EXPERIMENTAL RESULTS OBTAINED WHEN STUDYING THE NOXES REMOVED DURING THE PRODUCTION OF COMBINED FODDER FOR DAIRY COWS

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Abstract

Given the competition at the profile market, combined fodder factories have as their main objective to be as efficient as possible, which can be achieved by delivering to clients of very high quality finished products at a cost price as low as possible. Many combined fodder recipes are produced, depending on the species of animals fed and of their age.

This article analyses the production process of combined fodder used to feed dairy cows. That is because, analysing the statistics obtained worldwide, it can be seen that a fairly large percentage (approximately 16-17% of the total production of combined fodder) is directed to feed this zootechnical sector, represented by dairy cows.

An essential requirement imposed by the European Union is that of maintaining a level of pollution as low as possible. That is why this article presents the experimental results obtained at measuring the noxes eliminated by the work installations during the production of the combined fodder assortments for dairy cows. The rigorous monitoring of the noxes eliminated during the production process in a combined fodder factory is necessary for the following reasons: the safety of the human staff servicing the work equipment and a lowest pollution of the environment.

Key words**: **combined fodder, air jet, noxes, filters, automation

INTRODUCTION

The demographic evolution in an upward sense worldwide has automatically resulted in an ever-increasing demand for food and especially for animal products. That is why the production of combined fodder is an activity of great interest, considering the need to provide food for an increasing number of animals in zootechnical farms.[1]

It should also must be mentioned the fact that many types of combined fodder recipes are produced, depending on the breed and age of the animals fed in this way. All these aspects have determined an improvement of the activities of the technological flow from a combined fodder factory, by their endowment with high-performance work installations and equipment, of the latest generation, with a high degree of mechanization, automation and computerization, which ensure obtaining of high productivity under the conditions of lowest possible costs.[3], [10]

A very suggestive graphic statistic about the distribution of combined fodder consumption, by animal species, is presented in figure 1. From here it can be observed quite easily that the largest share of the combined fodder production is used to feed the animal species most sought after for food consumption.[8], [10], [11]

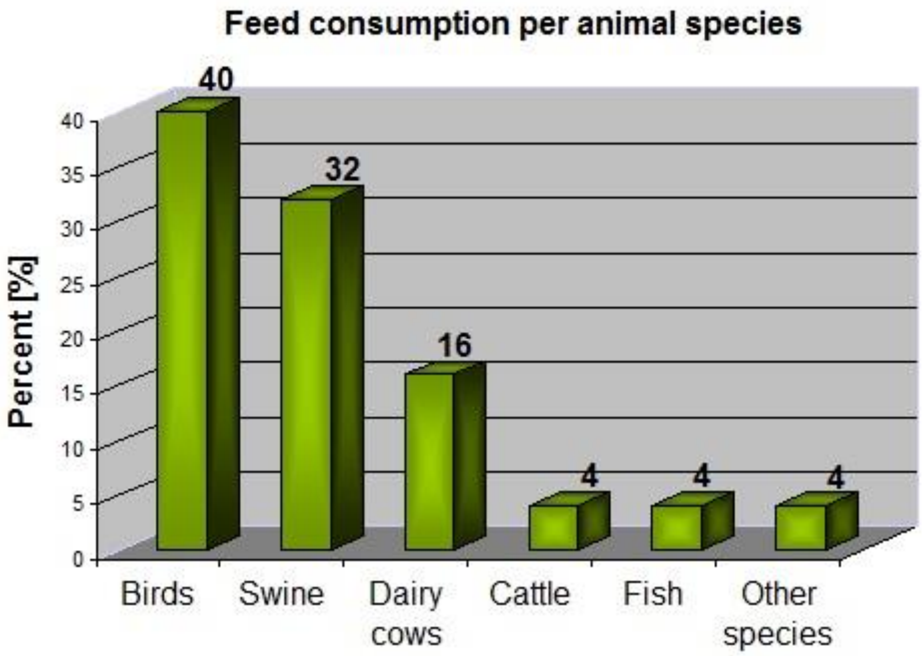

Figure 1 - Distribution of combined feed consumption, by animal species

Each combined fodder factory chooses its ingredients used in the production of certain types of recipes. Thus, the combined fodders can be obtained either by the combination of flours obtained from grinding of various cereals, or is made first the recipe (mixture) from grains and then the amount of the mixture is subjected to the grinding operation in order to obtain the fodder flours then used in the production process.[2], [4]

By their consistency and through the energetic contribution brought, combined fodder is an important element for the activity of feeding animals in zootechnical farms and automatically for obtaining very good productions in this field. That is why combined fodder factories have developed and diversified their activity a lot. But, in order to maintain on the profile market, they have two major objectives to fulfil: to obtain final products of the highest possible quality and to ensure the protection of the working personnel and the environment according to the rules established by the European Union, through a control very rigorously on the different types of noxes released into the atmosphere by the working installations.

MATERIALS AND METHODS

The technological process of obtaining combined fodder with the help of the work equipment analysed in this article can be carried out in two modes:

- the processing can be done automatically, in which case the human operator has the role of supervising the input of raw materials, of the parameters of the steam generator, of other operating parameters characteristic of the control point and to program the quantities of ingredients needed for each recipe;
- the processing can be done manually, in which case the human operator monitors all the thermodynamic parameters enumerated in the previous case, and the technological process suppose at making a single batch.

In order to take samples for the purpose of analysis the functional parameters of the work installation studied in this article were established 3 distinct measurement points, as follows:

A) in the first measurement point (PM1) were measured:

- the dust emissions, using the Strohlein STE4 device,

B) in the second measurement point (PM2) were measured:

- the noxes emissions, using the TESTO 350 M/XL gas analyser [120],

- the temperatures of the critical points of the installation, with the help of the National Instruments data acquisition system,

C) in the third measuring point (PM3) were measured:

- the thermodynamic parameters of the installation using the data acquisition system,

D) in the fourth measuring point (PM4) were measured:

- thermodynamic parameters of the installation,
- the concentration of dust from the air jets discharged into the atmosphere. The air analysis is done using the Strohlein STE4 dust analyser.

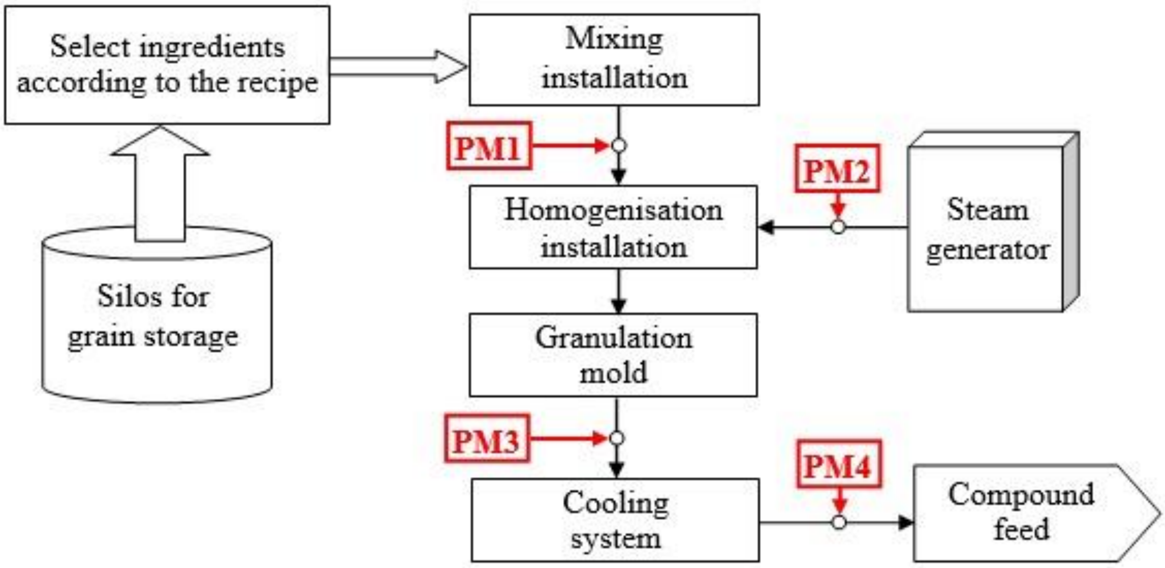

Figure 2: Indication of experimental measurement points

The working equipment used in the grinding of grains are the mills, which can be of several types. The most frequently used in combined fodder factories are the hammer mills, which work on the principle of shredding by free hitting and splitting the grains subjected to processing. As a result of this grinding activity, a powder consisting of small particles, also known as dust, is released into the air. For this reason, some of the measurements presented in this article were performed at the exit of the exhaust ports. The values obtained through the experimental measurements carried out confirm the need to use automated working installations, with absorption filters and recirculation of released air, which allow the retention of small particles removed by grinding, through the process of dedusting the removed air.[5], [6], [9], [10], [11]

The performance of a filter system for the separation of dust from the air is indicated by the effectiveness of dust removal (also called separation efficiency or degree of dust removal), which is defined by the following mathematical formula for calculation:

$$\eta = \frac{G_t - G_r}{G_t} \cdot 100 = \frac{G_e}{G_t} \cdot 100,$$

where:

η - efficiency of the separation system [%]

Gt - the amount of dust from the air which entering the separator [kg]

Gr - the amount of dust remaining in the air which leaving the separator [kg]

Ge - amount of dust extracted [kg]

The device used to collect samples from the removed technological air is of the Strohlein type and is shown in figure 3.

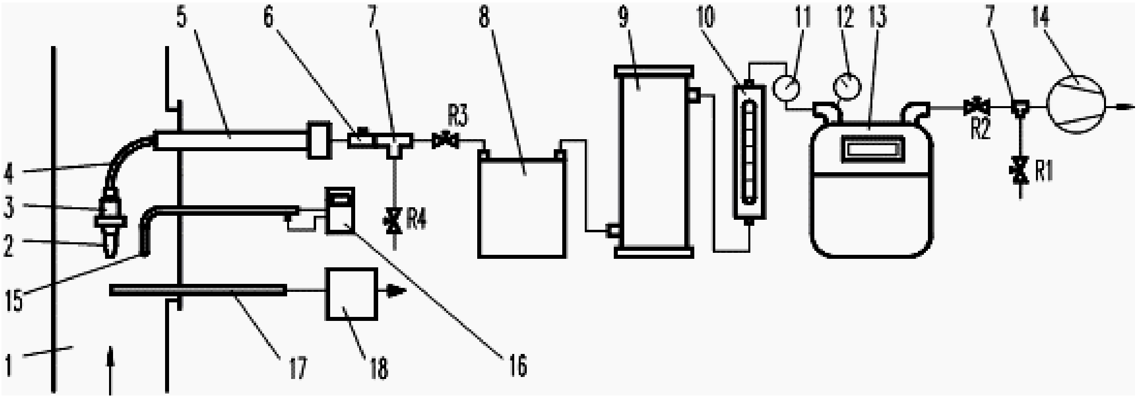

Figure 3 – The Strohlein device
1-gas channel, 2-calibrated nozzle, 3-filter cartridge housing, 4-connectors, 5-electric heating sleeve, 6-thermocouple, 7-Tconnector, 8-condensation tank, 9-drying tube, 10-flow meter, 11-manometer, 12-thermometer, 13-vacuum pump meter, 14-outlet, 15-Pitot-Prandtl tube, 16-electronic pressure gauge, 17-probe, 18-gas analyser TESTO-33, R1-R4-taps

The air removed at the exits of the mills of the working installation will be aspirated through the calibrated nozzle (2) and will pass through the filters contained in the filter cartridge (3) where the solid particles will be retained, then the air will pass through the probe (5) which is electrically heated at 180°C (6) and then it reach in the condensate tank (8). To protect the active elements of the Strohlein measuring device, the aspirate air is passed through a drying tube (9). The air will then pass through the measuring components of the device where the flow rate is determined with the flow meter (10), the pressure with the manometer (11), the temperature with the thermometer (12) and the quantity of air aspirate through the gas meter (13). The volume of analysed air is regulated by means of the R1-R4 taps.[6], [9], [10]

Other points of interest for making experimental measurements are those where steam jets with very high temperatures are used. The burner from the steam generator (figure 4) allows the adjustment of very high values for the steam temperatures used both for the homogenization stage and for the sterilization stage of the combined fodder granules. Exhausted combustion gases contain certain noxes that must be constantly monitored to ensure the protection of the environment imposed by European standards. Then the granules of combined fodder obtained in this way are cooled with the help of air in a cooling installation, and after cooling they will be transported to the storage bunker of the finished products or directly to packaging for delivery to the beneficiaries.[9], [10], [11]

Figure 4: The Certuss Junior steam generator

The TESTO 350 M/XL gas analyzer consists of three distinct parts: the analysis unit, the control unit and the gas sampling probe (figure 5). This high-performance device is used to determine the noxes in the combustion gases, with the help of special cells in which electro-chemical reactions of the Peltier type take place.

Figure 5: The TESTO 350 M/XL multigas analyzer

RESULTS AND DISCUSSIONS

The recipe and thermodynamic parameters of the working installation for the production of combined fodder for "Dairy cows" are characterized by:

a) Recipe:
- Maize: 20%,
- Wheat: 21%,
- Sunflower goats: 32%,
- Bran: 24%,
- Supplementary premix with vitamins: 3%

b) Thermodynamic parameters:
- Steam temperature in the installation: 160°C;
- Thermal agent temperature: 180°C;
- Nominal steam pressure: 8 bar.

The experimental measurements for the determination of dust concentrations in the air eliminated by the mills and the homogenization and sterilization facilities of the combined fodder granules used to feed dairy cows are presented in detail in table 1.

Table 1. Calculation of the dust concentration for the combined fodder of type "dairy cows"

Denomination	M.U.	Measurements
Initial mass of cotton wool filter	g	51.4587
Initial mass of paper filter + box	g	10.2564
Final mass of cotton wool filter	g	51.4598
Final mass of paper filter + box	g	10.2569
Temperature of effluent at chimney	°C	48.0
The pressure difference	mbar	0.10
Static pressure	mbar	0.00
Initial value of counter for aspired air	m^3	511.6790
Final value of counter for aspired air	m^3	512.6840
Start time	-	10:05
End time	-	11:45
Initial meter temperature	°C	28
Final meter temperature	°C	30
Initial meter pressure	mbar	300
Final meter pressure	mbar	310
Mass of dust collected	g	0.0016
Volume of air passed through the counter	m^3	1.0050
Dust concentration in technological air (C_{dust})	mg/ m^3_N	1.7462
Degree of dedusting (η)	%	89,51

In the table 2 presents the values of the experimental measurements for the concentrations of the noxes analysed from the combustion gases during the production of the combined fodder assortment for dairy cows. But the legislation in force stipulates that for stationary combustion installations operating with LPG, reporting is done for a reference oxygen value of 3% (marked with * in the table).

Table 2. ***The values of the experimental measurements, relative to the reference oxygen 3%***

Timp [min]	CO [mg/m^3_N]	NOx [mg/m^3_N]	SO2 [mg/m^3_N]	CO2 [mg/m^3_N]	CO* [mg/m^3_N]	NOx* [mg/m^3_N]	SO2* [mg/m^3_N]	CO2* [mg/m^3_N]
10	62.50	16.42	0.00	170.85	74.01	19.44	0.00	202.32
20	62.50	16.42	0.00	170.85	74.01	19.44	0.00	202.32
30	62.50	16.42	0.00	170.85	75.00	19.70	0.00	205.02
40	61.25	18.47	0.00	172.81	73.50	22.17	0.00	207.38
50	61.25	18.47	0.00	172.81	73.50	22.17	0.00	207.38
60	61.25	18.47	0.00	172.81	73.50	22.17	0.00	207.38
70	61.25	18.47	0.00	172.81	73.50	22.17	0.00	207.38
80	61.25	16.42	0.00	172.81	72.53	19.44	0.00	204.65
90	62.50	16.42	0.00	170.85	74.01	19.44	0.00	202.32
100	62.50	16.42	0.00	170.85	74.50	19.57	0.00	203.66
Media	**61.88**	**17.24**	**0.00**	**171.83**	**73.81**	**20.57**	**0.00**	**204.98**

The duration of the production process of the assortment of combined fodder for dairy cows was 100 minutes, and the values of the experimental measurements shown in table 2 were read at regular intervals of 10 minutes. At the end of the table are presented the average values of the noxes eliminated during the production cycle.

In the figure 6 are presented graphically the measured values for the types of noxes released into the air by the working installations, and in the figure 7 are presented the average concentrations of these noxes during the production of the combined fodder assortment for dairy cows.

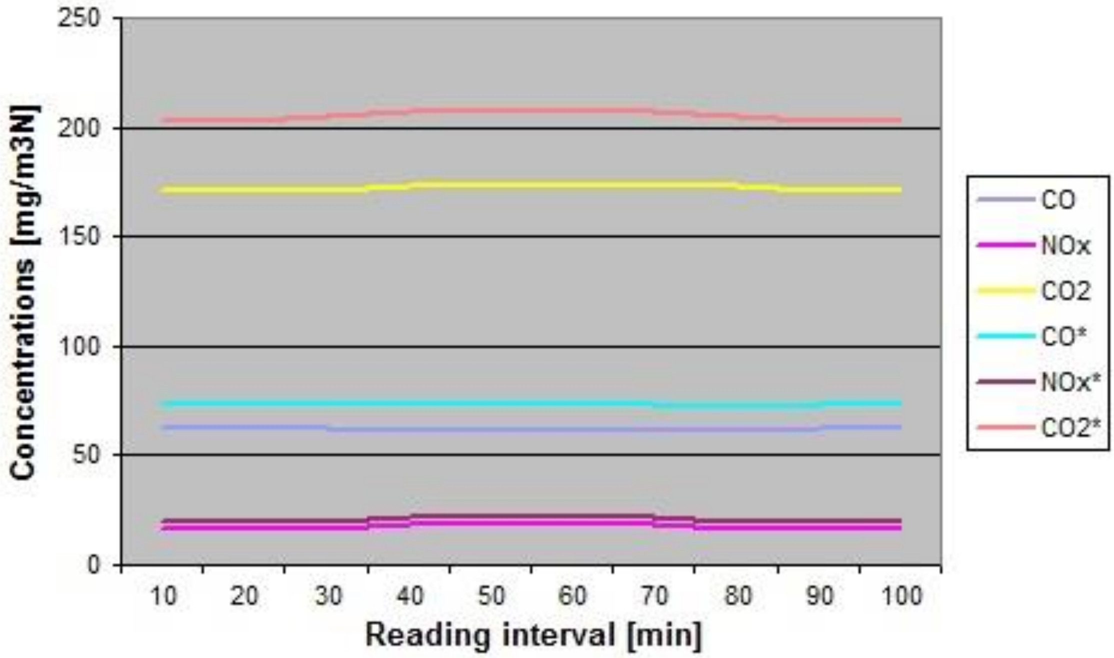

Figure 6: The measured values for the noxes analyzed

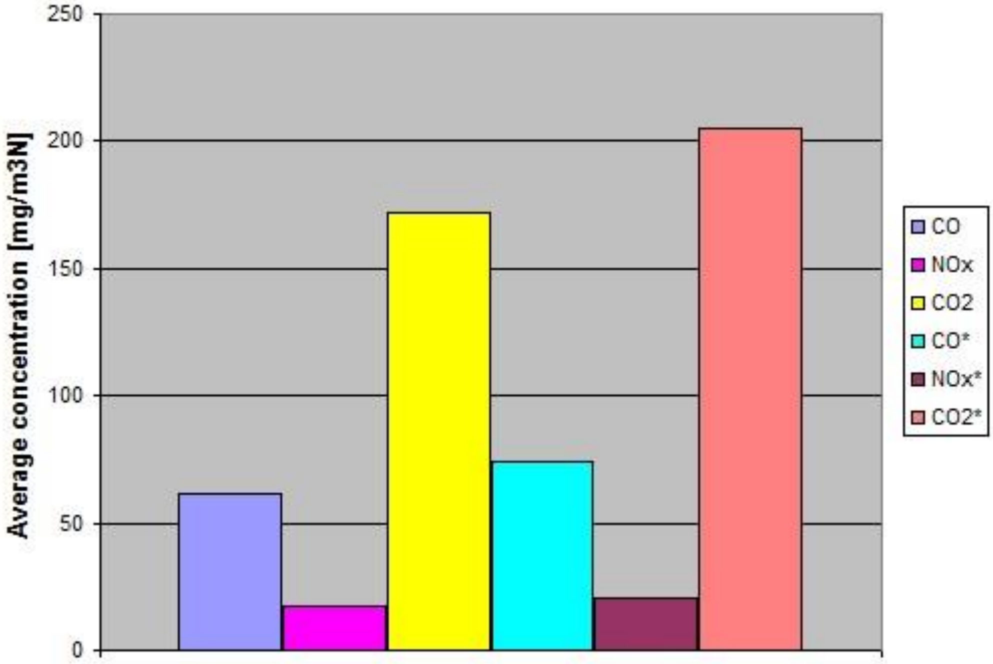

Figure 7: Average concentration for the noxes analyzed

CONCLUSIONS

The work performances of a combined fodder factory is determined by the quality of the technical equipment used, by the reliability and the yield pf them during the technological flow.

The purpose of this work is to study the noxes eliminated in the air during the technological process of producing the assortment of combined fodder used for feeding dairy cows. For this, experimental measurements were carried out at the critical points established on the technological flow route, more exactly at the grinding facilities and at the outlets of the hot steam jets for homogenization and sterilization or of the air jets for cooling the granules.

When conducting the research presented in this article were used equipment and measuring instruments by last generation, which are based on standard operating principles, which allow obtaining very high precision results.

Through the use of working installations equipped with automation and computerization modules, provided with special filters, are ensured both the optimal development of the flow of activities and the fulfilment of the norms imposed by the European Union regarding the accepted values for the pollutant emissions released into the surrounding atmosphere.

The results obtained from the experimental measurements carried out attest to the fact that the values of noxes eliminated during the production process of the combined fodder recipe used to feed dairy cows do not exceed the limits imposed by the legislation in force, that is, they fall within the accepted European environmental protection norms.

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