STUDY TO DETERMINE THE GASEOUS EMISSIONS FROM THE COMBUSTION GASES

Ioan MILOŞAN
Transilvania University of Brasov, Romania

Abstract. The paper presents some aspects about measurement of the pollutants emissions from a heat treatment plant. Responsibility belongs emissions monitoring equipment operators, environmental authorities and organizations involved (authorized organizations- companies, laboratories, operators are empowered to make measurements of emissions of air pollutants from large combustion plants).

In this paper, the practical examinations were made in collaboration between author and the Monitoring Department from the Environmental Protection Agency of Brasov, conducted in a company's "Metrom Industrial Park", the source of pollution was a tempering furnace fuelled by natural gas for heat treatment.

Sampling points were: before and after the filter basket mounted on the exhaust gas inside the oven. It was used a gas analyzers TESTO 350 XL – a performance equipment to determine gaseous emissions from the combustion gases. All the determinations were done in special cells, following chemical reaction type Peltier. Analyzed gases are: SO_2, CO, C_mH_n, O_2, NO and NO_2.

Following the experimental determinations, it can be concluded that they exceeding the emission limit values for the indicator of carbon monoxide (CO), both before and after the filter, gives a hot-performing incomplete combustion.

Keywords: monitoring, gaseous emission, combustion gases, heat treatment process

1. Introduction

Generally, the responsibility for environmental protection, belongs emissions monitoring equipment, to authorized organization, companies, laboratories, operators who are involved in measurements of emissions for all types of pollutants from large combustion plants.

The monitoring activity involves the monitoring changes which appear in certain chemical and physical parameters of emissions, discharges, consumption, equivalent parameters or technical characteristics [1]. Monitoring is based on repeated measurements or observations with a frequency determined according to procedures documented and supported and carried out to obtain information that can vary from simple visual observations to accurate numerical data [2, 3].

Information may be used for various purposes, mainly to verify compliance with emission limit values, but may be useful for monitoring correct operation of industrial processes, or to make decisions to improve industrial operations.

The main emissions are in the air – so called air pollutants which discharge gases and fine powder substances from industrial activities. Emission Limit Value (ELV) – represents the permissible quantity of a substance contained in exhaust gases from an industrial facility which may be discharged into the air in a given period of time [4].

The amount of the mass of substance in a volume of pollutants gas, considering the oxygen content in the flue gas of 3% by volume for liquid or gaseous fuels, 6% in volume in the case of solid fuels and 15% by volume for gas turbines and is expressed in [$mg/N\cdot m^3$].

In the previously works, [1-4], were studied the importance of monitoring emissions of pollutants from various industries, highlighting the need for air quality monitoring networks at local, regional and national level as well.

2. Choosing of the measuring/sampling points

Which will be better measuring method or sampling, it is to choose which will give the results for the representative of the emission behaviour of that facility. Therefore, if new plants are examined, the location of the planning stage will be done immediately.

It must be ensured the access to be safe and easy as possible for specialized personnel. The positioning and access facilities are established in advance and properly, taking into account with the rules of safety [5-7].

The dangerous of working terms are: exposure to toxic gas, hot temperature, flammable medium, exposure to dust and noise hazards of electric shock or static equipment, handling heavy or bulky equipment.

Sampling for the automated determination of gas concentrations at stationary source emission is done according to ISO 10396:2008. Standards containing: methods of sampling and analysis provide the measurement of the concentration of pollutants to be done in a representative volume of effluent [8-10].

Collection points must have concrete conditions regarding to the distribution of pollutants in the cylindrical section the homogeneity and speed as possible, the temperature and pressure in the sampling volume.

Gas flow in the pipe must be nearly laminar, with an upper speed limit of detection of the method used to measure them. Therefore, the presence of biases, the fittings, valves, fans or other equipment should be avoided [11-13]. It is recommended to measure the locations of straight exhaust pipes, shapes and sections constant. Where possible, the lengths of straight sections before (upstream) and after (downstream of) the location of measurement point will be at least 5 or 3 or the equivalent hydraulic diameter of the measuring section [13].

In any case, the input section must be longer than that at downstream. ISO 9096:2005 recommends a minimum of five hydraulic diameters upstream and two downstream. Bins at a rate of effluent sufficiently high (preferably > 5 m/s) are portions of recommended measures.

Regarding particulate measurements will be preferred to the horizontal vertical channels to avoid filing or uneven distribution of powder in the effluent. It is preferable to choose as section after (downstream) flue gas fan, because that portion is likely to be more homogeneous mixture of gases than before the fan.

Sampling must be representative of the effluent gas, i.e. sampling location must be typical for the entire pipeline. Representativeness of sampling location requires confirmation measurements using a computer network and must be given before the first installation of the measuring system and repeated in case of uncertainty.

The measuring place can be in a single point or along a single axis of measurement plan, then it must be shown that this location is representative cross-section measurement. The measured values should be weighted appropriately chosen point.

If there is the opportunity to meet all the criteria for the location of sampling points, it will ensure the representativeness of the sample by increasing the number of sampling points in the grid.

To access the measuring points is preparing a platform, fixed or mobile, ensuring a sufficient working space, the necessary connections to water and energy and taking into account measures for the protection of labour. Length probe sampling used should be appropriate diameter basket so to ensure representativeness of the sample and to allow its handling with maximum safety.

Gratings or railings of protection should not interfere with handling probes. There will be an opening access to sampling points, existing in the channel wall/chimney, to allow positioning of equipment and then seal.

3. Duration and frequency of measurements

Measurements for monitoring are done with a regular frequency, according to the monitoring program established, for example: IMA measurements of sulphur dioxide emissions, nitrogen oxides and particulates are a frequency of at least every six months.

Moments of time and frequency emission measurements have chosen to be representative and comparable facility emissions for all facilities operating under similar conditions.

It is recommended that an adequate number of measurements for cases where operating conditions vary. Choosing a measurement sampling period depends on:

- ensuring that sufficient evidence collected to allow analysis with an error acceptable standards;
- sampling mode, cumulative or incremental;
- the number of sampling points.

Have chosen the longest period of sampling that takes into account these considerations. If you know the approximate value of the pollutant concentration measurements/calculations prior, then we can estimate the volume V (liters) of gas to be drawn to collect sufficient evidence for a valid measurement.

In the case of low particle concentrations, the sampling duration can be 2 hours. In any case, during a sampling grid at each point of measurement do not need to be more than 30 minutes (ISO 9096:2005).

A series of measurements consists of three individual measurements. Individual point measurement is the average of measurements made on the axis or grid.

4. Continuously monitoring of emission

Discontinuous emission measurements are necessary for the establishment punctual, in a limited time, the emission behaviour of an installation. The advantage of this type of measurements from the continuous emission monitoring effort was to reduce measurement techniques. Certain objects cannot be measured continuously measured (automated) or can be measured not only by investing a lot.

To draw some conclusions about the behaviour of the continuous emission of an installation by applying the procedure of finding a limited time, measurements should be carried out so that the measured results reflect a representative picture of the emission behaviour.

Measurement planning is therefore a crucial factor. There are many reasons for making staple emission measurements. In addition to measurements required by the competent authorities, there are measurements required by stations, such as the measurements made to optimize self-monitoring or installation.

5. Emission measuring

Gas analyzers TESTO 350 XL, Figure 1, performance equipment to determine gaseous emissions from the combustion gases, their determination can be done in special cells, following chemical reaction type Peltier [11-13].

Figure 1. TESTO 350 XL gas analyzer

Analyzed gases are SO_2, CO, C_mH_n, O_2, NO and NO_2.

Also, excess air ratio "λ" detected and determined by calculating the concentration of CO_2, dynamic and static pressure, gas flow velocity and mass flow of gas for all species analyzed. The unit consists of three main parts: the unit of analysis, the control unit and a gas sampling probe. Unit response will contain cells, battery pack, filters for retaining solid impurities from flue gases and air, settling for condensation and electro-pneumatic connections.

The gas is sucked through the probe reaction when introduced into cells of the gas pump is turned on manually or automatically. But before the gas is cooled suddenly looked at 4-8 °C, condensate precipitates having low absorption of NO_2 and SO_2.

Dry gas then passes through a special filter, for solids retention. This filter works as a water trap.

Following reactions Peltier electrical signal is delivered and processed over the control unit being analyzed gas emission concentration values displayed. The excess gas is discharged continuously.

For measurements of large (several monitoring sources) can interconnect up to 8 units of analysis, fitted the same or different and up to 20 separate data acquisition unit (to determine speed, temperature, humidity, etc.) and all are connected to the same control unit and / or a PC.

Control unit (Figure 2) is a measuring device that can be used independently of the unit of analysis, but not for the determination of gaseous emissions. It is equipped with input jacks that can be connected (in addition to the unit of analysis) temperature sensors, humidity, speed, turbulence, pressure, voltage and current, and speed. It can display graphically to 6 channels simultaneously. The control unit can be operated either with the keyboard or a touch-pen.

Figure 2. Control Unit: 1 - IrDA interface; 2 - Switch On / Off; 3 - Magnetic holder (on rear); 4 – Display; 5 – Keyboard; 6 - Contact bar for meas. box (on rear); 7 - Interfaces: USB 2.0, charger, Testo Data bus

In addition to the measured data values are displayed information such as system configuration and location. By connecting a data acquisition system can be extended inputs for sensors.

The device can be equipped with multiple gas sampling probes. They differ depending on the characteristics gases collected [11-13].

5.1. Practical determination with system analyzer Testo 350 XL

Practical examinations were conducted in a specific company from "Metrom Industrial Park", with the source of pollution as a tempering furnace fuelled by natural gas.

Sampling points were: before and after the filter basket mounted on the exhaust gas inside the oven. Result appropriate determination of sampling points is presented in Table 1.

Table 1. The practical result analyzer measurements "Testo 350 XL" for the sampling points

No.	Sampling point	Indicators	Value determined		Value calculated		Emission limit value	
			Value	UM*	Value	UM	Value	UM
1	Before filter	CO	150	ppm	187.5	mg/m^3	100	mg/m^3
2		NO_x	15	ppm	30.75	mg/m^3	350	mg/m^3
3		SO_2	0	ppm	0	mg/m^3	35	mg/m^3
4	After filter	CO	106	ppm	132.5	mg/m^3	100	mg/m^3
5		NO_x	1.50	ppm	3.075	mg/m^3	350	mg/m^3
6		SO_2	0	ppm	0	mg/m^3	35	mg/m^3

* ppm or P/m (parts per million) is a measure of concentration

The calculated emission limit value is compared to an oxygen content of effluent gases of 3%, according to the Ministry of Environment and Forest no. 462/1993 for approval “Protection conditions on technical and methodological standards for determining atmospheric emissions of air pollutants produced by stationary sources” [7-10]. Conversions for the transformation of values "ppm" as measured by the analyzer system "Testo 350 XL" the values accepted by SI expressed in units of "relationships are presented in „mg/m^3” relationships are presented in (1), (2) and (3).

a) CO conversions for the "ppm" in [mg/m^3]:

$$CO = \text{measured value} \times 1.25, \quad (1)$$

where 1.25 is the conversion factor of CO from "ppm" in [mg/m^3];

b) NO_x conversions for the "ppm" in [mg/m^3]:

$$NO_x = \text{measured value} \times 2.05, \quad (2)$$

where 2.05 is the conversion factor of NO_x from "ppm" in [mg/m^3];

c) SO_2 conversions for the "ppm" in [mg/m^3]:

$$SO_2 = \text{measured value} \times 2.82, \quad (3)$$

where 2.82 is the conversion factor of SO_2 from "ppm" in [mg/m^3].

The influence of the calculated amount of CO and NO_x gases according to the measuring points are presented in Figures 3 and 4.

Analyzing data from measurements is currently aimed at characterizing the potential harm from that job. The levels determined relates to allowable emission concentration limit, which is the concentration of pollutants in the area which should not be exceeded at any time of day labour.

Following the determinations made, it can be concluded that they were exceeding the emission limit values for the indicator of carbon monoxide (CO), both before and after the filter, this situation thanks to a hot-performing (incomplete combustion) [9].

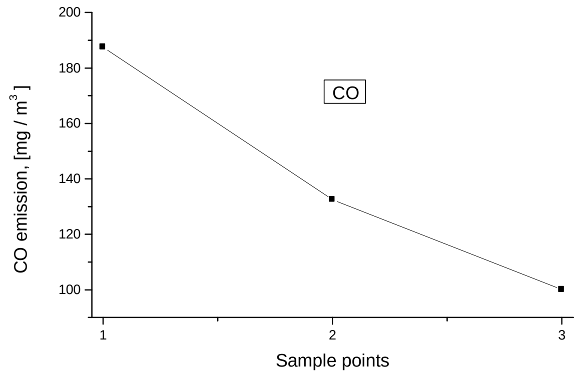

Figure 3. The calculated CO emission results according to the measuring points
1 – before filter; 2 – after filter; 3 – emission limit value

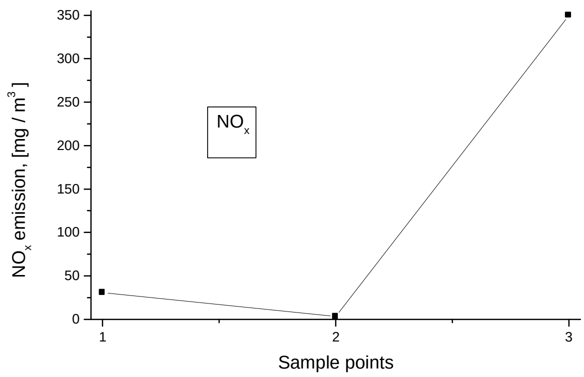

Figure 4. The calculated NO_x emission results according to the measuring points
1 – before filter; 2 – after filter; 3 – emission limit value

6. Conclusions

The dynamic analysis aimed at characterizing the potential harm from a work place during the working day.

For situations where contaminant-generating processes are discontinuous technology, sampling is done at short intervals, every two hours or depending on the process technology.

The levels relate to the average concentration determined allowable amount of which should not be exceeded during a work shift.

All EU Member States are encouraged to disseminate environmental information, particularly the measured values in order to develop knowledge and understanding of the phenomena of pollution impact on the environment.

In many European countries is encouraged by the operation of air quality monitoring network in parallel with national, made up of independent laboratories to ensure quality results and especially the quality control results.

The aspects encourage the implementation and maintenance, of air quality monitoring laboratories, reference standard ISO / IEC 17025:2005.

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