# COMMINUTION OF CEREAL FEED COMPONENTS – NEW TECHNOLOGICAL FACILITIES

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**Abstract**

An important element in the animal husbandry is to provide the animals with feed of suitable quantity and quality in due time. When blending feed mixtures, they attempt to use components of uniform size in order to produce easier an acceptable homogeneity.

In the case of the conventional crop grinding, the feed manufacturing mills use their old adjustment routines with their existing devices.

In grinding cereal crops, the variation of the rotary speed of the mill is not yet a routine solution.

**Keywords**

cereal feed, comminution, grinding, frequency converter, particle size

**Introduction**

An important element in the animal husbandry is to provide the animals with feed of suitable quantity and quality in due time. The stock-raisers balance the rations to achieve the best nutritive power; however, sometimes it requires compromises. When blending feed mixtures, they attempt to use components of uniform size in order to produce easier an acceptable homogeneity.

Due to the different physiological characteristics of the animal species and types, the reasonable solution is expressly the breed- and type-specific feeding. From the differences between the animal types, there are significant differences in the fodder or forage compositions as well. The physical properties of the ingredients (amount, ratio and particle size) influence the feeding efficiency for an actual breed or stock. Well-prepared animal-feeding tests are required to determine the feed utilization degree.

**In the case of feeding efficiency tests**

In the case of feeding efficiency tests with fattening pigs, it should be selected the live mass between 40 and 80kg. The minimum number of pigs in a test group is three and the tests should be triply repeated as usual in the experimental practice. An experiment includes a 5-day pre-stage and a 5-day post-stage period. Kidder and Manners (1978) have pointed out that the evacuation of the 5% of the feed matter needs averagely 20 hours while its 95% – 60 hours. The test animals are enclosed in special cages (batteries) for the whole amount of faeces and urine is to be completely collected and weighed. The test batteries should be placed in a room where a temperature of 18 to 20ºC, a relative humidity of 60 to 70% and the required air change (number of air changes per hour) can be provided.

The direct feed utilization test with a single forage matter fed alone is based on the comparison of the amounts of the nutrients intake and the evacuated (defecated) nutrients; the difference between them is the apparent efficiency.

In the indirect feed utilization test, the animals are fed with a so-called base ration. The base ration affects the feeding efficiency of the tested component and vice versa; by professional references, it is defined as the associate feeding efficiency of the matter. Table 1 shows the composition of the base feed ration recommended for indirect feeding efficiency tests with pigs [5].

Table 1. Recommended composition of base feed ration in indirect feeding efficiency tests with pigs. [5]

| Ingredients | (%) |
|---|---|
| Maize | 40.8 |
| Wheat | 20.0 |
| Barley | 20.0 |
| Extracted soy grits; 48 % | 16.0 |
| Supplements (MCP, feed lime, common salt, premix) | 3.2 |

Table 2. Effect of particle size of the feed matter on the feeding utilization of pigs [6]

| Particle size (mm) | Feeding efficiency (kg/kg) |
|---|---|
| > 1 | 3.00 |
| 0.9 to 0.7 | 2.92 |
| 0.7 to 0.6 | 2.76 |

In manufacturing complete feed, the grinding of the single components is essential. The goal of the process is that the digestive juice shall better get at the nutrients in the grains, and to mix easier the nutritive components together into a homogeneous bulk. A disadvantage of the comminution is that the oxidation of the released vegetable oil is quicker than in the whole grain. The decomposition of the starch of the mealy feed materials is too quick in the paunch (rumen) of a ruminant thereby the state of rumen becomes acidic and this worsens the rumen fermentation. The fine ground feed matters tending to be gelatinized stick onto the roof of the mouth, and worsen the feed intake. The too fine grits increases the risk of forming an oesophageal stomachic ulcer. [1]

**New technological facilities**

In the case of the conventional crop grinding, the feed manufacturing mills use their old adjustment routines with their existing devices. However, due to the recent changes in the energetic industry and in the field of the food safety, the development of a more economical and flexibly controlled system – that can be integrated with the existing one – should be considered.

In the larger plants, the electric equipment fleet overdesigned with safety load factors ties up significant yearly moneyed resources in advance. By a minimal expenditure, the orderly monthly costs can be reduced if the electric motors are equipped with frequency converters. This way, a smoother start and a controllable input/output performance can be achieved.

With a conventional assembly, before the operation the suitable screen is mounted in the mill for pre-adjusting the output – the required particle size (grits fineness) – and during running the slide-valve position is controlled in order to prevent an incidental overload.

In grinding cereal crops, the variation of the rotary speed of the mill is not yet a routine solution. The objective of my research is to prove that the same required grits size can be achieved by changing the rotary speed instead of the traditional way of exchanging screens. An existing hammer mill of the department was instrumented for the measurements. The input and output data of the experiment is shown in Figure 1 [4].

The original assembly was improved with a frequency converter for speed variation, rotary-speed transmitters ($n_1$ and $n_2$), a torque-meter ($M_2$), a thermometer (T) a slide-position displacement transmitter ($A_{inlet}$), and an electro-tensometric cell (m) to measure the mass of the output grits – the units displayed by thickening in the figure. The conditions of the gravitational feeding and discharge were not changed and I carried out each test series with a single screen. The measured values were recorded with the help of an eight-channel measuring data logger at a high sampling speed (50Hz). The used data logger and frequency converter is shown in Figure 2.

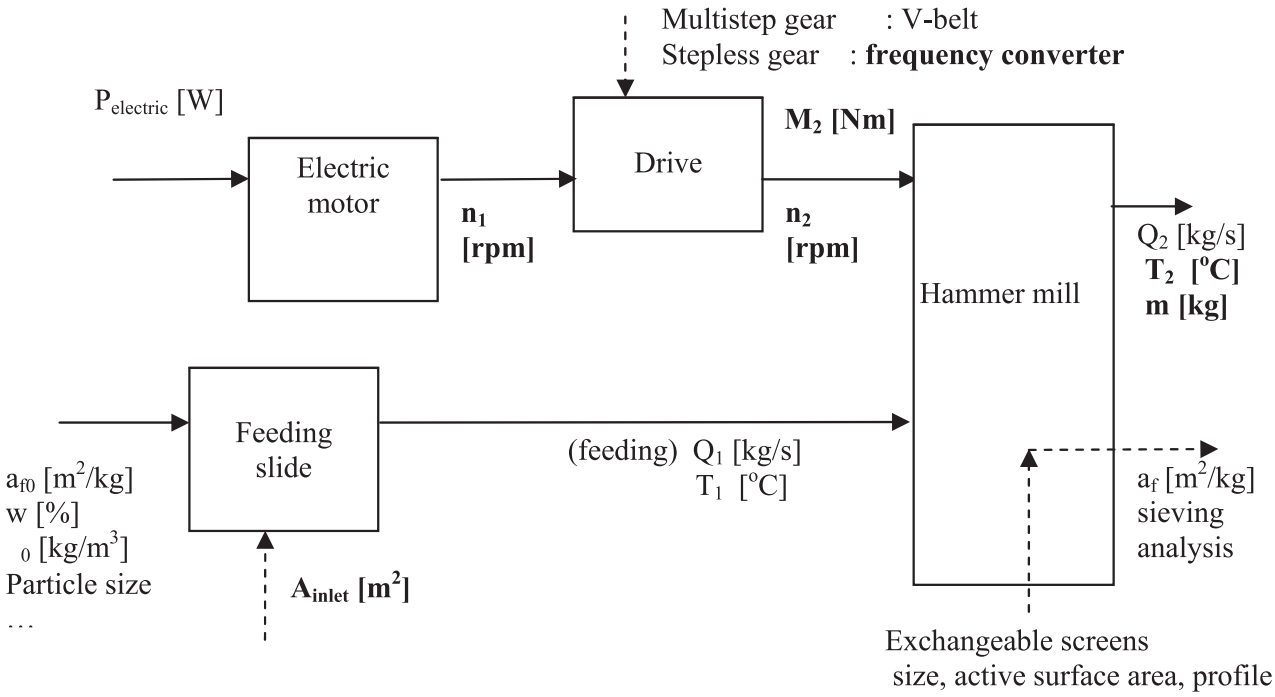


Figure 1. Construction of the experimental assembly, input and output variables, parameters

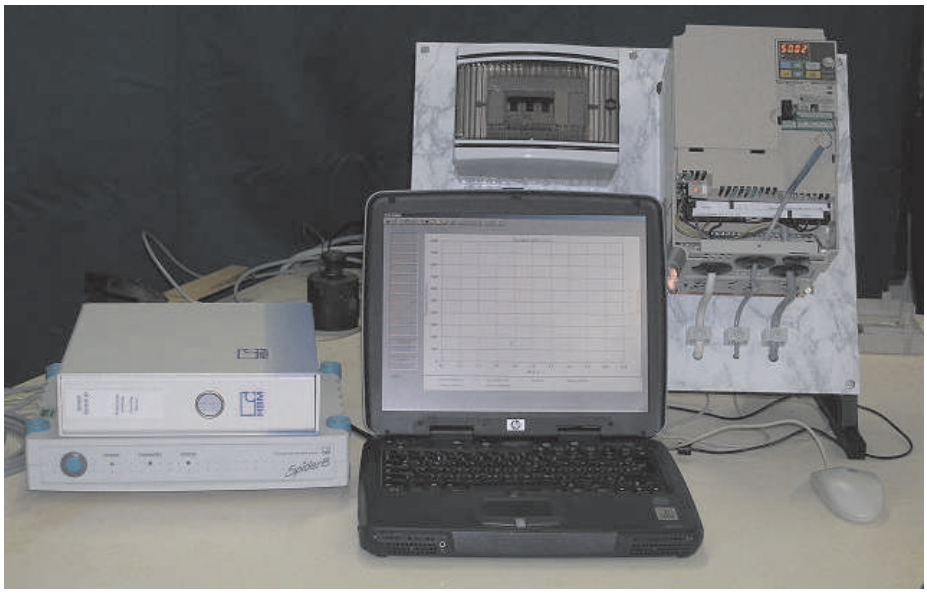

Figure 2. The eight-channel measuring data logger and the used frequency converter

When processing data, the coincidental phenomena have to be plotted as a function of time. The data base with 56,000 data per test served for the isochronal displaying of the different quantities. The gained data of a setting test are shown in Figure 3. In the case of an actual setting, the hammer speed was varied for the sake of comparability [3].

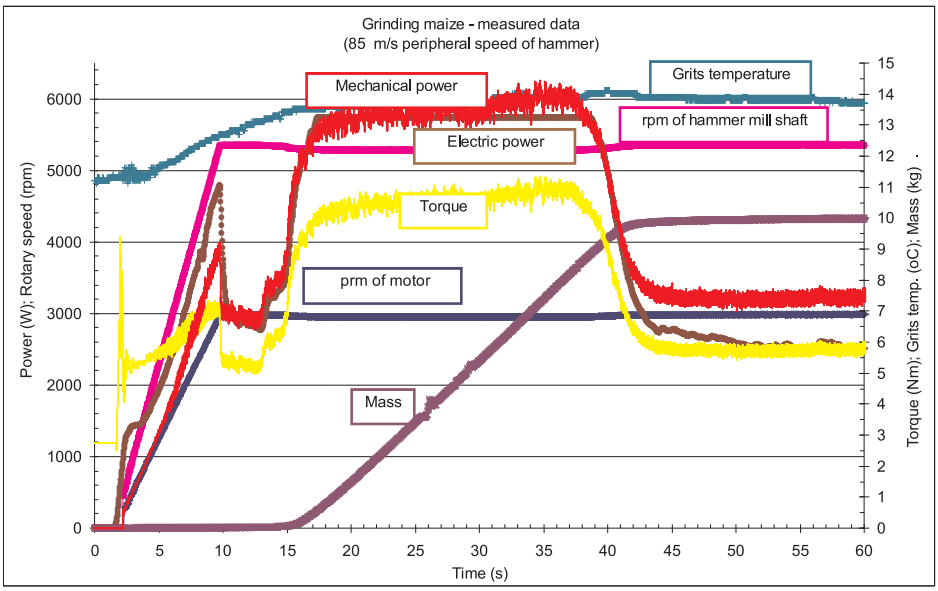


Figure 3. Data measured with grinding maize grain as a function of time

It can be seen in Figure 3 that the stationary period of the grinding starts only after the ninth second; in the previous period, the motor and the shaft of the mill accelerate – according to the determined characteristic curve – up to their operating speeds. In the thirteenth second, under the effect of the sudden opening of the slide, the real grinding starts and the torque measured on the shaft increases; thereby the mechanical power and the input electric power from the network increase as well. After the fifteenth second the first ground particles appear in the outlet opening of the mill; the grits collector is the weighing device as well. In the grinding process, the particles in the grinding chamber warm up – actually from the beginning temperature of 11ºC to 14ºC.

The produced grits was qualified by laboratory sieving analysis and, from the gained data, the characteristic values of average particle size of the single settings were determined.

According to the experimental plan, the above process was repeated three times with each item, applying different peripheral speeds of hammer.

The experimental results prove that the same output particle size can be achieved by the stepless adjustment of the rotary speed (without exchanging screens) as that – in the traditional way, by exchanging screens. Figure 4 shows the effects of increasing the rotary speed of the hammer mill upon the grits particle size (xaverage) and the mechanical power (Pmech) measured on the mill shaft. [2]

With the mill equipped with a 5.5-kW motor, an average particle size of 1.3mm belongs to the rated operational speed (vperipheral = 80m/s) while a particle size of 2.5mm – to the lowest peripheral speed of hammer (vperipheral = 20m/s). Between these two speeds, grits of arbitrary size can be produced by the infinitely variable adjustment.

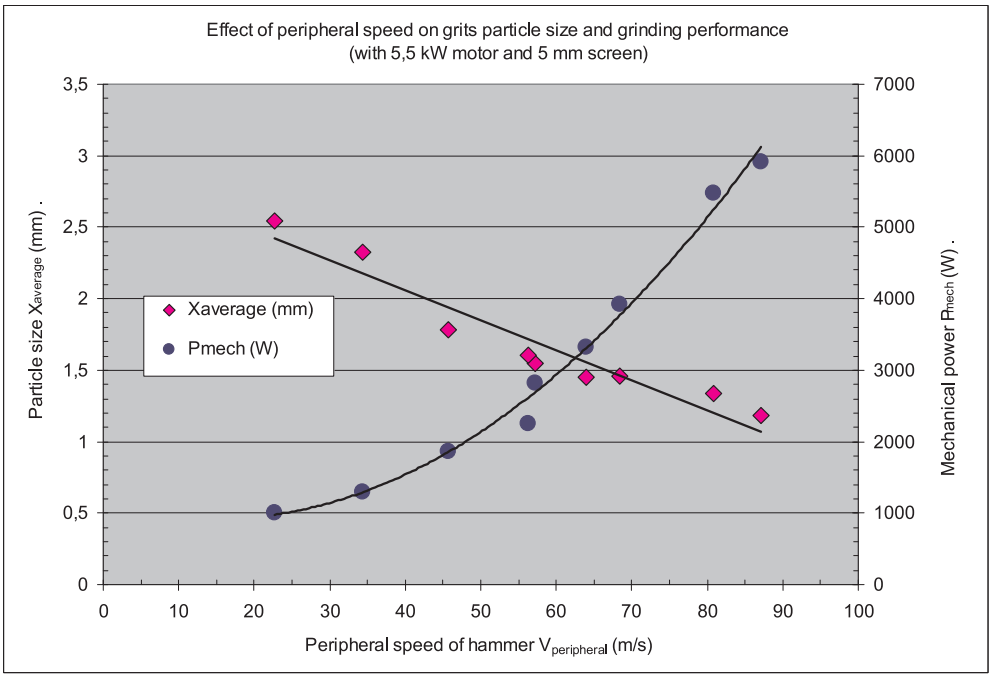


Figure 4. By increasing the rotary speed of the hammer mill, the grits particle size (xaverage) decreases and the required mechanical power (Pmech) of grinding increases

## Conclusions

According to the experimental results, a linear relationship can be observed between the increase of hammer peripheral speed and the increasing in grits fineness. The higher rotary speed with the same geometry means a greater impetus (momentum) and impact force thereby the released breaking energy is increased as well [2].

The simplest way of the stepless variation of rotary speed in actual practice can be the use of a frequency converter.

The suitable increase in weight of the animals requires the feed of good quality and in satisfactory quantity. One of the parameter influencing the quality is the average particle size of the feed matter. The adjustment facility of the particle size during the milling operation may open up a new prospect of improving the economical indices of the feed manufacturing. The infinitely variable particle-size output can be a new guiding area of the technological development in the animal feed manufacture.

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