Impact of Technologies of Obtaining Concentrated Fodder Upon Animal Nourishment and Environment

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Abstract. The elaboration of technologies for cereal seeds is funded on livestock requirements corresponding to each fodder type, according to its aim. When we elaborate these technologies we have to take into consideration, beside the quantity aspect, the essential aspect of quality:

- quality of raw materials used in manufacturing process and of end product;
- functional quality of equipment and installations;
- quality of personnel involved in production process.

As the modern livestock aims at a sustainable development of food products by complying to food safety of those products resulted from livestock sector.

The strategy of animal feeding has a huge impact on the livestock, the animal and human health state and the environment protection.

The fodder processing and preparing are performed in order to raise their nutritive value, to increase the edibility and digestibility degree and to get some various and complete sorts of fodder recipes.

The installation for obtaining concentrated fodders-IONC- is designed to micro-farms having a livestock sector in order to supply from their own production the concentrated fodders for feeding animals and poultry, by processing according to various recipes and in the required quantities, the fodders on the farm.

Keywords: animal food, cereal seed crushing, forage.

INTRODUCTION

Increased livestock production is directly related to a low cost complete nutrition and occupies an important place in the agricultural sector of our country.

Satisfactory results in the growth of animals largely depend on the use of quality fodder, the functional quality of machines and facilities for production, processing, the quality of personnel trained in the production process.

Among the products intended for animal feeding, the concentrates occupy a special place. Combined nutriments are concentrated feeding mixtures of simple and sometimes dehydrated fodder. Technologies for processing grain seeds nutriments are based on zootechnical requirements for each type of fodder corresponding to the destination.

Few fodder match, in their natural state, to all of the animal body needs, thus they must be processed, before consumption, by a particular technology. To maximize food resources that exist in livestock farms, especially those who have their own cereal sector, it is aimed to develop technologies with which can be efficiently obtained a wide range of combined feed, directly into the farm.
The processing nutrient from cereal grain by different technologies is necessary because (Păun, 2006):

- few fodder match, in their natural state, to all of the animal body needs;
- by means of processing, the physical (shape, structure, grain), chemical and biological properties are favourably modified;
- it leads to increased nutrition value, to increased digestibility degree and to a better exploit by animals;
- it allows the achievement of various and complete sorts of fodder recipes, depending on the needs of zootechnical holdings;
- it ensures the removal of impurities (ferrous bodies, soil scraps, etc..) out of fodder before the’ve administration to animals.
- it enables and favours the mechanization and automation processes of preparation and distribution of animal feed.

MATERIALS AND METHODS

The installation for obtaining concentrated fodders IONC, Fig.1, is intended to deserve micro-farms with animal husbandry sector, in order to ensure self production of concentrate fodder to feed animals and birds, by processing nutrients according to different recipes and in the required quantities.

![Fig.1. The installation for obtaining concentrated fodders](image)

The experimental model of the installation for obtaining concentrated fodders (Păun, 2006) consists of the following machineries: Simple elevator with shovels SE 100; Horizontal spiral conveyor HSC 160; Cereal bunker CB 3; Product dosing system; Hammer mill HM 22; Cyclone; Horizontal stirrer HS 1000; Tilted spiral conveyor TSC 110; Seed transport network, Power and board control.
The simple elevator with shovels, SE 100, is equipped with an unisens device for blocking the movement in the opposite direction of the shovel belt, when it occurs an accidental halt.

To achieve a high degree of homogenization of the mixture of ground grain and various additives, the horizontal stirrer, HS 1000, is provided with a twin-spiral rotor in continuous stripes of different diameters and with inverse orientation, to the left and to the right.

The production of concentrated fodders may be associated with the concept of "industry" because of the complexity of this area, on which in the end is related the performance of zootechny (animal nutrition), the profitability of the farm (supplying the fodder production), food safety and last but not least, environment protection.

Within the installation for obtaining concentrated fodders IOCF, the following processes are taking place:
- the interphasic transport between components of the plant;
- dosing of cereals seeds according to the fodder recipe;
- milling of cereals seeds;
- homogenization of the grinding blend;
- decantation and filtration of the dust resulted from the process.

Dosage, milling and homogenization of the concentrated nutrient as component of the technological processes for preparing animal feed, constitute basic operations that impact on finished products and the environment.

The cereal bunkers are provided with electrovalves for filling/emptying that are electrically operated and controlled from the control panel. Weighing (dosing) fodders in order to draw up the recipe (in the case when each bunker contains seeds of various cereals) is made using 3 subassemblies, one on each bunker. Each unit consists on three load cells (weighing doses - weighing accuracy: +/- 1%), located under the bunkers, and a signal amplifier. The signal amplifier (located near the load cells) receives signals from the three load cells, summates, amplifies and transmit them to the automation closet.

Each bunker is equipped with two sensors that measure the fodder level to seize if it is full or empty and transmits this information to a central closet. It signals (by LEDs) if the bunker is in one of the two extreme situations: full or empty.

The grinding of nutrient concentrates, as a part of the technologies for obtaining them, is one of the basic operations, while a large consumer of energy.

Grinding grain is a complex process which results in a wide variety of particles that differ by size, surface composition. Particle sizes are very important in achieving recipes fodder impact particularly on animal nutrition. The experimental model of the IONC installation comprises a hammer mill HM 22.

Starting from these considerations (Păun, 2004) we have to study the process of grinding in the mill with hammers. Basically, the dynamics of the hammer mill, Fig.2, can be imagined as a physical model composed of three elements:
1-the rotor as a clash pulses generator, leading to the achievement of a lot of shredded particles;
2-a layer of product-air as a volume (or mass) that supports the equality between two continuous concomitant processes of „multiplication” or „augmentation” (hammer-rotor’s capacity), and „of death "(the ability of the site);

3-the perforated surface of the grinding chamber (the sieve like a screen), which limits the intensity of the material stream passing through the mill.

The work process of the mill should be regarded as a stochastic process, described by pseudo-static methods. In this case, the established working of the mill is a continuous, incidentally, motionless process.

The grinding, in the case of the hammer mill, is influenced by: technological, mechanical, constructive, functional factors.

The main mechanical factors that influence the grinding in the hammer mills are: the percussions applied by the hammers to the fooder particles, the loss of deformation energy during the shock, the peripheral speed of hammers, the rate of movement of the fooder layer in the grinding chamber, the effect of fan produced by the rotor with hammers, the moment of inertia of the rotor with hammers.

The constructive factors influencing the grinding process are: the size of the grinding chamber, the constructive shape of hammers, the size of the gap between hammers and sieve, the constructive shape of the grooves, the fooder supply of equipment, the evacuation of grist.

The grinding of seeds in hammer mills can be regarded as composed of three phases:

a- the grinding of the fooder particles due to collision with rotor hammers in circular movement at the admittance into the grinding chamber;

b- the grinding of the particles in non-uniform motion resulted following first collision and thrown by hammers on the countertamper plates with grooves and also on the edges of sieve holes that edge the grinding chamber;

c- the grinding of the fooder particles due to mutual collisions in the grinding chamber.
In order to verify if the hammer mill HM 22 fulfills the technical requirements imposed by the grinding process (to allow grinding of the fodder with moisture up to 20%, to prohibit heating of grist, to allowing the production of grists with grain size between 0.2 and 3 mm) there were made a series of determinations with the product.

The methodology for determining the grist module has been based on the quantitative ratio between particles of different sizes.

For determining the particle’s average diameter \( d_m \) of the analysed sample (by sifting) was applied to the formula (Căsăndriu, 1993):

\[
d_m = \sqrt[3]{\frac{M}{\sum_{i=1}^{k} \left( \frac{M_i}{d_i^3} \right)}} = \sqrt[3]{\frac{1}{\sum_{i=1}^{k} \left( \frac{a_i}{d_i^3} \right)}}
\]

where: \( d_i = \frac{l_i + l_{i+1}}{2} \); \( l_i \) - the average diameter of fraction particles on the sieves

\( i=0,1…5 \); \( l_{k+1} = \sqrt{2} l_k \);

\( l_1; l_2; l_3; l_4; l_5 \) - the sides of sieve mesh 1; 2; 3; 4; 5;

\( l_0 = 0 \) - the bottom layer of sifting equipment;

\( a_i = \frac{M_i}{M} \times 100 \) - fractions share on the sieves with sizes: \( (l_i, l_{i+1}) \), (%)

To plot the variation of sieve refusal \( R(d) \), depending on the size of particles \( d_i [\mu m] \) was used the Rozen - Rammler-Bennett equation,

\[
\frac{100}{R(d)} = e^{bd^n}
\]

where:

\( R(d) \) - refusal on the sieve with holes diameter \( d_i \), %;

\( b, n \) – constant coefficients and distribution parameters.

The \( b \) coefficient is the parameter that determines the curve concavity (for coarse grist) of the grinding characteristic, in other words, this parameter is the ground size measure. The coefficient \( n \) is also a parameter that determines the curve shape and distribution of particles characterized by their size.

For determining the coefficients \( b \) and \( n \) from relation (2) one will logarithm twice resulting the formula:

\[
\lg \left( \frac{R(d)}{100} \right) + 0.434 = \lg b + n \lg d
\]

For determining the coefficients \( b \) and \( n \) was used the average method in relations (3) and were assigned the following notations:

\[
Y = A + nX
\]

where:

\[
y = \lg \left( \frac{R(d)}{100} \right) + 0.434
\]
\[ A = \log b \quad (6) \]
\[ X = \log d \quad (7) \]

Starting from the formula (4) a system was formed:
\[ \begin{align*}
\sum_{i=1}^{3} Y_i &= 3A + n\sum_{i=1}^{3} X_i \\
\sum_{i=4}^{4} Y_i &= 2A + n\sum_{i=4}^{4} X_i 
\end{align*} \quad (8) \]

To compare the results obtained using the sifting method and average method the coefficients \( b \) and \( n \) were determined:
\[ b = \frac{\ln\left(\frac{100}{R(d)}\right)}{d^n} \quad (9) \]
\[ n = \frac{\log_{10}\left(\frac{100}{R(d_i)}\right) - \log_{10}\left(\frac{100}{R(d_2)}\right)}{\log d_i - \log d_2} \quad (10) \]

**RESULTS AND DISCUSSION**

The refusal mass was determined as follows:
- a sample of 100 g was drawn and weight, quantity which was introduced in the sifting equipment;
- the sifting equipment was equipped with 5 sieves with mesh size of 800; 500; 200; 120; 80 \( \mu m \); 0 – for the equipment bottom;
- the sieves was assembled by ascending aperture size;
- the sifting was accomplished in 20 minutes;
- the refusals obtained on sieves were weight with a drift of max. 0,01 g and were 3; 16; 26; 14; 21 and 20 grams.

A granulometric analysis table, based on entrance date and on data obtained at experiments (Păun, 2007), was written down, (Tab.1).

<table>
<thead>
<tr>
<th>Mesh side bolters ( l_i ) [( \mu m )]</th>
<th>Material with particles size as ( l_i ) share (remained on sieve ( l_i )) ( R(x)_i ) [%]</th>
<th>Fraction share from sieves with ( (l_i, l_{i+1}) ), ( a_i ) size [%]</th>
<th>Medium diameter ( d_i ) of fraction particles from sieves [( \mu m )]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td>120</td>
<td>59</td>
<td>14</td>
<td>160</td>
</tr>
<tr>
<td>200</td>
<td>45</td>
<td>26</td>
<td>350</td>
</tr>
<tr>
<td>500</td>
<td>19</td>
<td>16</td>
<td>650</td>
</tr>
<tr>
<td>800</td>
<td>3</td>
<td>3</td>
<td>966</td>
</tr>
</tbody>
</table>

Replacing the values from Tab.1 in formula (1) resulted \( d_m = 0,34 \times 10^{-1} \) mm.

For \( b \) and \( n \) coefficients determination Tab.2 was written down.
Using the above formula and Tab. 2 data, values: 

\[ n = 1,023; \quad b = 0,00328 \]

were obtained and the Rozen – Rammler- Bennett equation becomes:

\[ R_{(d)} = 100 e^{-0,00328 d^{1.023}} \]

Using the results obtained in experimentation and registered in Tab.1 and Tab.2 as well as a calculate values with relation (3) has been drowning diagram from Fig. 3.

From analysis the diagram from Fig. 3 it can be observed that it approximate exist an overlap for experimentation points obtained from direct screening with those are calculate with relation (3) and (4). With the help of these figures it can be determinate the medium diameter \( d_m \) of grinding particles (Pâun, 2008).

The installation for obtaining concentrated fodders IOCF has in its constitution technical equipment that involve technical solutions to prevent the risks due to powders or others wastes that appears in the installation work process.

Simple elevator with shovels SE 100 is part of interphasic transport between the installation machine components and ensures the cereal seeds suction in order to exude powders and light corpuses. The stirring apparatus is equiped with cyclone, to prevent and reduce pollution (dust resulted from crushing and stirring process).
The dust produced while crushed material movement in cyclone and during homogenising in horizontal stirring apparatus is caught through filtration head mounted on cyclone at the upper part and collected into a filter sack.

CONCLUSIONS

The results obtained during experimentation with products have proven that the installation for obtaining concentrated fodders IOCF can be implemented within micro-farms and will lead to sustainable animal nutrition included in the Methodology Application Standards of the Zootechny Law / 2003 and to:

✓ fodder resources efficient utilization within its own farms, in animal feeding, in order to ensure productive performances and safety of the food chain;
✓ resizing profile livestock units from small to large to apply a scientific nutrition and the most modern technologies for breeding farms;
✓ investments in concentrated fodders industry to ensure a scientific nutrition to farm animals whole effective.

Nutrition and food have a very important role because the goal aimed by modern zootechny is sustainable development of food products in compliance with food security and environment protection of the products derived from livestock and cause it to develop technology for obtaining a concentrated feed should be taken into account besides the quantity the essential aspect of quality, regarding:

❖ the quality of rough materials (maize, barley, lucerne etc.) used in manufacturing process and of final product;
❖ the functional quality of machines and installations;
❖ the quality of personnel involved in the production processss.

A nutrition is effective if the following are taken into account:

- fodder material (maize, barley, wheat, alfalfa, etc..) is defined very precisely as sorts, hybrids and varieties
- obtaining fodder for feeding is related only in terms of race, hybrid, line;
- concomitant use of forage and nutritional services;
- the purchase of raw materials from the raw material manufacturer, processing and marketing in the corresponding units certificated according to international standards.

REFERENCES