REDUCTION OF DUST EMISSIONS THROUGH THE INSTALLATIONS OF DUST EXTRACTION IN THE COMBUSTION GASES

Adriana Foanene, *"Constantin Brâncuşi" University of Târgu Jiu, Romania*
Josef Timmerberg, *Jade University of Applied Sciences, Wilhelmshaven, Germany*

ABSTRACT: *Installations for the production of electric and thermal energy are a large and continuous source of pollution of the environment through ash particles and exhaust gases emitted into the atmosphere. They influence all natural environmental factors such as air, water, soil, flora and fauna. Therefore, most of the environmental regulations concern the energy sector, and as a result they must be known and respected by both thermoenergetics designers and staff in the operation of thermoelectric power plants. Reduction of ash deposits and slagging in steam boilers is an efficient way of reducing fuel consumption in steam generators.*

KEY WORDS: *ash, environment, energy, pollution, filters.*

1. INTRODUCTION

The paper presents a simplified description of the main techniques used to reduce dust emissions from industrial gases resulting from various technological processes. As is well known, the process of purifying industrial gases can be classified into mechanical and electrical.

• Mechanical processes include all those that essentially depend on inertial or mechanical forces.

• Electric processes commonly referred to as electrofilters differ in principle from mechanical methods in that the forces that cause particle separation in the suspension are of an electrical nature and act directly on the particles to be retained.

The choice of construction type and sizing of dusting installations depends generally on the type of fuel, the size of the plant, the type and configuration of the boiler, but also a number of factors such as: particle diameter, particle size distribution, particle shape, sedimentation rate, physical properties, dust concentration in the gaseous medium, gas flow, resistivity, etc. For the separation of dust from the combustion gases, different installations are used, such as: mass-based separators; separators with filter media (bag filters); gas scrubbers (scrubbers); electrostatic filters (ESP - electrofilters).

2.INSTALLATION FOR THE SEPARATION OF DUST

2.1.Gravitational separators

The simple deposition chamber is shown in Figure 1. It is used for the heavy gas capture of coal dust and ash from the combustion gases. By using this type of separators, yields of about 40% for particles larger than 200 μm can be achieved.

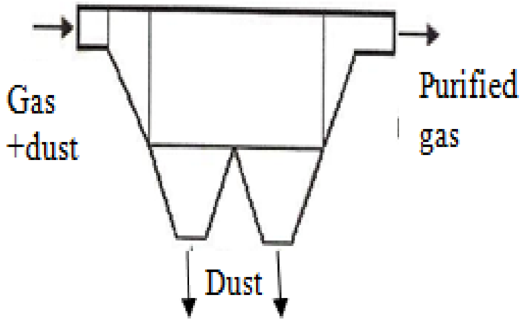

Figure 1.Smart of the simple depositing chamber

The efficiency of the separation process can be improved by the use of deflector or baffle deposition chambers. For these types of separators dust separation takes place especially under the action of inertia force.

2.2. Separators based on mass forces

It is classified according to the nature of the prevailing force in the following groups:

• gravity separators, which in turn are divided into simple deposition rooms, depositing rooms with deflector or sprayers respectively;

• centrifugal separators consisting of cyclones or cyclone batteries.

2.3. Centrifugal separators (cyclones)

These types of separators, known as cyclones, use gavitation acceleration to separate dust from gases. Cyclones have a simple construction, safe in operation are robust and cheap, do not have a wide use in all areas of solid suspension capture and are used either as individual or battery-mounted devices.

Experiences with cyclones have led to the following conclusions: Cyclones with d> 3 m, mounted on boilers with pulverized coal foams, have a purge rate of 50%, and in the case of the assembly of cyclones with d = 1 m, the degree of dust removal can be increased to 60%.

The multicylinders are different from the battery-mounted cyclones, both in smaller dimensions of the elements, and by the existence of a common dustbin, through which the elements communicate with each other. The degree of gas purification in multicyclones, compared to the single element separator, is lower. Cyclones are indicated as a first step of filtering small gas flows.

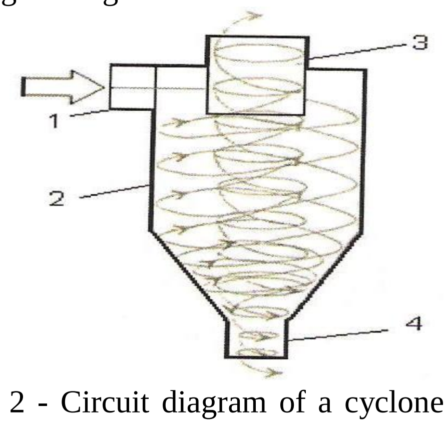

Figure 2 - Circuit diagram of a cyclone: 1-raw gas inlet connection, 2-cylindrical casing, 3-pipe exhaust cleaner, 4-pipe dust extraction

2.4.Separators with filter media (Bag filters)

Sack filters, generally operating in the temperature range 120 - 220 ° C, are used for dehumidifying gases from power boilers that equip low energy energy groups and reduce cement dust pollution.

The bag filter assembly comprises:

the filter itself; the force and command panel; exhaustor; suction and discharge pipes.

The filter itself consists of the following subassemblies: housing - a sealed metallic structure that has filtering system inside it; filter system made of textile bags; shaking system; the bunker and helical conveyor; access stairs; thermal insulation.

Under the action of the exhaust, dust gases are aspirated and enter the filter through the access and distribution compartment. In the hopper there is a first stage of separation due to the movement of the transporting speed and the change of the gas flow direction.

Gases of suspended particulate matter reach the filter bag compartment where it separates on the surface and pores of the filter material, and the dewatered gases penetrate into the space between the concentric bags and then into the scrubbed compartment, after which they are discharged into the atmosphere.

In order to reduce gas permeability, the filter bags are shaken from the accumulated dust layer in a filter cycle by putting the shaking mechanism into operation when the pressure difference between the filter bag compartment and the dust compartment compartment reaches a predetermined optimum limit .

This opens the access of the reverse cleaning jets to one row of bags simultaneously. The cleaning operation continues to shake the last row of bags. The whole process is automated, and the presence of the operating staff is not required. The automation system signals centralization of defects in operation, stopping it in case of major faults.

The bags are made of glass fiber coated with teflon to withstand the rough working conditions.

During cleaning, the dust deposited on the bag is removed for later storage. Regular removal of dust from filters is an important operation for filter efficiency, but it has an impact on the life of the bag.

Textile filters are normally classified by how the filter area is cleaned. The most popular methods include: reverse flow, mechanical shaking, vibration pulse and compressed air.

The choice of filters should take into account the composition of the gases, the nature and size

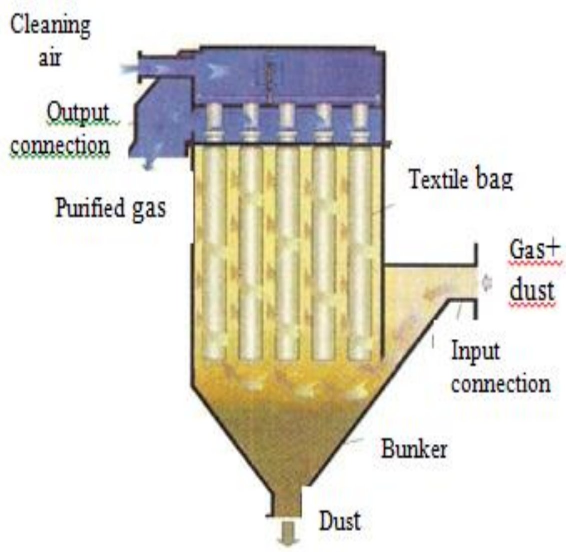

Figure 3. - The principle of a bag filter

of the particulate matter, the cleaning method to be used, the required efficiency and the economic factors. You still have to consider the temperature, the presence of water in the flue gases and the "acid dew point temperature", if any.During operation, a gradual reduction in plant efficiency occurs. Extreme damage can occur due to corrosion, erosion, and fire.There are fuels that can cause clogging of the textile filters, causing operating problems. Clogging can occur during starts when fuel is used. Generally, the sack material is very sensitive to temperature, so high temperature ash or unpleasant fuel can affect the plant. If the construction is modular and the modules are isolated, the maintenance of a filter can be performed while the others work.

Investments are lower than electrostatic filters, but the problems caused by pressure drops and cleaning results in high operating costs.

These costs vary depending on the type of sack material and the cleaning method. Maintenance costs are also high because the bags need to be changed for periods of between two and five years.

Although such installations achieve a high degree of separation (99.9%), irrespective of the particle size, their spread is hampered by the difficulty of making and operating the filter elements.

At present, a relatively small number of bag filtration plants are used on the industrial scale worldwide for the removal of combustion gases.

2.5.Water separators

Wet separators (wet scrubbers) perform the retention of solid particles from a gas stream by fixing them with a flushing liquid. The raw gas is first brought into contact with the washing liquid. In the second phase, the dust particles are removed together with the liquid.

Wet scrubbers have been used for decades as dust reduction systems with the advantage that they require a small investment.

These installations have the disadvantage of a large pressure drop and high operating costs. Combustion gases are cooled in wet scrubbers and require heating prior to evacuation into the atmosphere, which leads to additional energy consumption. Because of this, in the last decade, wet scrubbers have been used less and less.

2.6. Dust Separator with Venturi Tube

Figure 4 shows a simplified scheme for a gas purification plant with a Venturi tube dust separator. From the distribution chamber, the gases are sucked through the access passages to the canals (Venturi nozzles).

Gases cross the nozzles at high speed. This speed will be determined experimentally, using different types of nozzles. The water injection is performed in the minimum nozzle section. Uniformization of the mixture takes place in the diffuser. The gas mixture with solid suspensions and water is designed on the scrubber wall where the centrifugation is carried out.

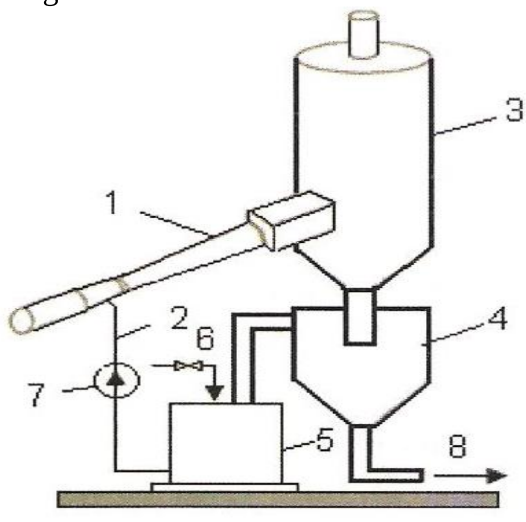

Figure 4.- A schematic diagram of a sewage treatment plant with a nozzle tube diffuser Venturi, 2-water injection, 3-cyclone, 4-sedimentation vessel, 5 water tank, 6-water addition, 7 - pump, 8-sludge

By centrifugation, the gases are pressed continuously onto the cylindrical surface and permanently moistened with water through the upper nozzles. Glowing flue gases in Venturi scrubbers makes fine dust particles gathered into larger and heavier particles, easy to extract into separation plants.

2.7. Mobile layer scrubber

For the collection of ash particles he uses plastic spheres that are in full motion within a moving layer. Several mobile layers can be used to increase efficiency. Inside the filter, countercurrent with the combustion gases, a water jet that cleanses the plastic spheres is sprayed. The movement of these spheres is ensured by both combustion gases and flushing water.

Continuous movement reduces any tendency to form plugs.The separation efficiency is good when the amount of dust is moderate. This technique is not suitable for fuels with a very high ash content.

If the removal of water particles is not appropriate, fly ash may remain in the flue gases.

Large dusting attempts can lead to plant clogging with consequences for the entire process.

Wet scrubbers for dust containment are used less than bag filters and electrofilters. They can have high energy consumption and low efficiency for retaining fine dust particles, compared to electrofilters and bag filters.

2.8. Electrostatic filters

The operation of electrostatic filters is based on the action of electric forces that are exerted on charged particles with electric charge through an electric field.

Unlike conventional filtering (mechanical filters using inertial or centrifugal forces) in electrostatic precipitators, the separating forces act directly on the particles to be retained. Either a simplest electrostatic filter, built from a ground-bound cylinder and a wire placed in the center axis of the cylinder (Figure 5).

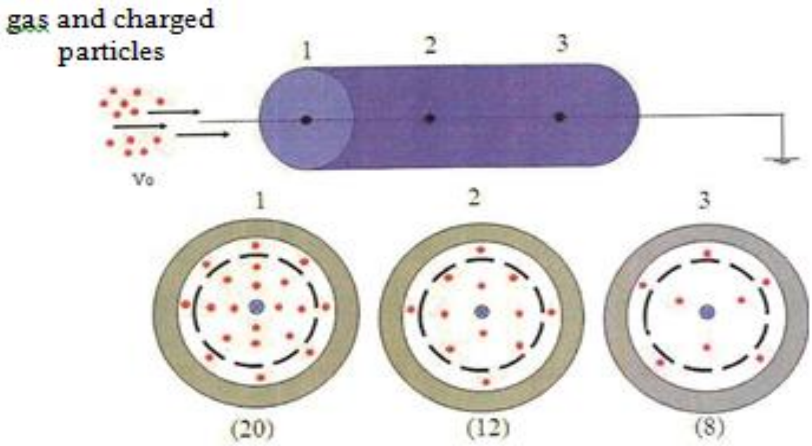

Figure 5 - Schematic representation of a simple electrostatic precipitator.

If the central wire is connected to a high electrical potential (tens of kilovolts), a corona discharge occurs and the ions of the same polarity as the wire are trained to the cylinder. This phenomenon leads to the formation of an ionic burden with a high density at the end of the yarn and decreasing along the surface of the cylinder. Some of these ions are captured by particles due to the local distortion of the electric field due to the difference in value between relative particle and gas permissiveness. Thus, the particles are charged by capturing the ions up to a maximum load. The charged particles are subjected to an electrically driven force. along the surface of the outer cylinder connected to the ground. They form a layer that can be removed mechanically The functioning of the electrofilters is determined by both electrical parameters and the properties of the working gas and especially those of the separated particles (electrical resistivity, electrical permissiveness, particle size).

Types of electrofilters

Depending on the purpose of the electro-filter and the solutions adopted for the installation as a whole, the electrical de-dusting installations can be constructively classified according to several criteria:

a)After loading and loading areas:single-stage electrofilters; two-stage electrofilters.
b)Following the direction of flow of the gas relative to the ground:
horizontal electrophilters; Vertical electrofilters.
c)After the geometry of the electrodes system: with concentric electrode system (tubular electrofilters); planar electrodes system.
d)After the number of independent fields that can be formed in a room: with a field (electric areas);with two or more fields.
e)By how the gas impurities are captured: dried; Wet.

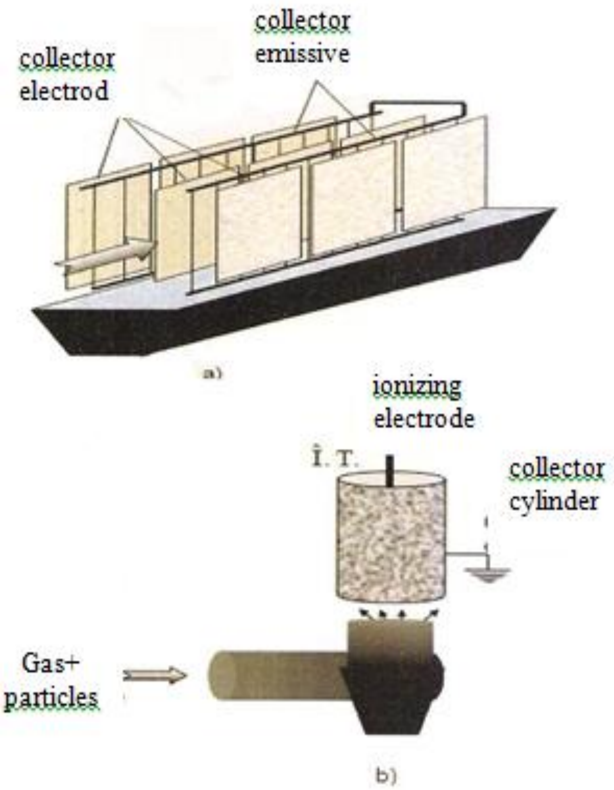

Figure 6 Schematic view of an electrostatic filter:
a) plate-plate type; b) wire-cylinder type

In all the increasingly intense concerns of reducing pollutant factors, industrial degreasing methods that provide superior efficiency, among which electrostatic dust removal with electrofilter occupy a priority place. Based on the principle of retaining dust particles by positive electrostatic charging and retention on negative electrodes, dust removal with electrofilters is distinguished by the following advantages:

- can be built for any desired degree of desiccation (over 99%) and for as large a gas flow, from several hundred m3 / h to several million m3 / h.
- retain both wet and dry particles.

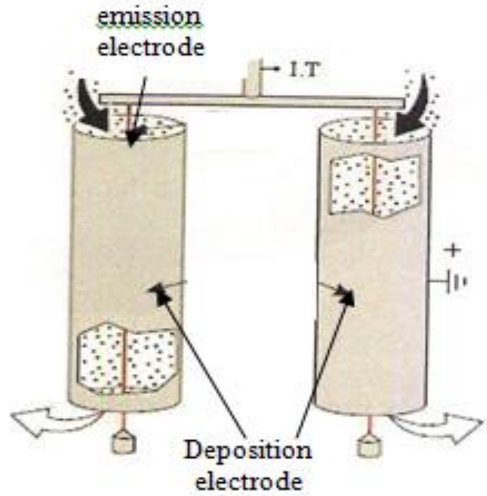

Figure 7 - The gas inlet in a tubular electrofilter.

- is distinguished by a very low hydraulic resistance, within 3 15 mm col. H_20, as well as a relatively low power consumption of 0.05 + 3 kWh / 1000 m^3 of purified gas.
- can work in a wide range of temperatures, up to 500 ° C, ie under both pressure and overpressure conditions (up to several atmospheres).
- the concentration of dust in the treated gases may range from several mg / m^3 to several tens of g / m^3.
- can hold with high efficiency both coarse dust and dust <1μm in size.
- there is a possibility of a higher automation of the gas removal process.
- Once designed, they have a service life of between 15 and 25 years.

CONCLUSION

Coal ash resulting from coal combustion as well as other noxious NOx, SO_2 emissions can be said to have the most damaging effects on both human health, producing diseases from the most diverse, as well as on soil, construction, and the environment.
Due to the pollution caused by these pollutants resulting from the combustion of coal, we are currently trying to reduce pollution by adopting new technologies capable of reducing as far as

possible their harmful effects.
The burning of lignite in the Oltenia basin results in large quantities of volatile matter. They favor the ignition process.
However, the application of primary NOx reduction methods also has some side effects, such as the possibility of mechanical and chemical unpleasances (due to incomplete combustion), the greater risk of surface contamination or zygulation; increasing the amount of gas at the exhaust gas in the case of combustion gas recirculation; the risk of occurrence of hydrogen sulphide in the furnace, for fuel with more than 1% of sulfur due to poor atmospheres in oxygen; the risk of corrosion of pipes in the outbreak; changing the heat dissipation distribution between the focal chamber and the immediately following surface due to major changes in the burning process; modifications and adjustments of the burner automation system; complicating the trace of pipes from the outbreak, resulting in disturbances in the circulation of the emulsion.
Since some denoxing procedures require large investments, it can be easier to implement the best performing methods even if the efficiency is not very high.
The use of new methods has also highlighted the fact that the most important effects that influence the effectiveness of collecting pollutants are gas distribution, particle deposition, particle concentration, particle reentry and turbulence.

The essential conclusion is that particles are charged with electric charge as long as they visit areas where ion density is important. A decisive factor determining the repeated passage of particles through these areas is the secondary flow of gas, the structure of the gas flow inside the electrofilter being therefore decisive with regard to the filtration efficiency of such a precipitator.
At present, a reduction in the pollution resulting from the combustion of lignite is being attempted by using the wet desulphurization process at CTE Rovinari and CTE Turceni with significant results so far.

The use of these new methods of containment of pollutants leads to an optimal adaptation to the current rules on environmental protection.

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