MEASURING THE CONCENTRATION OF POWDERS RESULTING FROM FLUE GASES OF A CFF

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ABSTRACT

The long term objective of Romanian economy is that of putting the bases of a real market economy, which will integrate in the structures of the European Union and will respect the Community provisions.

This way, even for the industry production sector from the zoo-technical domain, reaching of this objective means the endowment with modern, efficient equipment, with a higher level of mechanization, automation and computerization, with higher productivity and lower specific consumptions.

In this article is made an analysis of dust concentration in flue gases emitted of a Compound Feed Factory (CFF), regarding the conformity to European norms concerning the quality of the environment.

INTRODUCTION

In the firing equipment that produce the necessary steam at the homogenization in different forms of the pre-mixtures and in the cooling plants of the final product will be eliminated in the atmosphere both exhausts and dust or powder, which determinates the affecting of the environment and also is affecting the life and the surrounding nature.[3, 4]

The flying ash, eliminated through the smoke flue of burning installations, soft smoke dust driven by wind, the fine ash from the ash deposits and the coal dust, derived from the coal tailings or from its transport and preparation, together constitute a solid exhaust, that is found even as aerosols. The ashes contaminate and pull down the environment, deposits on the vegetation, buildings, and streets and give an unpleasant cast, in the end being inhalant by people [1, 2, 9].

Deleterious aerosols constitute the pollutants that give the most noxious effects for people. Happily, these ashes have a poor content of heavy metals (Cr, Ni, Cd, As, Pb) so that in most of the cases the formed aerosols are not noxious.

More important is the work of moving the noxious gases through powders and carrying out their hazardous effects at very large distances from emission location.[6, 8]

Therefore it is absolutely necessary to follow-up and rigorously to control the concentrations of dust in the exhaust gases at working plants that have engines with internal combustion or fans that collect different particles. This paper presents exactly such a methodology for measuring the dust concentrations resulting from the process of compound feeds obtaining.

MATERIAL AND METHOD

The technological flow in a Compound Feed Factory (CFF) is quite complex considering that pre-mixture feeds are mixtures obtained by the combination of cattle food of plant and animal origin with mineral salts, antibiotics, vitamins, enzyme preparations and drugs dispensed so that its meet physiological requirements of different types of animals. [5, 7]

Two of the most important activities in the compound feeds manufacturing process are those for the production of steam at high temperatures and cooling of the obtained granules.

The steam produced in the firing plant with the aid of the steam generator has an important role for both the homogenization of the granules and their sterilization. Granules obtained in this way are then cooled by air in a cooling installation, and after cooling the granules are conveyed to the finished product storage hopper or directly to packing for delivery. [7]

Thereby, in the cooling process of the obtained product, the air used as a heat carrier grows hot due to the high temperatures of the granules, but at the same time it moves with it also the unstuck particles in the drying phase of relative compound feeds, forming thereby the dust.

In the figure 1 it is shown the technological flow of CFF and indicates the working point for measurements on dust concentration (PM) in the exhaust gases from working plants.[8]

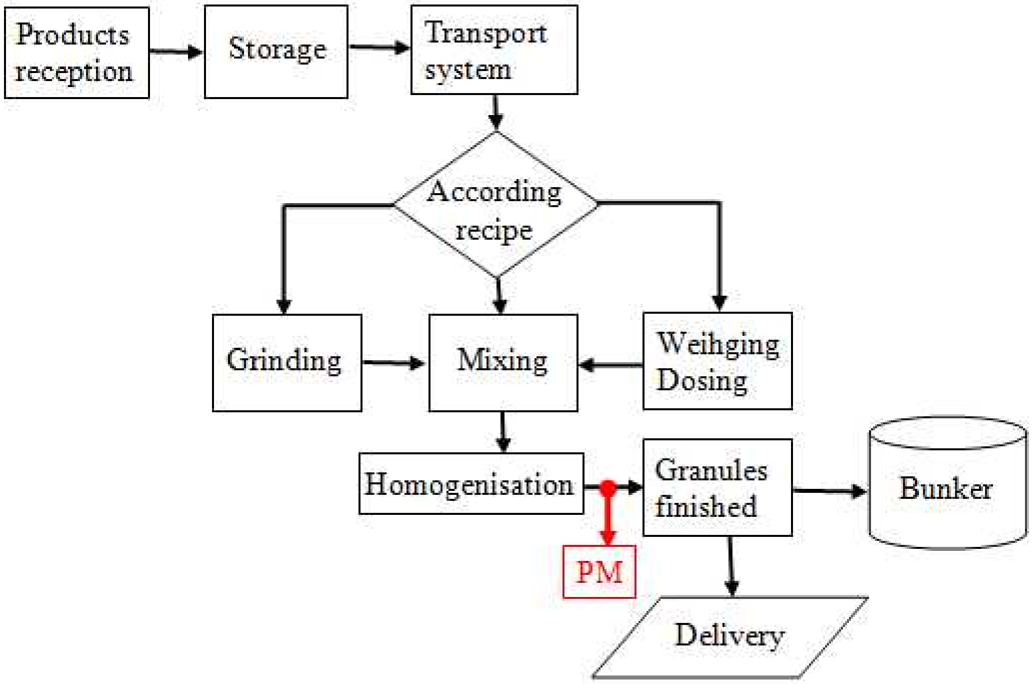

Figure 1: The diagram of operation in which is marked the point of analysis (PM)

The measurement principle consists in analyzing a representative volume of the extracted effluent from the flue gases removal duct. As it is schematically shown in figure 2, there are made multiple simultaneous and successive heat engineering determinations.

The plant, whereby is realized the powder amount measuring of the flue gases from their exhaust ducts, is complex and basically consists of several independent parts.

After assembling the plant, this will be brought to the temperature of normal working condition and then the aspirant tube is brought to approximately 120°C, the tightness is checked by obstructing the well, operation followed by starting the drawing pump so that the drop pressure stays at 200 mbar, the debit that falls over through the installation must be lesser than 2% of the debit that falls over trough this during the measurements [1, 2, 9].

Then it follows the positioning of the well in the first point of measurement in the gas flow direction, whereupon the well is obstructed within the opening of the duct wall, the drawing pump is turned on and through the by-pass system it goes to the gases aspiration in the smoke duct (exhaust duct).

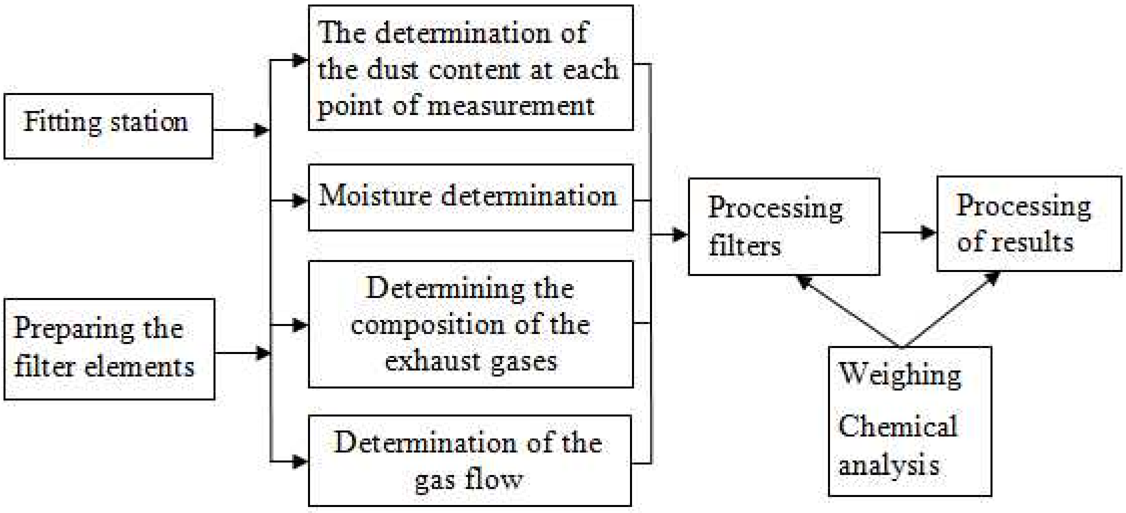

Figure 3: Flow chart of chaining procedures for the determination of the powders from flue gases

During the measurement, the settings of the emitted gases running are being observed (speed, debit) and data of the measured values are periodically marked.

Knowing that there is an irregular distribution of dust in the inflow section, measurements are made by the disposal of many more sampling points in the used well section, which will allow the right determination of medium density of the dust emitted on a section.

To assess the actual conditions in the operation of the firing plants that are serving the working process of obtaining compound feeds, it is necessary to measure the pressure, temperature, and density participation of the main components of exhaust gases carried out through firing plants by using gases analyzer TESTO 350 M/XL [...] with the aim of calculating accurate density of exhaust gases.

The device for measuring the dust concentration of the emanated gases by furnacing, as STROHLEIN STE4 type, is shown in figure 3.

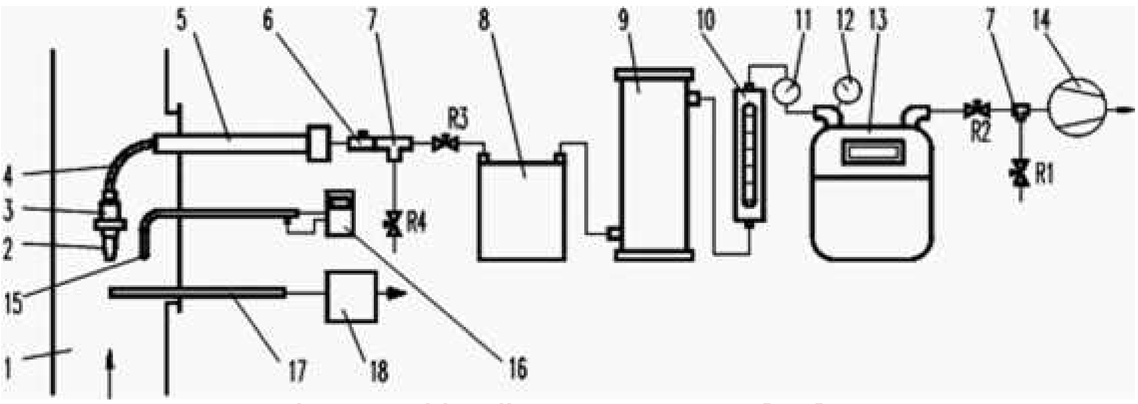

Figure 3: Wiring diagram STROHLEIN [119].
1-gas passage, 2-nozzle calibrated, 3-housing filter cartridge, 4-connectors, 5-socket electrical heating, 6-thermocouple, 7-tees, 8-tank condensate, 9-drying tower silica gel, 10-flow meter, 11-gauge, 12-thermometer, 13-meter vacuum pump exhaust, 14-channel, 15-Pitot-Prandtl tube, 16-electronic micromanometer, 17-well, 18-analyzer TESTO, R1-R4-taps

The exhaust gases induced will go through the following route: after the suction through the calibrated air nozzle (2) it will pass through the filters contained in the filter cartridge (3) where the solid particles will be retained following the gases going over through the well (5) electrically heated to 180 °C in the condensate tank (8). In order to protect the active elements of the device, the gas is passed through a drying tower (9) with silica gel. It follows the flue gas passing through the unit itself where the flow meter determines the capacity (10), depression with pressure gauge (11), the temperature with a thermometer (12) and the sucked gas amount through the gas meter (13). The volume of gas which will be sucked it adjusts by R1 valve.

The speed of the current in the gases channel is determined by next equation:

$$w_c = \sqrt{\frac{2\,\Delta p_{din}}{°_{gtc}}} \quad \left[\frac{m}{s}\right] \qquad (5.21)$$

in which:

Δp_{din} – dynamic pressure, as measured by Pitot-Prandtl, [Pa];

ρ_{gtc} – the wet gas density from pressure and temperature of the composition in the channel, [kg/m³].

For exact knowledge of work conditions in the time of measurements, it determines the composed gases temperature t_{gc} (°C) and static pressure Δp_{st} [mbar] using the TESTO device.

During the measurements are observed and marked at equal time intervals (at the beginning from 3 to 3 minutes, and then from 10 to 10 minutes) the values of flow parameters such as: the gases temperature in wells t_s [°C]; gases temperature t_k read on the thermometer of the rate meter t_c [°C]; gases depression ap_k read on the counters manometer [mbar]; gas flow indicated by the tachometers [m^3/h]; barometric pressure [mbar]. On completion of the measurement in a certain point of gas issue the aspiration of eliminated gases, from the removed from studied firing plant, stops and at the same time the timer and power supply of the sleeve well stop and the induced gases flow is marked as well as the elapsed time for carrying out these analyzes.

To obtain the final results concerning the dust concentration in the analyzed flue gases there must also be followed the next steps: it dimensions the quantity of intercepted water in the condensate container and it measures the wet silica gel, and after the well is cooled, it carves the filter cell, then it stocks in a special prepared recipient and then are measured the filter unit as well as the plain filter.

THE OBTAINED RESULTS

During the analyses performed in the CFF, the dust concentrations were measured at the evacuation flue of the heat carrier. For the assortment of compound feed, named “Broiler Chicken - starter phase", tested in this operation, it will be applied the certainty of dust concentrations method, described in the previous paragraphs.

According to the measurement standard of dust concentrations, the minimum required volume of sampling under the isokinetic conditions, is 1 m^3. Depending on the speed of the effluent at flue, the sampling time can vary from minutes to hours. To take samples in isokinetic conditions, it is necessary to know some thermodynamic parameters of effluent.

Thus, for the pre-mixture feeds “Broiler Chicken – starter phase” the settled thermodynamic parameters of effluent are:

- ambient temperature t_{amb} = 20 [°C];
- dynamic pressure p_{din} = 0.1 [mbar];
- effluent temperature t_{ef} = 48 [°C];
- humidity effluent Rh = 78 [%];
- speed effluent w_{ef} = 5.2 [m/s].

In the table 1 it is indicated the value of dust concentration and also the number of other characteristic parameters of that measurement sample.

Table 1

Calculation of dust concentration for "Broiler Chicken – starter phase"

Name	**U.M.**	**Broiler SPh**
Initial mass wool filter	g	51,4587
Initial mass filter paper + box	g	10,2564
Final mass wool filter	g	51,4598
Final mass filter apper + box	g	10,2569
Temperature of the effluent at flue	°C	48,0
Pressure difference p	mbar	0,10
Static pressure p_s	mbar	0,00
Initial counter	m^3	511,6790
Final counter	m^3	512,6840
Start time	-	10:01
End time	-	10:37
Temperature initial counter t_{ci}	°C	24,0
Temperature final counter t_{cf}	°C	25,0
Pressure initial counter p_{ci}	mbar	-300
Pressure final counter p_{cf}	mbar	-311
Mass of collected dust m_{praf}	g	0,0016
Volume of gas passed through the meter V_{cont}	m^3	1,0050
Concentration of dust in burning gases C_{ref}	**mg/ m^3_N**	**1,7462**

For the studied firing plant there have been carried out several measurements on different time intervals, and the results obtained for the dust concentrations are shown in table 2.

Table 2

Concentration of dust in burning gases C_{ref}

Sample measurement	1	2	3	4	5
Time slot	10:01-10:37	11:05-11:42	12:02-12:39	13:09-13:46	14:01-14:40
C_{ref} [mg/ m^3_N]	1,7462	1,7483	1,7395	1,7478	1,7448

In the figure 4 it is graphically shown the evolution of the measured values for the dust concentration in the emanated gas at the studied firing plant flue.

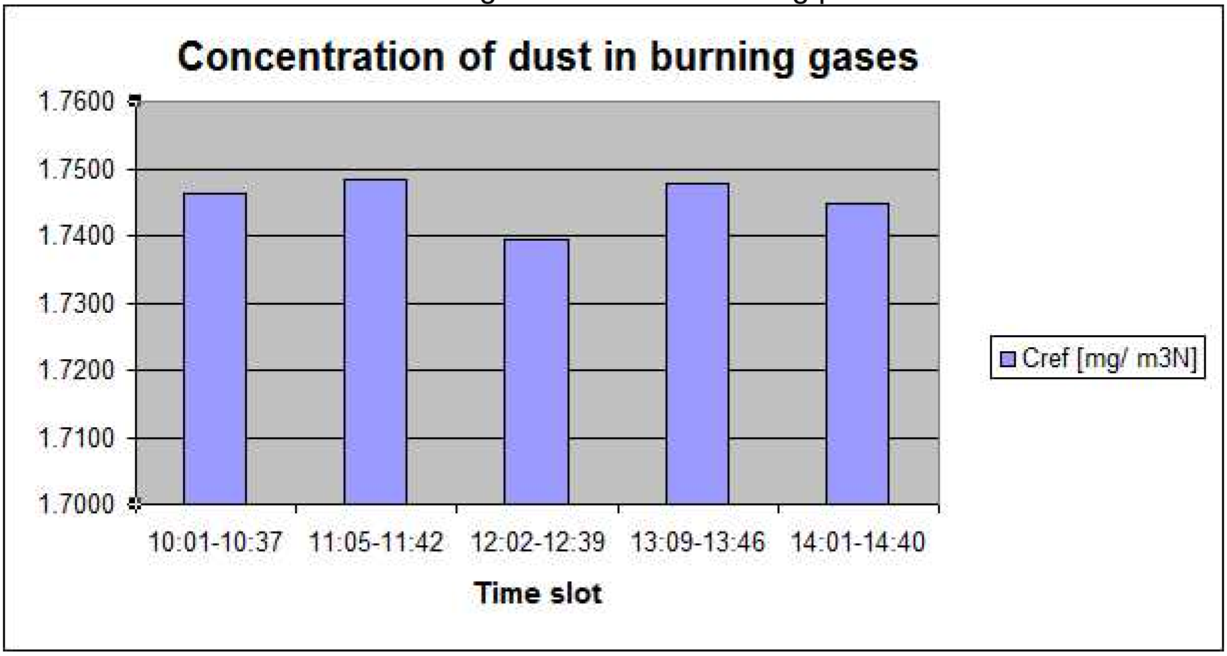

Figure 4: Concentration of dust in the burning gases of CFF

DISCUSSIONS

To obtain accurate results for tests carried out for monitoring the working process in CFF the, dust concentrations were measured at the evacuation flue of the heat carrier.

We should be mentioned that the 462/1993 Order requires, besides the exhaust limits, also limits of dust concentration. Thus, dust emission limit for feed production plants and combined feeds is 5 $mg/m^3{}_N$.

A very important conclusion resulting from these determinations is that the firing plant, in terms of dust emissions, is within the normal limits set by laws in force.

Considering the importance of compliance to European standards on environmental protection it is necessary that the working plants in CFF to be upgraded and equipped with the most efficient automated and computerized control equipment of developed activities, as well as the existence of a strict control of pollutants and dust concentrations eliminated through flue gases.

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