METHODS OF PROTECTING THE ENVIRONMENT BY USING AUTOMATED AND COMPUTERIZED WORK TECHNIQUES IN THE CEREALS GRINDING PROCESS

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Abstract
The technological flow from a compound feed factory is a very complex one, starting from the storage of raw materials in special bunkers, then their movement to the processing installations with the help of conveyor belts, grinding the cereals, adding all the ingredients indicated by the assortment recipe, mixing and homogenization, and finally granulation and sterilization of the finished product obtained.
As can be seen, one of the basic activities carried out during the production process of various types of compound feed is the grinding of cereal grains, which involves the release of small dust particles into the atmosphere. Therefore, it is aimed to use high-performance work installations in compound feed factories, with a high degree of mechanization, automation and computerization, with high productivity and low specific consumption, to ensure a rigorous monitoring of dust and other noxes according to accepted European norms.
This article analyses the technical working parameters in the cereals grinding area and presents the results of the experimental measurements carried out in the dust discharge areas, which prove the advantage of using automated and computerized work installations, equipped with special filters which respect the optimal projected parameters and which ensure the rules imposed by the European Union for the protection of the environment.

***Key words**:automation, compound feed, dust, filter, grinding*

INTRODUCTION

According to the statistics provided worldwide by the companies and producers which activates in the profile market, there is an increase in the demand for compound feeds that are widely used in animal nutrition, considering the caloric intake brought and the fact that dedicated recipes have been obtained for each animal species, depending on race and age.

A very important component on the technological flow path of a compound feed factory (CFF) is the grinding installation, as it ensures the crushing of the cereal grains. Given that the raw materials in the compound feed factories are cereal grains, which will be grinded and then transformed into finished product granules, it is very clear that during the technological flow dust particles can be released into the atmosphere. The experimental studies in this article propose an analysis of the functional parameters of the work installation in the compound feed factory for the automated control of the grinding installations that determine the appearance of dust clouds in the surrounding atmosphere.

For this purpose, the concentration of eliminated dust was measured at the exhaust holes provided at the grinding installation.The experimental research carried out has shown that, depending on the recipe used in the preparation of a certain assortment of compound feed, the quantity of dust released into the atmosphere changes.That is why, knowing that each recipe of compound feed requires different operating parameters of work installations, in this article were analysed the results of experimental measurements obtained during the

technical process of producing three distinct types of compound feeds.
According to the studies and experimental research carried out exists two working methods that ensure the protection of the environment by maintaining the dust concentrations within the limits imposed by the European norms: choosing a recipe of compound feed with a higher hardness of the final granules or the use of high-performance installations equipped with filters to retain dust particles.Because the first variant is more delicate, considering that the recipes are dedicated to the category and species of animals fed, this article presents the experimental research carried out to check if the filters used in the grinding installation permit the efficient retention of dust, to ensure protection of the environment.

MATERIALS AND METHODS

The technological flow that takes place in a compound feed factory involves performing several activities: storage, transport, grinding, dosing and mixing, granulation, cooling, packing.The dust removed during the grinding stage must be constantly monitored so that it does not exceed the limits imposed by the European norms in force and that is why this paper presents the experimental measurements made at the point of measurement PM (figure 1).

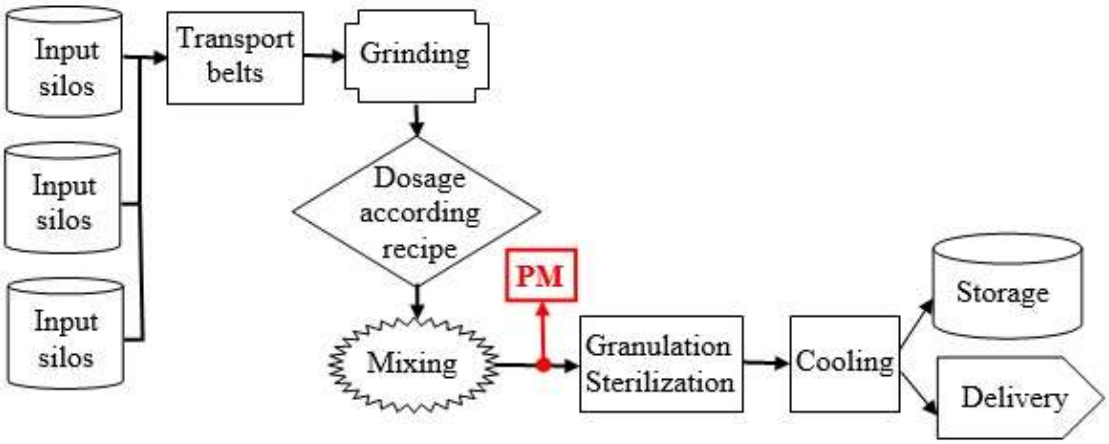

Figure 1. The flow diagram of CFF where the measuring point (PM) is marked

Any compound feed recipe is composed of different types of cereal grains (with a share between 40-80%), at which are added mineral salts, vitamins, protein, amino acids and energy supplements, indispensable for animal development.That is why the grinding of cereal grains is a stage of the technological process in a compound feed factory which influences the quality of the final product.It is very important that the cereals, which represents the biggest component of a compound feed, is ground as uniform as possible and the quantity of dust released into the air is as small as possible.
In compound feed factories, the most used installation for grinding grains is the hammer mill, whose main components are shown in figure 2.

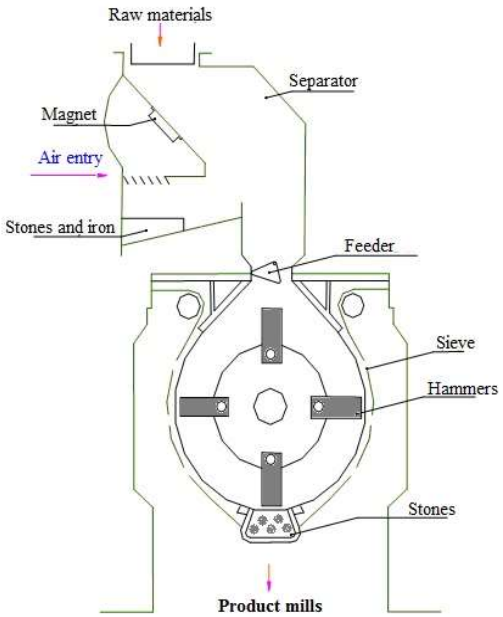

Figure 2. The general structure of the hammer mill

The cereal grains will be grinded through the crushed by the mill walls or by the moving hammers.The grinding activity is made until the particles have a size small enough to pass through the holes of the sieve with which it is provided the hammer mill at the evacuation part.

The studies and measurements carried out determined that very small particles (below 0.3 mm) represent more than 20% of the grind quantity.Of course, here are many very small particles that, inevitably, during the work process, are eliminated in the air in the form of dust, a phenomenon that must be avoided or reduced as much as possible.That is why in this article are presented the results of the experimental measurements carried out, which demonstrated that the grinding installations used in the production of compound feed, equipped with high-performance filters, are fiable and satisfy the European standards regarding the protection of the environment.

To collect samples from the air with dust which is eliminated by the grinding installation was used a Strohlein type device, specialized for such analyses.Figure 3 shows the assembly consisting of the calibrated nozzle and the filter cartridge body, which is a basic element of the Strohlein type dust analyser.

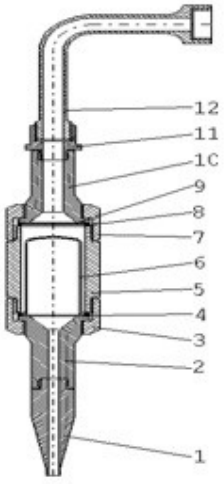

Figure 3: Calibrated nozzle assembly + filter cartridge body
1 - Calibrated nozzle,
2, 10, 11 - Connecting piece,
3, 7 - Tightening nut,
4, 8 - Gaskets,
5 - Filter cartridge body,
6 - Cotton filter,
9 - Flat filter,
12 - Connectors

During the entire duration of the experimental measurements it is followed the strictly respecting the values of the operating parameters of the work installations corresponding to the compound feed recipe produced at that time.

RESULTS AND DISCUSSIONS

The experimental researches was carried out at the grinding installations of grain cereals, meaning at the work point from the technological flow where is eliminated a certain quantity dust.

To certify the respecting of the European norms regarding the protection of the environment, the experimental measurements of the quantity of dust (C_{dust}) removed into the atmosphere and the effectiveness of dedusting (η) aimed the production processes of three types of compound feed, which are used for feeding laying hens, of cattle and rabbits.

A.) Measurements made in the case of the production of compound feed for laying hens

For the compound feed of the "laying hens" type, the determined thermodynamic parameters of the effluent (removed technological air) had the following values:

- the temperature of the ambient environment t_{amb}= 29 [°C];
- dynamic pressure p_{dyn} = 0.1 [mbar];
- effluent temperature t_{eff}= 68 [°C];
- effluent humidity a_{hum} = 81 [%];
- effluent velocity v_{eff} = 5.5 [m/s].

Table 1. Calculation of the dust concentration at compound feed of "laying hens" type

Parameter name	U.M.	Measurements
Initial mass of cotton filter	g	51.8873
Initial mass of paper filter + box	g	10.5467
Final mass of cotton filter	g	51.8884
Final mass of paper filter + box	g	10.5469
Temperature of effluent at chimney	°C	68.00
Initial value of counter for aspired air	m^3	479.5680
Final value of counter for aspired air	m^3	480.5740
Mass of dust collected	g	0.0013
Volume of air passed through the counter	m^3	1.0060
Dust concentration in technological air (C_{dust})	mg/ m^3_N	1.4412
Degree of dedusting (η)	%	89,65

The values recorded for the concentration of dust in the eliminated technological air do not exceed the maximum limit of 5 mg/m^3_N imposed on the national level by Order 492/1993 and nor the European environmental protection limits.

B.) Measurements made in the case of the production of compound feed for cattle

For the production of the compound feed given to cattle, the determined thermodynamic parameters of the effluent are:

- the temperature of the ambient environment t_{amb} = 30 [°C];
- dynamic pressure p_{dyn} = 0.1 [mbar];
- effluent temperature t_{eff} = 71 [°C];
- effluent humidity a_{hum} = 86 [%];
- effluent velocity v_{eff} = 5.4 [m/s].

The calculation of dust concentrations for this type of compound feed is presented in table 2.

Table 2.Calculation of the dust concentration at compound feed of "cattle" type

Parameter name	U.M.	Measurements
Initial mass of cotton filter	g	49.9513
Initial mass of paper filter + box	g	10.5542
Final mass of cotton filter	g	49.9525
Final mass of paper filter + box	g	10.5546
Temperature of effluent at chimney	°C	68.00
Initial value of counter for aspired air	m^3	480.5740
Final value of counter for aspired air	m^3	481.5820
Mass of dust collected	g	0.0016
Volume of air passed through the counter	m^3	1.0080
Dust concentration in technological air (C_{dust})	mg/ m^3_N	1.7732
Degree of dedusting (η)	%	89,53

For this type of compound feed, the concentration of dust in the air did not exceed the permissible limits, but it is little higher than the previous case analyzed.

C.) Measurements made in the case of the production of compound feed for rabbits
At the production of the compound feed destined for feeding rabbits, the determined thermodynamic parameters of the effluent are:

- the temperature of the ambient environment t_{amb} = 30 [°C];
- dynamic pressure p_{dyn} = 0.1 [mbar];
- effluent temperature t_{eff} = 72 [°C];
- effluent humidity a_{hum} = 88 [%];
- effluent velocity v_{eff} = 5.6 [m/s].

The measured dust concentration for this type of compound feed is shown in table 3.

Table 3. Calculation of the dust concentration at compound feed of "rabbits" type

Parameter name	U.M.	Measurements
Initial mass of cotton filter	g	50.4126
Initial mass of paper filter + box	g	11.2374
Final mass of cotton filter	g	50.4134
Final mass of paper filter + box	g	11.2380
Temperature of effluent at chimney	°C	72.00
Initial value of counter for aspired air	m^3	481.5820
Final value of counter for aspired air	m^3	482.5870
Mass of dust collected	g	0.0014
Volume of air passed through the counter	m^3	1.0050
Dust concentration in technological air (C_{dust})	mg/ m^3_N	1.5587
Degree of dedusting (η)	%	89,58

Conform to the measured values, it can be observed that for the production of the "rabbits" type compound feed, the concentration of dust in the surrounding air did not exceed the permissible limits, being lower than the limit imposed by the legislation in force, as in the previous cases analysed.

In figure 4 are graphically presents the results of the experimental measurements regarding the concentration of dust removed in the air through the exhaust holes of the grinding installations.

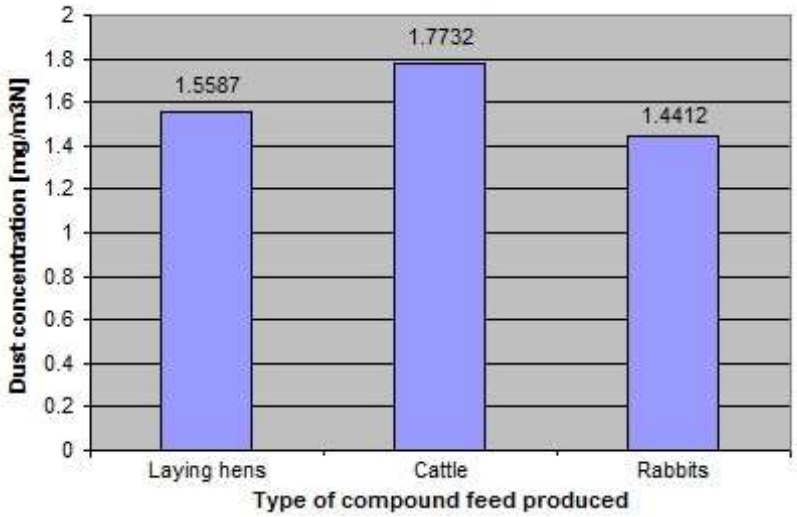

Figure 4. Measured values of dust concentrations in the removed technological air

CONCLUSIONS

The process performed in compound feed factories must be very rigorously controlled in each phase of the technological flow, according to very clearly established criteria, to ensure both the quality of the final product, respectively of the compound feed recipe delivered to the beneficiaries, as well as the control over the quantities of dust released in atmosphere.

The operating parameters of the work installation change depending on the compound feed recipe that is produced. The experimental measurements presented in this article were carried out during the work processes corresponding to the production of the compound feeds used at feeding laying hens, cattle, respectively rabbits.

At all the three types of compound feed that were analysed it was observed the good functioning of the filtration installations, by ensuring an increased efficiency of retaining dust particles from the eliminated air.

To survive in the profile competitive market, compound feed factories (CFF) must to be equipped with high-performance work installations, which ensure automated and computerized control of the technological flow, for increase work productivity and to protect the environment according to European norms.

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