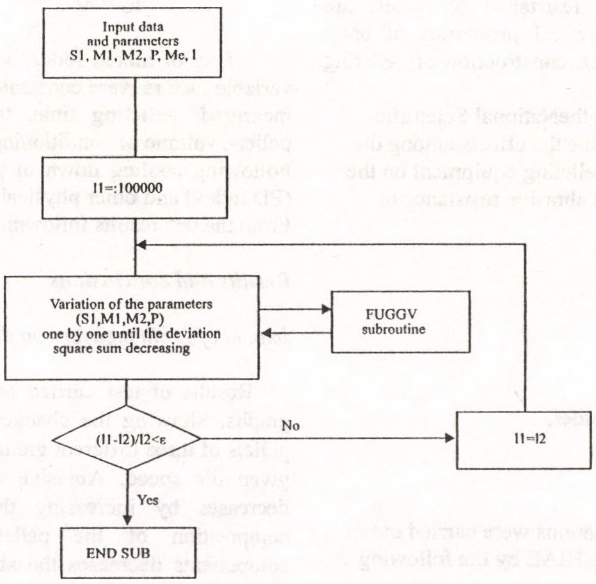

FIGURE 1.
Flow chart of the process

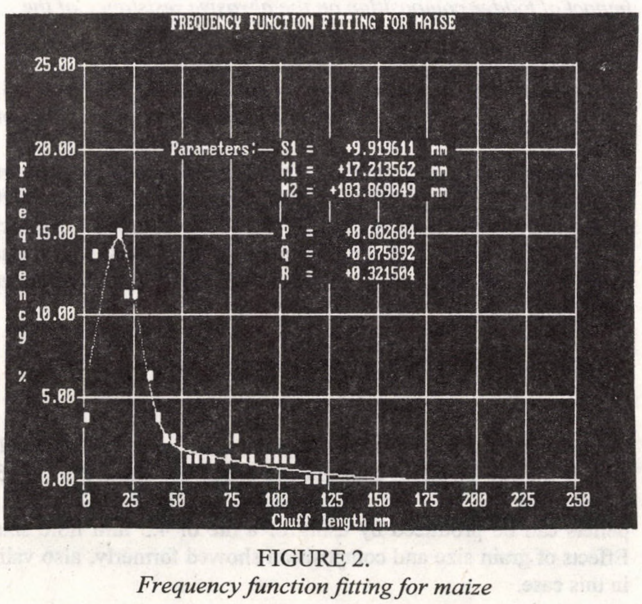

FIGURE 2.
Frequency function fitting for maize

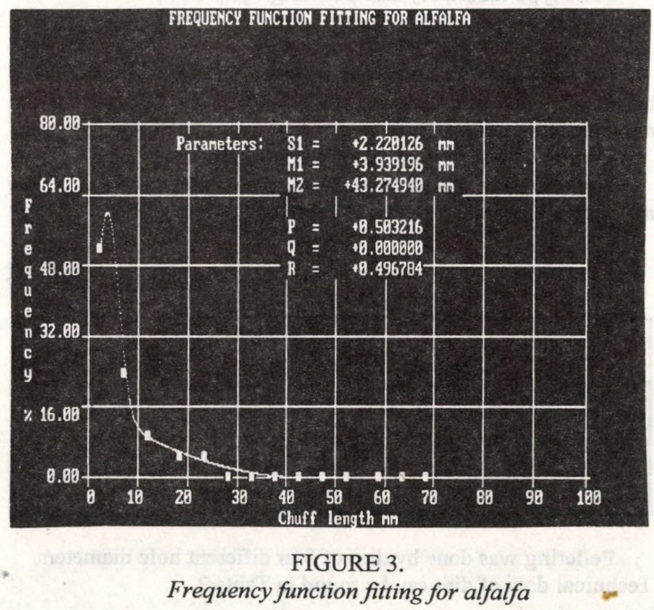

FIGURE 3.
Frequency function fitting for alfalfa

INFLUENCE OF THE TECHNOLOGICAL CHARACTERISTICS ON ABRASIVE RESISTANCE

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Introduction

Granular fodder production in increasingly volume entails increasing requirements against the quality of pellets. Owing to the abrasion during the pelleting process on the repeated mechanical or pneumatic conveying, formation of dust and scrap proportion of fodder pellet is a well known problem. Fodder is distributed to animals in such state those advantages become invalid that come together with pellet feeding, and at the same time pelleting, having added cost, seems to be unnecessary. Advantages of pelleting are among others cessation of fractioning during transportation, decreasing of dust loss of the valuable components and decreasing the number of the animals sickness of respiratory organs as well as moderation of storage loss.

Required strength and abrasive resistance of pellets are influenced by many factors e.g. physical properties of basic material, composition of mixed fodder, construction of pelleting machines, pelleting process and so on.

Aim of the research, sponsored by theNational Scientific Research Fund (OTKA), was to examine the effects among the granular fodder components and the pelleting equipment on the physical characteristics, mainly on the abrasive resistance of pellets.

Method and measures

Main characteristics:

- composition of the mixed fodder,
- average grain size of the mixed fodder,
- hole size of the die,
- periphery speed of the die.

Pelleting experiments and examinations were carried out in the laboratory of the Division 3. of the HIAE by the following production line:

- Petkus K-294 A type grate set,
- Lödige M5 type laboratory size mixer,
- CPM type laboratory size pelleting equipment,
- Q-Tester type abrasion tester.

For the purpose of the experiments grinded grain was riddled by the grate set and was fractioned by 0.5 mm, 1.5 mm and 2.5 mm particles.

Results of screen analysis of wheat can be seen in Fig.1.

Three kind of fodder mixture were composited from the raw material of different grain size (Table.1.)

Table 1.
Composition of mixed fodder

Code & Fodder	Composition (%)			
	Maize	Wheat	Barley	KP premix
ö1	70	12	12.5	5
ö2	40	27.5	27.5	5
ö3	20	37.5	37.5	5

Pelleting was done by dies of four different hole diameters. Technical data of dies can be found in Table 2.

Table 2.
Technical data of dies

Die				Number	Area of	Flow
Diameter of hole d (mm)	Diameter D (mm)	Length of hole l (mm)	l/d ratio	of holes (pcs)	hole (cm2)	coeffi-cient
3.2	165.2	19.1	6.0	4x84	27.0	0.267
4.5	177.0	25.4	5.6	3x60	28.6	0.282
6.0	190.5	31.7	5.3	2x50	28.3	0.279
12.7	228.7	50.8	4.0	1x22	27.9	0.275

Experiments were carried out by four different r.p.m. or die speed:

R.P.M.	Speed (m/s)
$h_1 = 200$	$v_1 = 1.33$
$h_2 = 260$	$v_2 = 1.73$
$h_3 = 400$	$v_3 = 2.66$
$h_4 = 460$	$v_4 = 3.08$

0.5 kg of mixed fodder were used for one test. Three of the variable factors were constant one was changed. Followings were measured: pelleting time, temperature and water content of pellets, volume of conditioning water and power sousumption. Following cooling down of pellets, density, abrasive resistance (PD index) and other physical characteristics were measured. From the test results following are stressed.

Results and conclusions

Impact of grain measure on the abrasive resistance of pellets

Results of test carried on until present are summarised on graphs. Showing the changes of PD index in connection with pellets of three different grain sizes and four of die sizes beside a given die speed. Abrasive resistance of the pellets gradually decreases by increasing the grain size depending of the composition of the pellet. Higher proportion of maize components decreases the abrasive resistance. 2.5 mm particle size fodder is hardly pelletable by the ∅ 3.2 mm size die. At the same time pellet mill is not fed with 0.5 mm particle size fodder mixture using a die of 12.7 mm hole size.

Impact of fodder composition on the abrasive resistance of the pellets

Connections of fodder mixture composition, different hole size of dies, graine size and a constant die speed are shown on Fig.2.

Unambigously seen on Fig.2. that there is a linear connection between the abrasive resistance and composition of the pellet. Increasing proportion of maize (20, 40, 70 %) abrasive resistance of pellet decreases. Pelleting of pure grits of maize has also carried out. Results of it fit well to the above mentioned conclusion (Fig.2.)

Impacts of hole size of die on the abrasive resistance of the pellets

Connections among different grain sizes, compozitions, hole size of the die beside a constant die speed are shown on Fig.3. Graphs sow that in given circumstances, the highest PD index of pellets can be produced by using of a die of 4.5 mm hole size. Effects of grain size and composition showed formerly, also valid in this case.

Examintations are carrying on for gaining determining connections concerning impacts of composition, grain size, hole size of die and different die speeds on abrasive resistance of pellets.

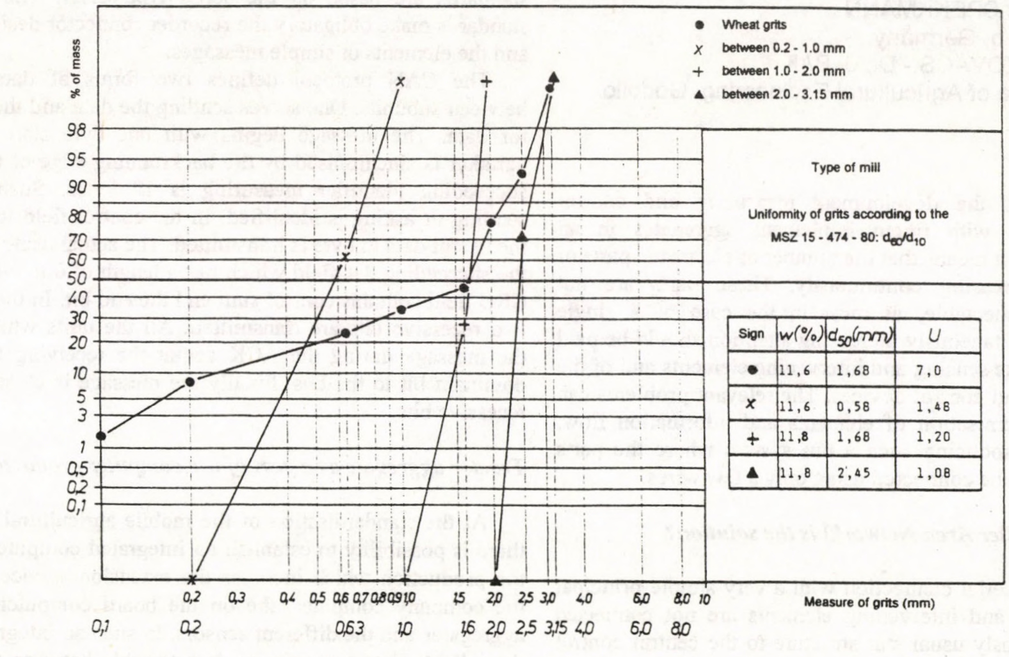

FIGURE 1.
Distribution of grain size of fractions and grinded wheat

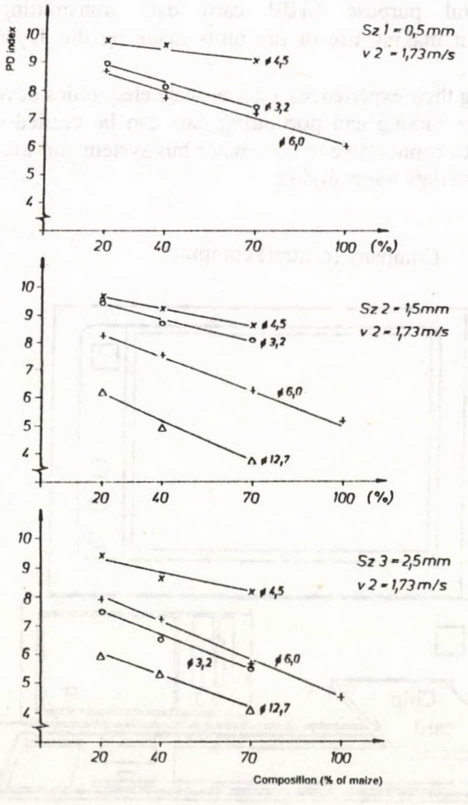

FIGURE 2.
Impact of fodder composition on the abrasive resistance of the pellets

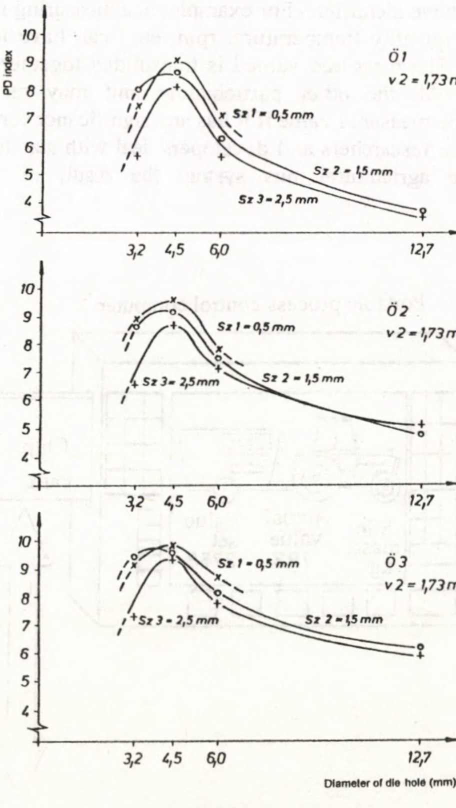

FIGURE 3.
Impact of hole size of die on the abrasive resistance of the pellets

APPLICATION OF NO CONNECTOR SOCKET CHIP CARDS IN THE OPERATION OF AGRICULTURAL MACHINES

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Introduction

As a result of the development measuring and control elements are used with tractor-implement aggregates in an increasing number. It means that the number of electronic parts of compounds is increasing continuously. These parts are not replaceable or connectable, at most in the case of a single manufacturer. Simultaneously increasing attention should be paid to the cableing of the sensing and intervening elements and of the timing, adjusting and control devices. The relevant problems can be solved by modernisation of elements and information flow, standardisation, introducing such a bus system where the parts and subsystems can be connected using only a few wires.

Why CAN (Controller Area Network) is the solution?

The CAN is a serial connection with a very simple principal idea. The sensors, and intervening elements are not connected through the previously usual star structure to the central control unit, but all the parts are connected to the serial data bus through small computers. The cost surplus of the connecting modul of subunits is already torelable as the industry produces resonable price IC-s. Every unit sharing the bus can start to transmit, when the bus is not occupied. In this system not the units but rather the messages have identifiers. For example, in a measuring system all measured quantity (temperature, rpm, etc.) can have individual identifier. The measured valued is transmitted together with the identifier. All the other participating unit may receive and evaluate the measured value if it has any significance for the unit.

German researchers and developers deal with standardisation of mobile agricultural bus system the result of which is summarised in the DIN 9684. In this field the international standardisation has been going on since 1990. The international working group elaborated the standard proposal ISO/DIS 11786 which is identical to the German standard in a great extent. Both standards are based on the serial type CAN. The mentioned standards make obligatory the recorder connector designs (Fig.1.) and the elements of simple messages.

The CAN protocol defines two forms of data exchange between subunits. One serves sending the data and the other asks for data. The message begins with one byte start signal. All partaker is sinchronised by the backrunning edge of the bit. The succeeding identifier measuring is 12 bytes. Such way data sending or asking is identified. In the control field the length of the useful data in byte is transmitted. The actual useful data are in the succeeding datafield which has a length of 0 to 64 bytes. The CRC field contains control sum and the end bit. In the ACK field two recessive bits are transmitted. All the units which received the message during the ACK acquit the receiving by giving a dominant bit to the bus. Finally the message is closed with two recessive bits.

Tractor aggregate as a part of the computer production control

At the standardisation of the mobile agricultural bus system there is possibility to establish an integrated computer control of the production which includes the extension service connecting the company computer, the on the board computers of tractor aggregates and the different sensors. In such an integrated system the reliable data transmission is inevitable between the portable process control computer and the central computer. For this purpose instead of contact type IC cards or magnetic discs the CHIP cards without connection are the most favourable.

The German authors of the paper accomplished an agricultural purpose CHIP card data transmitting model equipment making use of the units made by the Japanese LSI company.

Using their experiences a home scale electronics development for fodder mixing and portioning cars can be carried out. This electronics connectable to the tractor bus system and incorporates CHIP card data transmission.

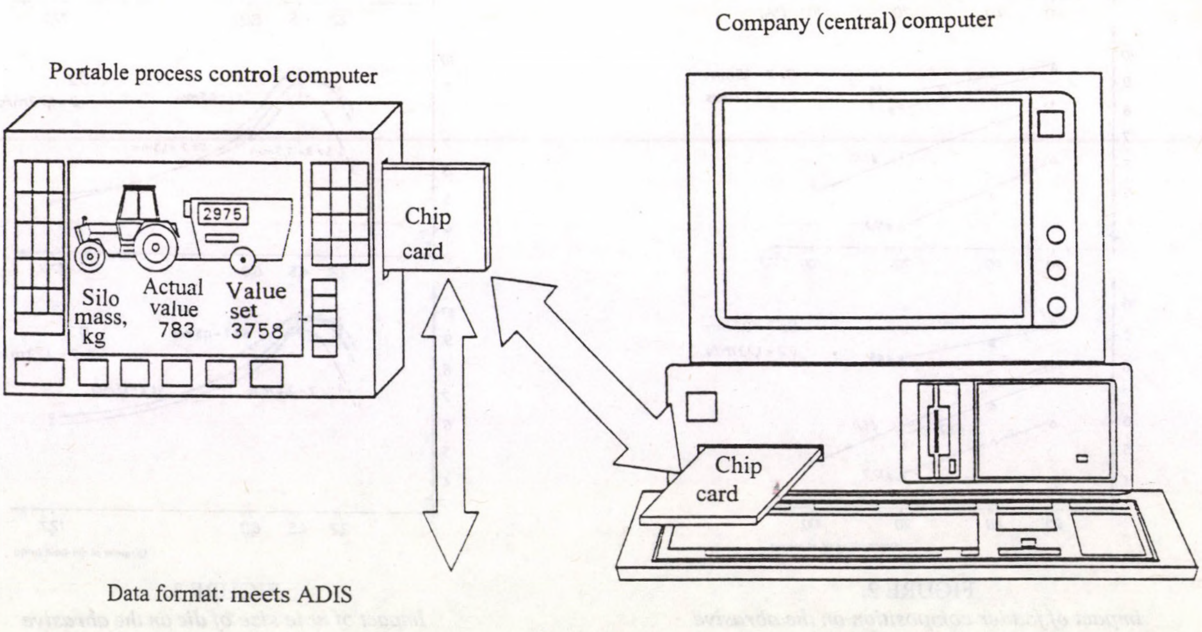

FIGURE 1.
Data transfer between the central computer and the process control computer

TECHNOLOGY RESEARCH ON THE APPLICATION OF DIGITAL CODE IDENTIFIERS INJECTABLE INTO ANIMALS

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Introduction

There are several method having been elaborated for identifying stock animals to recognise them individually.

In the most methods marks, marking devices are placed and fixed on body surface of the animals. They meet the fundamental requirements, but they have some drawbacks. They age, become dirty and may be mechanically hurt and may be lost. There is no such kind of drawbacks with injectable identifiers, and at the same time the farm, transport and slaughter-house technology applications have several details to solve.

Results

To collect experiences for injectable identifiers in October 1993 transponders were engrafted into 3 Holstein calves, 7 Limousine calves, 3 pigs, 3 Merino sheep, one white African silure, one grey African silure, and one Little-Balaton slender carp. Each injection injury recovered in a few days. The injection had no negative outcome for the animals. After the injection the reading of the identification numbers was free of errors and problems using the devices available.

With the pigs having injected identifiers slaughtered in November 1993 the transponders were feelable by touch after sticking and singeing. The sticking and singeing as slaughter technology process did not influenced the identifying.

The German authors of this paper have been dealing with research on using TIRIS system type identifiers (Fig.1.) in cattle beefing technology for three years.

They determined the requirements of the reading distance and the reading speed (Fig.2.).

The minimum reading distance in standing position is 30-40 cm, and 50 cm in motion. In motion the necessary reading speed should be set to the approximately 3 m/s motion speed of the animal. To meet the likely defects of the identifiers and the slaughter-house demands, and the readability in motion, the identifiers were engrafted into three places on the head.

In the area between the horn and the ear different injection directions were tried. The transponder break was significant in the case of the groups 1 and 2 with plastic case identifiers. There occured no breaking in the case of 4.3 diameter glass case identifiers injected into the area between the horn and the ear. Considering the experiences have been obtained so far, the technology research on injectable identifiers are practicable to start or continue for all the animal species.

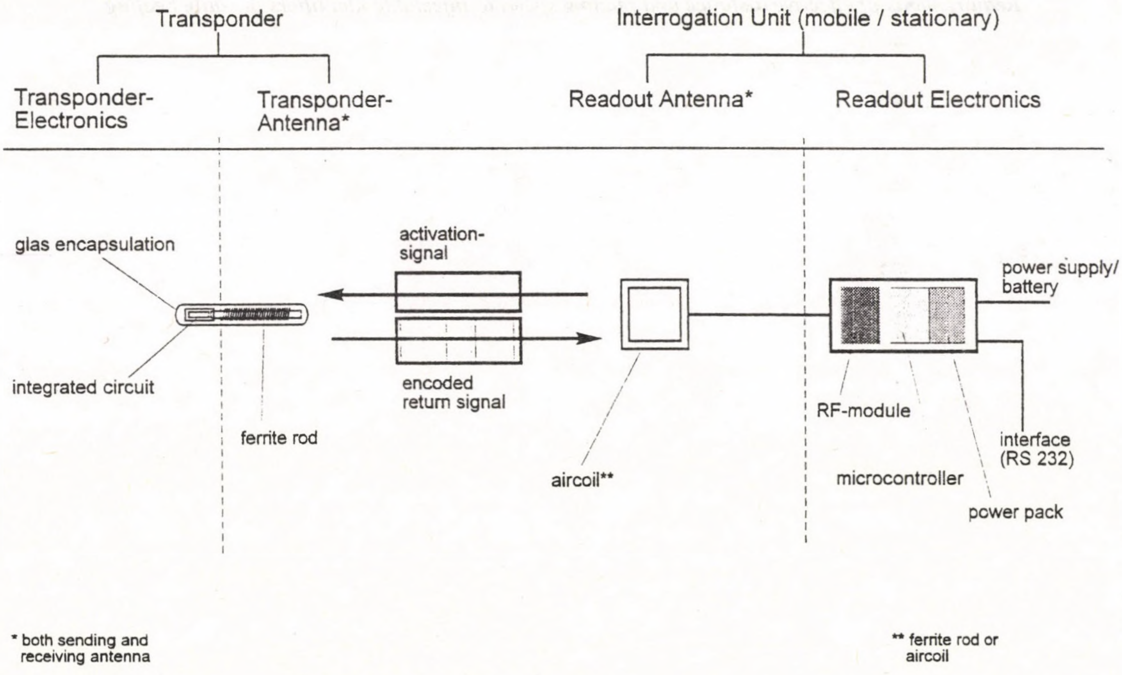

FIGURE 1.
Structure of electronik identifying systems
(Example of injectable identifiers, TIRIS sytem)

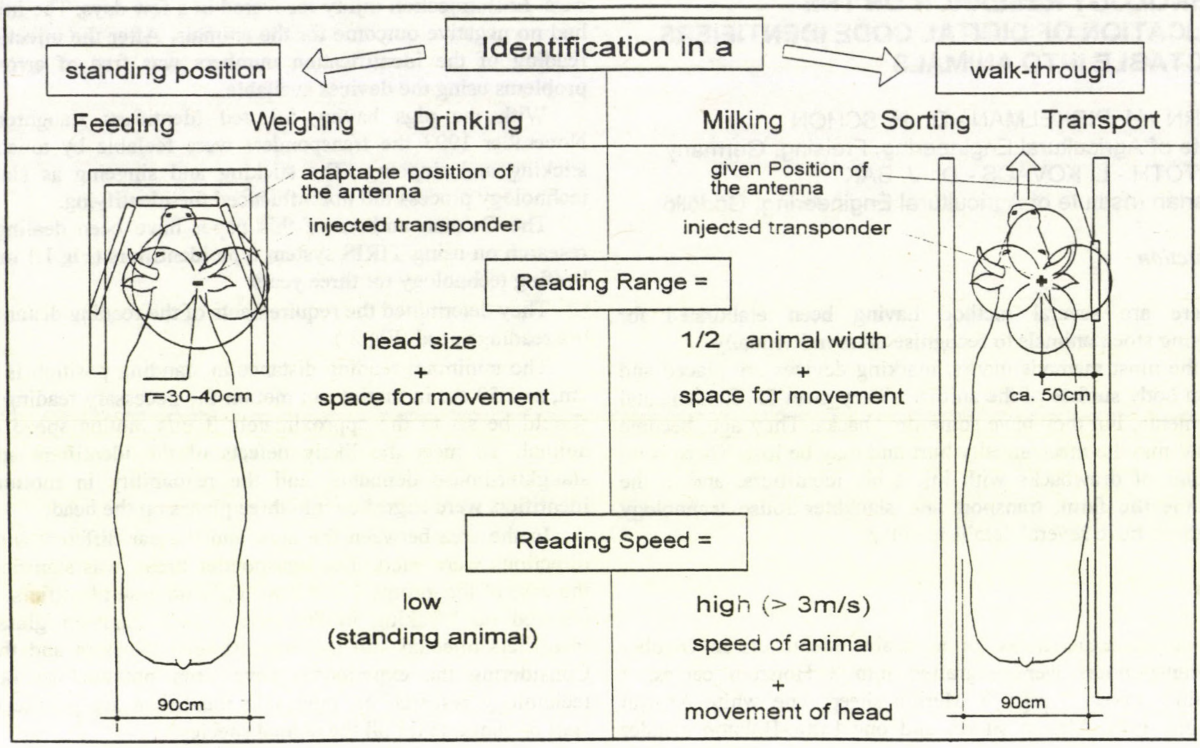

FIGURE 2.
Requirements of effective distance and reading speed to injectable identifiers in cattle beefing

ELABORATING MEASURING METHOD FOR SEED DIELECTIC PERMITTIVITY

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For seed mixtures which can not be separated according to species or only with low efficiency by the traditional seed cleaning machines an electrodynamic process was developed to separate these mixtures intensively.

The effect proved to work for some mixtures and not to work for other ones. While investigating the reasons it was guessed that the different dielectric permettivity, otherwise same behaviour components can be separated by electric stimulation procedure which has been published and patented in the former years.

This compelled us that based on the measuring method elaborated in 1992 which is not used, to make an instrument for determining the permettivity of the individuals of bulk materials. The measuring method is based on the determination of the rate of charge in electric field of ring discharge.

According to Fig.1. there is a d diameter particle in the approximately homogenous electric field of the needle-row plane. If the voltage of the pin row is above the limit tension of the discharge then depending on the extent of discharge there will be negative charges in the space between the electrodes and the particle will be charged by the electric drift and diffusion.

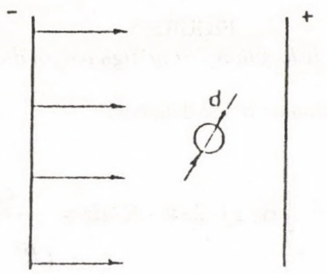

FIGURE 1.
Pin-row plane electrode

The physical model of the charging process were constructed by White (1). According to his results, if the particle stays in the discharge field for a short period, then it will be charged:

$$Q = 9 \cdot c_1 \cdot \lambda_i \cdot d^2 \cdot \pi \cdot E \cdot \frac{\varepsilon_r}{\varepsilon_r + 2} \cdot t \qquad (1)$$

where

- Q - the charge of the particle at t instance
- d - particle diameter
- c_i - negative ion concentration
- λ_i - mobility of ions
- ε_r - electric permettivity of particles
- E - value of electric field intensity at the particle

If the particle is not spherical $k \cdot d_1 \cdot d_2$ expression should be used instead of $9 \cdot d^2 \cdot \pi \cdot d_1$ and d_2 are the two sizes of the particle perpendicular to the electric field intensity and k is the shape factor. Thus the expression to evaluate the measurement is

$$Q = k \cdot d_1 \cdot d_2 \cdot \lambda_i \cdot c_i \cdot E \cdot \frac{\varepsilon_r}{\varepsilon_r + 2} \cdot t \qquad (2)$$

from which the relative permittivity ε_r can be determined by measuring Q.

The expression of the charge contains several factors which are difficult to measure. That is why the seed is covered with thin metal layer and transmitted through same parameter discharge field. The charge in this case

$$Q^* = k \cdot d_1 \cdot d_2 \cdot \lambda_i \cdot c_i \cdot E \cdot t \qquad (3)$$

because the electric permettivity will be practically infinite due to the metal layer.

From equations (2) and (3) Q/Q^*

$$\frac{Q}{Q^*} = \frac{\varepsilon_r}{\varepsilon_r + 2} \qquad (4)$$

from which ε_r can be easily calculated.

Now the theoty of charge measurement is discussed. The sketch of the charge detector can be seen in Fig.2. This incorporates three uniaxial metal cylinders which do not contact each other. The upper and the lower tubes are grounded for shading and disturbance protection. In the next it will be verified that the integral of the output voltage of the detector amplifier is proportional to the charge of the particle going through the detector. In the Fig.3. two characteristic position of the particle is shown.

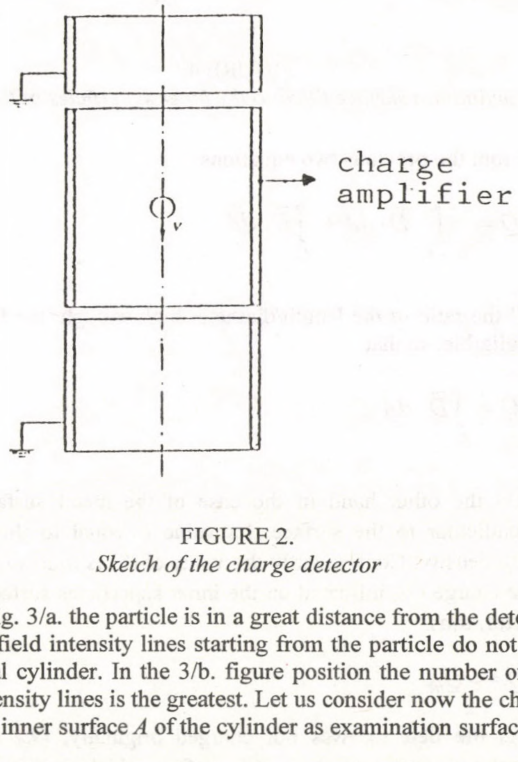

FIGURE 2.
Sketch of the charge detector

In Fig. 3/a. the particle is in a great distance from the detector and the field intensity lines starting from the particle do not join the metal cylinder. In the 3/b. figure position the number of the field intensity lines is the greatest. Let us consider now the charge with the inner surface A of the cylinder as examination surface.

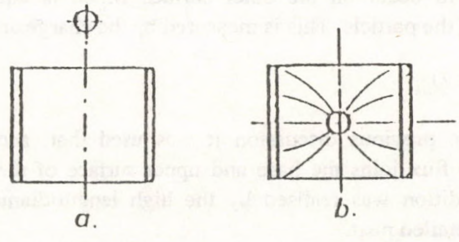

FIGURE 3.
Two characteristic position of the particle in space

According to the first law of the electrostatics the charge of the particle is

$$Q=\oint_A \tilde{D}\cdot d\tilde{A} \qquad (5)$$

where D is the dislocation vector. As A is the surface of a cylinder one can write

$$A=A_p+A_a+A_f \qquad (6)$$

where A_a, A_f and A_p are the area of the base, upper circle, and the cylinder superficies areas, respectively.

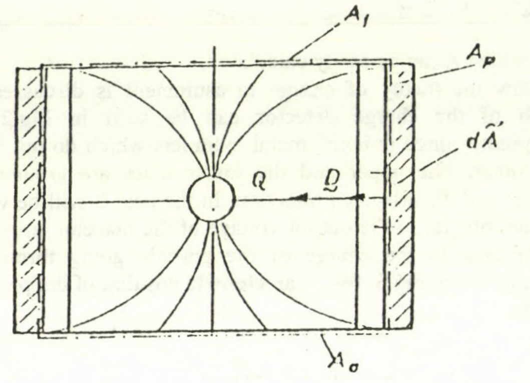

FIGURE 4.
Examination surface fitted to the inner superficies of the tube

From the previous two equations:

$$Q=\int_{A_a+A_f}\tilde{D}\cdot d\tilde{A}+\int_{A_p}\tilde{D}\cdot d\tilde{A} \qquad (7)$$

If the ratio of the length/diameter high enough, the first term is negligible, so that

$$Q=\int_{A_p}\tilde{D}\cdot d\tilde{A} \qquad (8)$$

On the other hand in the case of the metal surface D is perpendicular to the surface. Its value is equal to the surface charge density. Consequently the value of (8) is minus one times of the charge Q_{ifb} influated on the inner superficies surface of the detector, thus

$$Q=Q_{ifb} \qquad (9)$$

As the detector was not charged originally, Q_{ifk} influated charge will occur on the outer surface which is equal to the charge of the particle. This is measured by the charge amplifier.

$$Q=-Q_{ifk} \qquad (10)$$

In the previous discussion it was used that, according to Fig.4. no flux joins the base and upper surface of the detector. This condition was realised by the high length/diameter ratio. This is detailed next.

Fig.5. is now considered. According to Jackson's calculations (2), the absolute value of the D dislocation vector is

$$D(z)=\frac{1}{4\cdot\pi}\cdot\frac{Q}{(R^2+z^2)^{\frac{3}{2}}} \qquad (11)$$

so the surface charge density on the inner superficies of the detector is

$$\sigma(z)=\frac{1}{4\cdot\pi}\cdot\frac{Q}{(R^2+z^2)^{\frac{3}{2}}} \qquad (12)$$

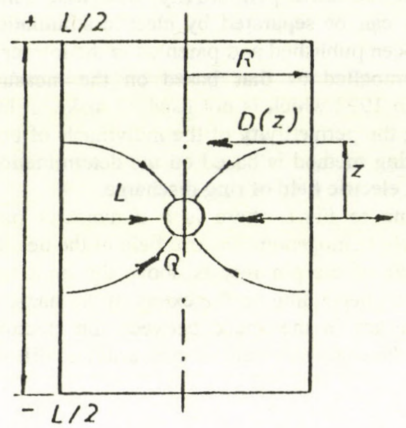

FIGURE 5.
The join of the dislocation flux at high length/diameter ratio

The charge influated in the detector:

$$Q_{ifk}=-Q_{ifb}=\int_{-\frac{L}{2}}^{+\frac{L}{2}}\sigma(z)\cdot 2\cdot\pi\cdot R\cdot dz=\frac{Q\cdot L}{(R^2+L^2)^{\frac{1}{2}}} \qquad (13)$$

And Q_{ifk}/Q ratio:

$$\frac{Q_{ifk}}{Q}=\frac{L}{\sqrt{R^2+L^2}}=\frac{1}{\sqrt{1+\left(\frac{R}{L}\right)^2}} \qquad (14)$$

Using (14) one can calculate that if $L/R=9.6$ then $Q_{ifk}/Q=0.955$. In the measuring device the length of the detector is chosen forty times of the radius resulting in less than 0.001%.

The principal arrangement of the measurement is shown in Fig.6.

The apparatus has three main parts.

The first is the seed feeder consisting of a replaceable vacuum pipette (5), and its service vacuum pump (2) driven by electric motor, a reductor and vacuum meter (3), and an exchange valve (4). The measurements needed different size vacuum pipettes since the grains had rather different sizes. For similar reason it is necessary to know and control the value vacuum. The vacuum pipette is made of brass for its surface should not oxidise. The oxide layer would have caused measuring error because it had made impossible to neutralise the seed electrically before the measurement.

The second main part is the electrode system to charge the seed. It is mounted with an optoelectric service unit. The (9) negative electrode pin rows are arranged regularly. At the ends of the pins electric discharge occur inducing negative charge for the seed (6) polarised in the field of elecrodes.

The electrode has ground potential. The bakelite block is fixed to it. This incorporates the fototransistor (11), too. The electrodes have electric supply when the seed closes the light beam path from the lamp through system of lenses. The electric handling time and voltage of the seed is adjustable. This is obtained by a special high voltage impulse source.

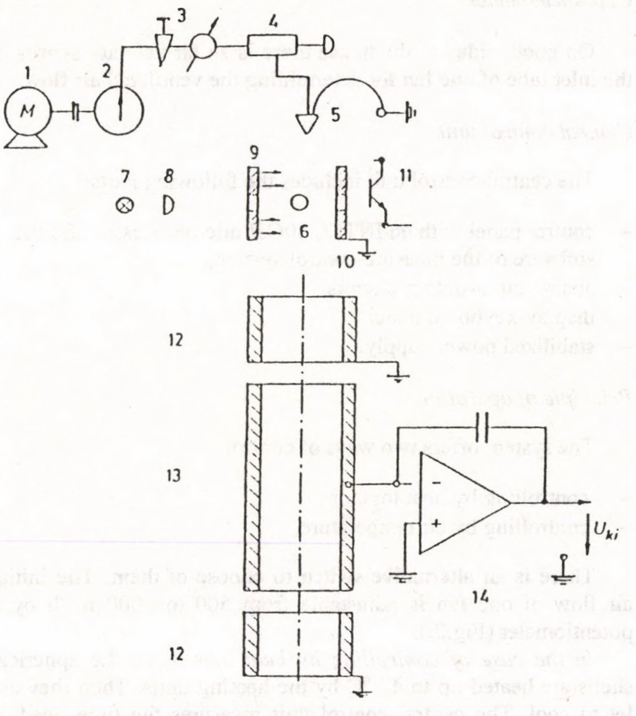

FIGURE 6.

Sketch of the measuring assemblage

1 - electromotor; 2 - vacuum pump; 3 - reductor and vacuum meter; 4 - exchange valve; 5 - vacuum pipette, 6 - polarised seed; 7 - light source; 8 - system of lenses; 9 - negative electrode; 10 - positive electrode; 11 - fototransistor; 12 - grounded electrode; 13 - tube electrode; 14 - charge amplifier

Hereupon the seed falls in the grounded (12) and the tube electrode (13). The charge of the seed is measured here by the aid of the charge amplifier (14). These latter elements make the third main part of the measuring device.

To measure the dielectric permittivity ten pieces were taken from each seed (material) bulk. For the same measuring order they were placed on plates. From the plates the seeds were fallen into the tube electrode through the electrode system by using vacuum pipette. The charge of the unhandled seeds (Q_{1ai}) could be measured by the connected charge amplifier.

Measurement were repeated three times for each single seed. After this the seeds were put back on the plates and supplied with metal covering layer. After they had dried they were transmitted through the same parameter dischaarge field and their charge (Q_{2ai}) was measured.

From the measured values of Q_{1ai} and Q_{2ai} the individual (ε_i) and the average (ε) dielectric permettivity was calculated.

$$\varepsilon_i = 2 \cdot \frac{Q_{1ai}}{Q_{2ai}} \cdot \left(1 - \frac{Q_{1ai}}{Q_{2ai}}\right)^{-1} \tag{15}$$

Denotations of the equation (15) are:

Q_1 - seed charge unhandled;
Q_2 - seed charge for metal covered seed;
a - subscript for measuring repetition ($i = 1,2,3$);
i - subscript for individual seeds ($i = 1,2,...,10$)

For calibration plastic grains called Corning 7052 were used as the dielectric permittivity of this material is known and published by the manufacturer.

The dielectric permittivity values of several materials are included in Table 1.

Table 1.
Dielectric permettivity of some seeds

Number	Material	Moisture content (%)	Dielectric permittivity
1.	Corning 7052	-	5.34*
2.	Saffron seklice	5.73	2.87
	Fungus in seklice	6.36	2.12
3.	Wet saffron seklice**	12.30	5.22
	Wet fungus in seklice**	20.80	4.26
4.	Maize	5,23	4,76
5.	Maize	16.56	6.03
6.	Granulated sugarbeet seed	-	1.27
7.	Kartal peas	10.10	5.72

Notes: * manufacturer's data: 5.10 - 5.20
** remoistured in climate chamber with same time and circumstances

The first measuring results are promising that the dielectric permittivity of single seeds from bulk can be measured with high preciseness making use of our method.

FAN CONTROL SYSTEM BASED ON HEAT LOSS SENSOR

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Purpose

Controlling of fans is generally based on measurement of air temperature. However the heat sensing of animals is influenced not only the temperature but the air velocity, the heat-radiation of surrounding surfaces and the relative humidity too. Heat sensing can be characterized by Kata-index and can be measured by Kata-thermometer.

In the interest of a more correct ventilation of livestock houses our purposes was to develop

- an electric heat loss sensor for sensing the resultant effect of heat comfort characteristics listed above,
- an electric dew point sensor for determining relative humidity,
- a digital control unit for processing the signals of the sensors.

This development was realized by financial assistance of the National Committee for Technological Development.

Description of the control system

The main parts of the control system are as follows:

- 2 pieces of combined sensor-transmitter units,
- 2 pieces of cup anemometer,
- central control unit.

Combined sensor-transmitter unit

For determining parameters of the inside air the combined sensor-transmitter unit includes a heat loss sensor, a dew point sensor, an air temperature sensor and a transmitter unit. (Fig.1.)

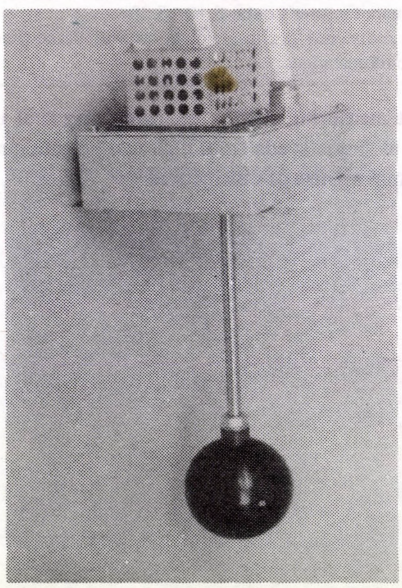

FIGURE 1.
The combined sensor-transmitter unit

The heat loss sensor is a black coloured, spherical shell with diameter of 80 mm. There is a heating unit in its centre and four temperature sensors are embedded in its inner surface. These sensors measure the average temperature of the spherical shell.

The dew point sensor is based on a thermoelectric cooler, so called Peltier-element. Its cold face is gilded. In the course of cooling the condensing humidity is sensed by an optical reading unit and the temperature of the mirror surface is sensed by a miniature temperature sensor.

Cup anemometer

On booth sides of the house there is an air velocity sensor in the inlet tube of one fan for determining the ventilated air flow.

Central control unit

The central control unit includes the following parts:

- control panel with an INTEL 80C31 microprocessor and the software of the measure-control system,
- analog input-output circuits,
- display-keyboard panel,
- stabilized power supply.

Principle of operation

The system offers two ways of control

- controlling by heat loss, or
- controlling by air temperature.

There is an alternative switch to choose of them. The initial air flow of one fan is adjustable from 500 to 5000 m^3/h by a potentiometer (Fig.2.).

In the case of controlling by heat loss mode the spherical shells are heated up to 45 °C by the heating units. Then they are let to cool. The central control unit measures the time need to cool from 38 °C to 35 °C. In that case if the measured value is higher than the required one, the ventilation is increased otherwise it is decreased by the control software step by step, independently on both sides of the house. The required cooling time is adjustable by keyboard or potentiometer depending on position of the second alternative switch. For digital controlling there is a keyboard and a 16 digit display with 8 input channels, 6 output channels and 7 test channels.

Every heat loss measurement is preceded by a dew point measurement. The chronological order of the events can be seen on Fig.3. Cooling of the left side Peltier-element is followed by heating of the left side heat loss sensor then these processes are repeated on the right side too. The relative humidity is calculated from the dry and the dew point temperatures of the air. When the cooling time values are between the limits and the relative humidity, as the secondary control parameter is higher than 85 %, the control unit increases the ventilation rate.

In the case of controlling by air temperature mode the heat loss measurement is omitted. The air temperature is the main control parameter and the relative humidity is the secondary. The heating is permitted by the software only when both rows of fans work on basic ventilation level. The basic ventilation is calculated by the software taking into consideration of the kind, number and average weight of animals and the number of fans. These data are inputs on keyboard. Missing these inputs the software permits 500 m^3/h minimum air flow per fan.

Results

Fan controlling by heat loss is a totally unique development. Cooling time of the spherical shell form heat loss sensor from

38 °C to 35 °C is a more proper climate parameter than air temperature, because it comprises the effects of air velocity and heat radiation of surrounding surfaces too. This complex parameter is completed by measurement of relative humidity. However beside controlling by heat loss it is also available the conventional controlling by air temperature.

The system includes two combined sensor-transmitter units and two digital-analog outputs for independent controlling two groups of fans. It is – for decreasing the disturbing effect of cross-wind – also a novelty.

After the function trials the complete control system was installed to a battery type weaner house. The different control modes were tested and the system ran well. The system also can be used in industrial or public buildings.

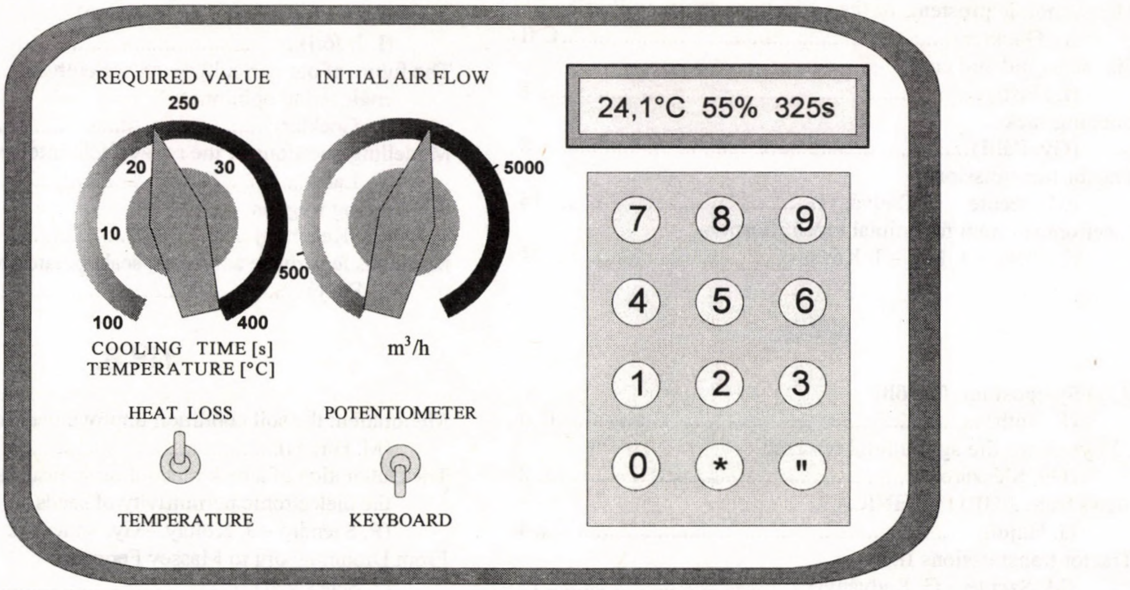

FIGURE 2.
Face of the control unit

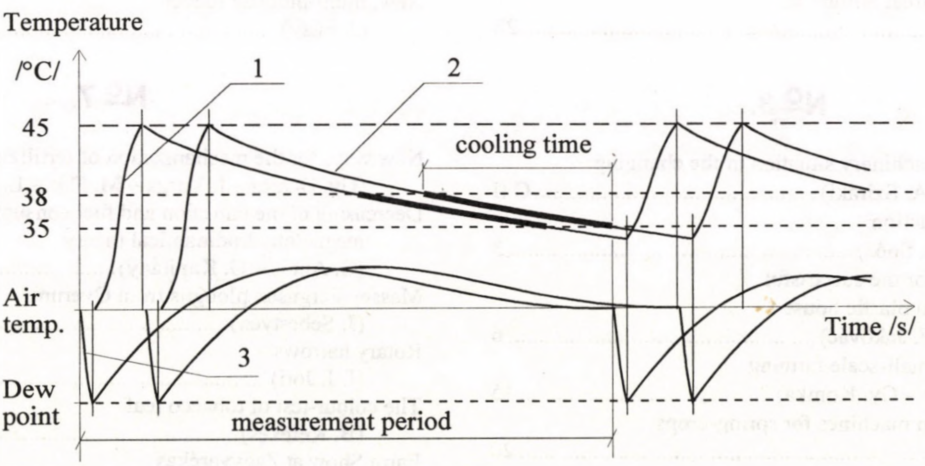

FIGURE 3.
Scheme of the measurement cycle
1 - heating of the heat loss sensor up, left side
2 - cooling of the heat loss sensor, right side
3 - cooling of the Peltier-element, left side

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