EXPERIMENTAL MEASUREMENTS FOR THE ANALYSIS OF POLLUTANT EMISSIONS IN THE PROCESS OF OBTAINING COMPOUND FEED FOR RABBITS

VASILE CRISTIAN

Keywords: technological flow, compound feed, experimental measurements, noxes

ABSTRACT

The rapid increase in the world's population and lifestyle changes have led to an increased demand for animal products and a diversification of people's food needs.

The technological flow from the compound feed factories involves the grinding of cereal grains, granulation, homogenization and cooling of the granules. These operations determine the use of steam jets at high temperatures and elimination of various substances or particles in air. The experimental measurements followed the noxes values eliminated in air, to comply the European norms regarding the quality of the environment. The results presented in this article highlight the reliability of work installations from a compound feed factory. Also it is accentuated the advantages offered by the use of high-performance work equipment, with a high degree of automation and computerization.

INTRODUCTION

In all countries with advanced zootechnics, the feed base is optimally ensured both quantitatively and qualitatively, thus obtaining very high productions of meat, milk and other animal products, in accordance with the requirements and needs of the population benefiting from the products delivered on the market. This can be achieved by allocating large areas of land for the fodder base, by significant investments in the production and preservation of feed, but also by the widespread use of various recipes of compound feed.

That is why compound feed factories have seen an ascending evolution in production capacity in recent years, due to the need to obtain various recipes depending on the species of animal, as well as the stage of evolution of the fed animals.

The processes that take place during the technological flow from a compound feed factory (CFF) are the following: reception-storage of grain cereals and other ingredients and substances necessary to obtain the desired recipes, transport between different work installations, grain grinding with the help of mills, mixing the ingredients according to the recipe of combined fodder to be produced, homogenization, granulation, sterilization, cooling, packaging and finally storage-delivery of finished products. All this confirms the complexity of the activities carried out in the compound feed factories and the advantages offered by the use of work installations with a high degree of automation and computerization of these activities.

During the processing of the raw materials formed mostly from cereals, they are crushed, then mixed with other substances and ingredients from the combined feed recipe that will be produced and under the action of a steam jet with very high temperatures produced by a steam generator will be obtained granules of different shapes and sizes. The steam at very high temperatures (approximately 180÷190°C) produced in the steam generator has the role both for the homogenization of the granules and for their sterilization, so as to eliminate the danger of the existence of microbes left from the raw materials or other ingredients used. At the output of the

steam generator, samples were taken and various experimental measurements were made in order to analyze the functional parameters of the work installation. Thus, at this working point, were measured the pollutant emissions from the flue gases resulting at obtaining the steam jet necessary to homogenize the mass of mixed raw materials in order to obtain the combined feed granules.

These analyzes and experimental measurements of the pollutant emissions from the flue gases from the steam generator exit were performed using the TESTO 350 M/XL gas analyzer, for a period of 100 minutes, which represents the minimum duration of a batch of combined fodder assortment.

MATERIAL AND METHOD

The working principle of the analyzers from the TESTO range is the following: the measuring cells are in fact galvanic elements that contain anode, cathode and an electrolyte. They generate an electric current proportional to the number of ions that dissociate in the electrolyte solution after the interaction with the analyzed gas emission.

Analyzers built according to this principle are much cheaper compared to analyzers in IR, but can only be used for short or medium duration determinations, usually in portable devices. With their help, concentrations can be determined for the following gases: O_2, CO, H_2S, NO, NO_2, SO_2, etc.

The TESTO equipment used to carry out the experimental measurements in the analyzed compound feed factory has three components:

- analyzer, containing the reaction cells, the accumulator battery, the filters for retaining solid impurities from the flue gases and the condensate decanter;
- the control device is a measuring element that can be operated either with the help of the keyboard or a contact pencil (touch-pen);
- the gas suction probe, allows to take the gases eliminated in the air and send them to the analyzer.

At start-up, the TESTO gas analyzer must first be zero-calibrated and it is done automatically a initialization of the the measuring cells. Then, with the help of the control device, the desired parameters are set so that the device collect and displays the data of interest for the measurement performed (figure 1).

Figure 1 - Calibration and setting of measurement parameters at TESTO 350 M/XL

The probe from the equipment endowment (figure 2) will be installed in the place of the gas exit from the working installation of the combined feed factory and the aspirated gas will be introduced in the measuring cells.

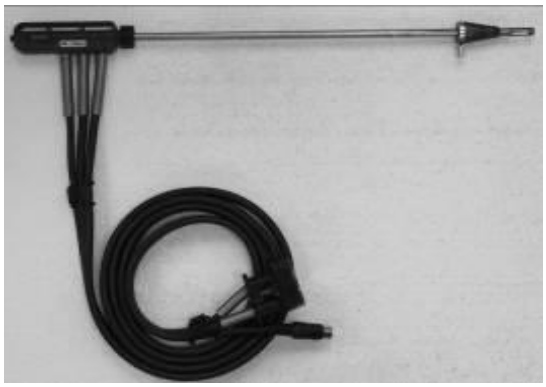

Figure 2 - Gas collecting probe

Following the Peltier reactions that take place in the galvanic measuring cells an electrical signal is emitted which will be sent and processed in the control unit, the values of the analyzed gas emission concentration being displayed.

By connecting the TESTO 350 M/XL equipment to a computer, it can be used to perform long-term measurements (hours, days or even weeks), all under the control of a special program called TESTO Easy Emissions.

The values obtained through the analysis performed during the work in compound feed factory will be compared with the limit values provided in the legislation in force for the analyzed combustion installation.

RESULTS AND DISCUSSIONS

The recipe and thermodynamic parameters of the steam generator at the production of combined fodder for "Rabbits" are characterized by:

a) Recipe:

- Maize - 20%,
- Wheat - 18%,
- Groats of sunflower - 7,5%,
- Bran - 12%,
- Lucerne flour - 40%,
- Complete premix - 2,5%;

b) The thermodynamic parameters of the steam generator are:

- Steam temperature in the installation: 180°C;
- Thermal agent temperature: 190°C;
- Nominal steam pressure: 9 bar.

Table 1 shows the results of measurements for pollutant emissions during the production of compound feed for rabbits. The production interval of an assortment of combined forage was 100 minutes and during this time were maked 10 experimental measurements at a distance of 10 minutes between them.

Table 1

Results of experimental measurement for the "Rabbits" assortment

Time [min]	tga [°C]	CO [ppm]	NO [ppm]	NO_2 [ppm]	NO_x [ppm]	SO_2 [ppm]	CO_2 [ppm]	CO* [ppm]	NO* [ppm]	NO_x* [ppm]	CO_2* [ppm]
10	309	51	8.7	0	10.8	0	6.74	74.01	17.84	20.44	15.2
20	307	47	8.5	0	10.4	0	6.72	74.01	17.95	20.44	15
30	310	51	8	0	10.2	0	6.77	75.00	17.33	20.70	15.3
40	314	51	8.6	0	10.7	0	6.75	73.50	18.49	22.17	15.5
50	311	51	8.4	0	10.3	0	6.71	73.50	19.27	22.17	15.4
60	320	51	9.2	0	11.1	0	6.78	73.50	19.9	22.17	15.7
70	315	51	9	0	10.9	0	6.72	73.50	19.02	22.17	15.3
80	312	47	8.1	0	10.1	0	6.7	72.53	18.86	20.44	15.1
90	315	47	8.3	0	10.5	0	6.73	74.01	18.25	20.44	15.4
100	316	50	8.4	0	10.8	0	6.74	74.50	18.91	20.57	15.5
Media	**312.9**	**49.7**	**8.52**	**0**	**10.58**	**0**	**6.736**	**73.81**	**18.58**	**20.57**	**15.34**

*) reported to the reference oxygen of 3%

Figure 3 shows the results of measurements refer to flue gas temperatures at critical points of work installations, at the production of combined feed for rabbits.

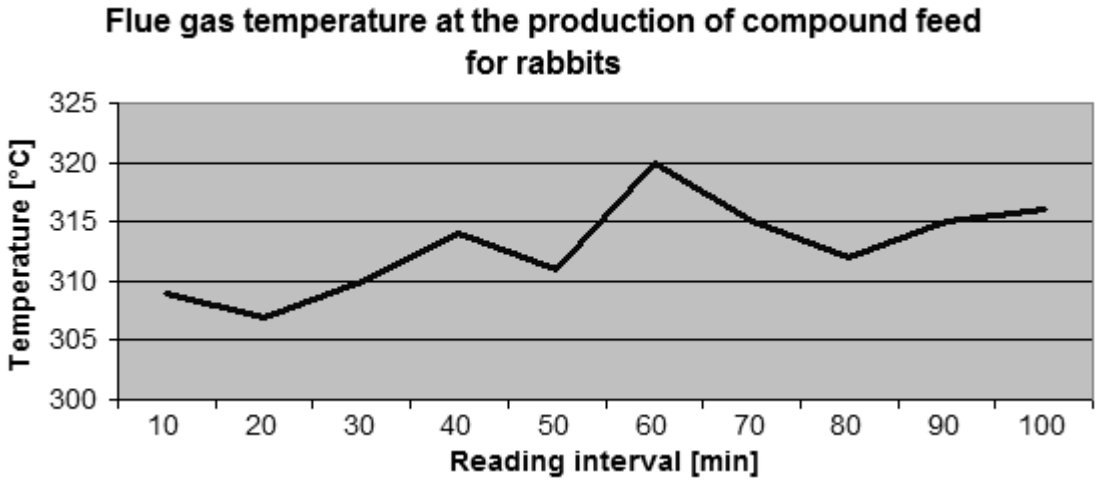

Figure 3 - Flue gas temperature for the "Rabbits" assortment

In this case a higher temperature is required for the thermal agent, which implies an increased fuel consumption. By default, the flue gas temperatures will be above 300°C when producing this assortment of compound feed.

Also, it are shown in graphical form, in figure 4 and figure 5, the values obtained for the pollutant emissions from the flue gases.

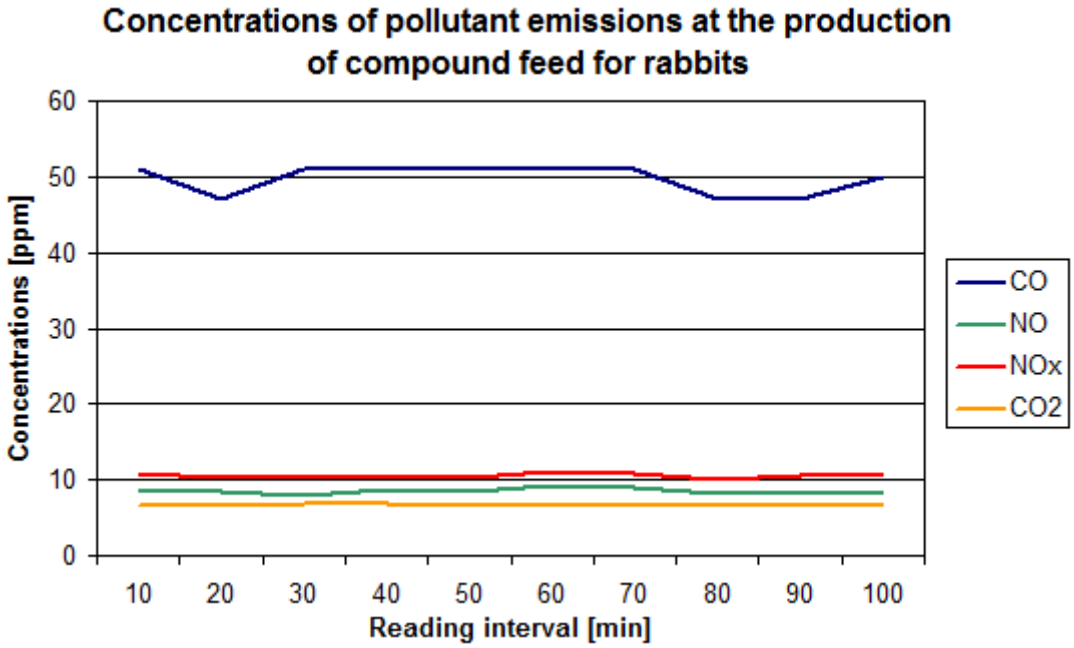

Figure 4 - Values of pollutant emissions of CO, NO, NO_x and CO_2

It is observed that the values of pollutant emissions are higher than in case of the production of other assortments, but this aspect is attributed to the automated adjustment of the steam generator.

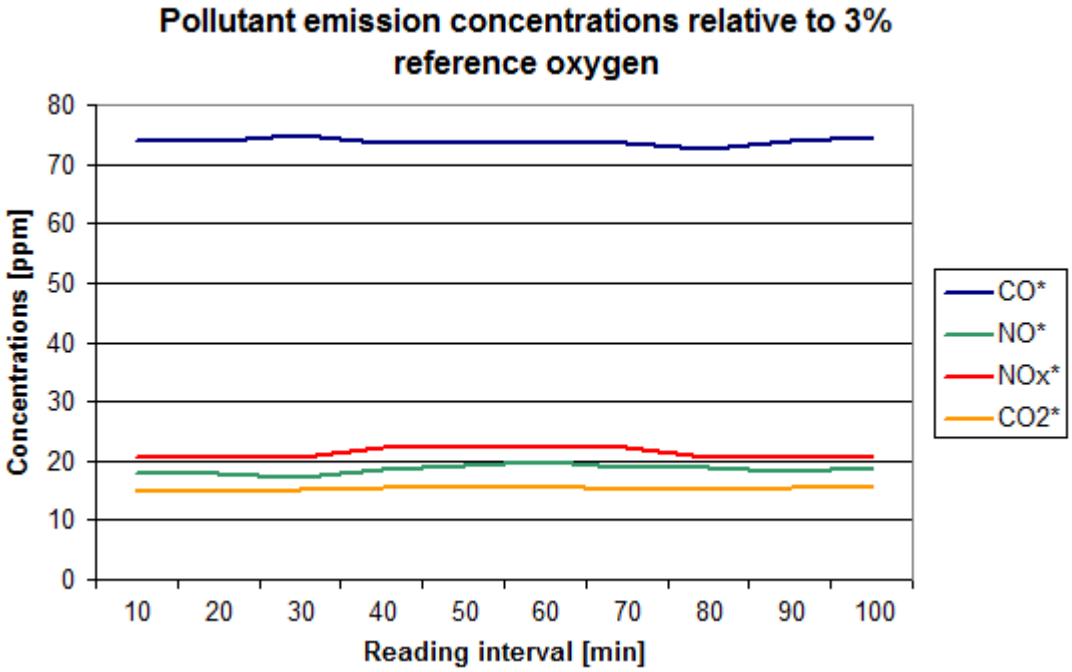

Figure 5 - Values of pollutant emissions reported to the reference oxygen of 3%

According to data provided by the International Institute for Environment and Development, the concentration of carbon dioxide (CO_2) in the atmosphere is about 388 ppm. Which shows that the working plant used in this compound feed factory is very little polluting for the environment.

Following the experimental measurements and calculations made with the values thus obtained resulted in a debit of noxious substances emitted during the production of the compound feed for rabbits shown in Table 2.

Table 2

Debits of noxious substances

Steam generator	Measurement point	Debit of CO [t/h]	Debit of NO [t/h]	Debit of SO_2 [t/h]	Debit of CO_2 [t/h]	Debit of NO_x [t/h]
CERTUSS Junior	Steam generator exit*	0.028306	0.002485	0.000000	0.035754	0.003563
	Steam generator exit	0.022569	0.002163	0.000000	0.029337	0.002925

*) reported to the reference oxygen of 3%

These measured values for the debits of the polluting gases discharged comply with the standards imposed by the European and international rules in force. This confirms the fiability and the safety of the working facilities used to produce the assortment of compound feed for rabbits.

CONCLUSIONS

Analyzing the values of pollutant emission obtained for the compound feed used to rabbits, in figures 4 and 5 it can be seen that they do not exceed the permissible limits which are imposed by European legislation:

- the values of CO emission are between 47-51 ppm and do not exceed the maximum permissible value 55 ppm;
- the values of NO emission are between 8-9,2 ppm and do not exceed the maximum permissible value 10 ppm;
- the values of CO_2 emission are between 6,7-6,74 ppm and do not exceed the threshold limit of 8 ppm;
- the values of NO_x emission are between 10,2-11,1 ppm and do not exceed the threshold limit of 12 ppm.

A major advantage of the analyzed work installation, which is due with the burning of fossil fuel (LPG) at the steam generator, is the absence of emissions of polluting gases such as NO_2 and SO_2.

Thus, from the analyzes and experimental measurements performed, it can be highlighted, from the point of view of automation, that the work installation presented optimal operating parameters and the use of such equipments in compound feed factories is very indicated, because it complies with the required rules by the European Union for the protection of the environment.

BIBLIOGRAPHY

1. **Bollen, J.**, **Brink, C.**, 2014 - *Air pollution policy in Europe: Quantifying the interaction with greenhouse gases and climate change policies, Energy Economical*, pp 202–215;
2. **Bond T.C., Covert D.S., Kramlich J.C., Larson T.V., Charlson R.J.**, 2002 - *Primary particle emissions from residential coal burning: Optical properties and size distributions, Journal of Geophysical Research: Atmospheres*, vol. 107, no. D21, pp 1-14;
3. **Gaceu L.**, 2006 - *Tehnici moderne de uscare a cerealelor si plantelor tehnice,* Editura Universitatii "Transilvania" Braşov, pp. 68-71;
4. **Heinsohn R.J. , Kabel R.L.**, 1999 - *Sources and Control of Air Pollution, Prentice Hall*, NJ, pp. 32-34;
5. **Ionel, I.**, 1994 - *Măsurarea emisiilor din gazele de ardere cu ajutorul senzorilor electrolitici,* The National Conference of Thermodynamics, Romania, Vol. I, pp. 231-235;
6. **Mihăilă, C.**, 2001 - *Procese şi instalaţii industriale de uscare,* Editura Tehnică, Romania, pp. 27-32;
7. **Popescu C**., 2008 - *Ecopedologie*, Editura Universitaria Craiova, Romania, pag. 9-12.
8. **Popescu C**., 2016 - *The modification of some features of soils located nearby chemical plant Craiova zone that is affected by noxioux substances,* SGEM 2016 Conference Proceedings, vol. 2, pag. 409-415;
9. **Roden C., Bond T., Conway S., MacCarty N., Still D.**, 2006 - *Laboratory and field investigations of particulate and carbon monoxide emissions from traditional and improved cookstoves*, Environmental Science and Technology, 40(21), pp 6750–6757;
10. **Vasile C.**, 2016 - *The implementation of an automated system of monitoring of the steam tempertures at the formation of compound feed granules*, Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, Vol. XLVI, no. 2, ISSN: 1841-8317, pag. 588-593;
11. **Vasile C., Glodeanu M., Alexandru T.**, 2017 - *Environmental protection through automated monitoring of steam temperature in the work installations of compound feed factories*, SGEM 2017 Conference Proceedings, Vol. 17, Issue 51, pp. 387-394.