METHODS FOR INCREASING ENERGY EFFICIENCY

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Abstract:*The purpose of this paper is to present and compare the main methods of dusting, advantages and disadvantages of these methods. Class distribution was performed to total suspended particle size and particle size class distribution feature . Based on a specialized program was conducted to map the dispersion of pollutants in the atmosphere , isolines of maximum daily and annual concentrations of PM10.*

Keywords : *energy, electrostatic precipitators , cyclones , dedusted gas , power plants.*

INTRODUCTION

Electricity is currently one of the most used forms of energy. Electricity is a clean form of energy but most of the time, its production is based on coal combustion processes of land, natural gas and fuel oil in power plants .

Following these processes are released into the surrounding atmosphere large amounts of carbon monoxide, carbon dioxide, sulfur oxides, and particularly SO2, nitrogen oxides (NO/NO2), unburned hydrocarbons, volatile salts (chlorides , fluorides, sulfates), vapor water, etc.

In Romania, over 30% of all electricity is produced in coal power plants , which are usually located around large mining basins , but also in large urban industrialized area. Coal power plants are major polluters, particularly complex. Baskets exhaust flue gases are high sources of environmental pollution while sources low ash dumps. High sources discharging into the atmosphere large quantities of gaseous, metal powder and fly ash.

Pollutants like this are dispersed over large distances, depending on stack height, gas velocity at the outlet of the chimney, the direction and intensity of air currents.

Today, as ever more solid fuel is used to produce electricity, power plants have become a major source of environmental pollution. The amount and type of pollutants are dependent on the quality and use of fossil fuel power plants each technology. The emission power plants consist of CO2, CO, SO2, NO, NO2, steam, hydrocarbons, volatile salts (chlorides, fluorides, sulfates, etc.). (Ionescu ., 1973)

A basket of high capacity power plant spread into the atmosphere daily 3-5 cars unburned coal dust and ash and 500 tons of sulfur compounds (mainly SO2), suspended on the wind drives them around the power plant within a radius of 25 km (Barnea şi Papadopol, 1975).

Action power plants can be classified from the point of view of the impact of pollutants on different compartments of the environment. From this point of view, the impact that it had on coal power plants can be aesthetic, climate, groundwater and the surface of the soil, vegetation, human health .

TECHNIQUES TO REDUCE DUST EMISSIONS

Oltenia Energy Complex (CEO), the largest energy producer of coal in Romania, formed,

by merging complex Turceni, Rovinari Energy Complex, Craiova Energy Complex and the National Society of Lignite Oltenia Targu -Jiu, was established in May of 2012 and plays an important role in Europe, with a total production capacity of 3,900 megawatts (MW).

Oltenia Energy Complex activity is conducted in four counties: Gorj, Dolj, Valcea County and, comprising four plants. Activity and production of lignite mining began in 1957, extracting far an amount of about 1.06 billion tons. The highest yields were recorded lignite Tismana, which was extracted amount of 125 million tons, Rovinari, with 103 million tons, and Lupoaia, 100 million tons of lignite extracted over the years. Basin Oltenia lignite resources are distributed 82% in Gorj, 10 % in Michigan and 8 % in Valcea County.

Activity energy production is provided by power plants Rovinari, Turceni, Işalniţa and Craiova II.

The thermal Rovinari, production started in 1972, it has a total installed capacity of 1,320 MW, with four blocks of 330 MW and an amount of energy produced by the establishment of 176 TWh.

The highest yields of energy were recorded in October 2013 to 1.28 TWh and in January 2014 to 1.31 TWh. The peak was reached in December 2013, when it reached 3280 MW power.

CE Oltenia has developed investment projects for environmental compliance requirements , but also to extend the life of existing production capacities. CE Oltenia can give now secure, efficient , clean and relatively cheap production cost is below the average of SEN.

At present , the EC Oltenia Branch Mining Division has 17 operating surface mining areas with continuous flow extraction technologies and a perimeter underground stopes with long front to Tehomir.

Fig. 1. Thermal Power Rovinari

First line technology for excavation , transport and dump that was made up of modern machinery was put into operation at the coal basin Rovinari Cicani career in 1967, and consisted of a excavator, conveyor and abzeter.

Currently there are a number of 170 high capacity mining equipment and over 280 kilometers of conveyor, which can provide an output of over 34 million tons of lignite per year.

During the combustion of fossil fuel, mineral mass (inorganic impurities) turns into ashes and partially leaves the boiler as fly ash with the flue gases .

Particulate matter from the Flue Gases That is the amount of fly ash Particles of the base, used for cleanashtray which plants flue gases are divided into four groups:

1. separators based on mass forces ;
2. wet separators ;
3. electrical separators ;
4. separator with filter media .

Electrostatic precipitators (ESP - electrostatic), baghouses, wet scrubbers are generally used for holding dust from flue gases (ANPM, 2005). Electrostatic precipitators (ESP) is currently used in large combustion plants and can operate in a wide range of temperatures, pressures and dust loading conditions.

Not very sensitive to particle size and particle can retain both wet and dry conditions.

A typical configuration is shown in Figure 2. In the filter during the combustion (calorific value low, and when the boiler is unstable) problems may arise forming volatile compounds can stick to particles and limits their effective precipitation.

For starters investment costs may be higher or lower depending on the fuel used and the operational costs are lower than those for other techniques and use of modern monitoring systems further reduce these costs. Wet Electrostatic filters work the same way as the ESP and collected dust is removed from the collection plates by washing with a suitable liquid, usually water, intermittent or continuous spray irrigation.

This has the advantage for some powders which adheres to the plate normal, or when other operational components of the gas occur, for example, in the case of cold gas wet.

Wet ESP is applied only in LCP - ups that use fuel oil with high sulfur content being tested as a control device for aerosols. Fabric filters (baghouses) used worldwide for flue gas cleaning (especially fly ash) in the industrial sector, and the small capacity power plants.

Bag filters are used with dry injection scrubbers pads for sludge or sulfur dioxide powder (such as lime or sodium bicarbonate) for simultaneous control of emissions of sulfur dioxide and fly ash .

Regular removal of dust from the filters is an important operation to maintain the collection efficiency of the filter, and the lifetime of the bag. Fabric filters are classified according to how the filter is cleaned as follows: reverse flow , mechanical shaking , pulsing vibration and air. Selecting filters should take into consideration the composition of the gas, the nature and particle size of the powder , the method of cleaning efficiency required, economic factors, the temperature of the combustion gas of the gas cooling method, and the resulting water vapor dew point of acid. Pulsating jet technology has become the most preferred fabric filter system (primary device monitoring utilities and industrial boilers powders).

Ashes flying high temperature or unburned fuel can affect the filter material, cracks can form in textile material , difficult detected during operation. If the bags are in modular form and modules are isolated , the repair may be possible without stopping the entire process.

Maintenance costs are high because the bags should be changed to periods ranging from two to five years. The minimum cost of changing the filter is about 10% of investment costs .

Centrifugal precipitator (cyclones) uses gravitational forces and can process all types of combustion gases in dry conditions, but the performance of limited use in small to medium sized installations that pre-collection technique when combined with other means of dust control .

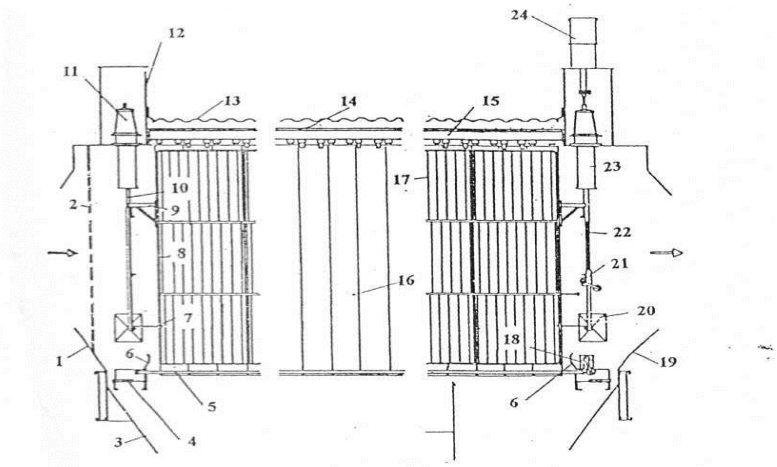

Fig.2 . Scheme of a horizontal electrostatic dry, with a field :
1 - inlet; 2 - wall flow uniformity; 3 - powder hopper; 4 - Inner platform; 5 - bar shaker; 6 - baffle plate; 7 - spacer; 8 - frame transmission; 9 - console; 10 - supporting rod; 11 - electrically insulating support socket; 12 - roof beam; 13 - rain roof; 14 - tight roof; 15 - beam deposition supporting the electrodes; 16 - electrode deposition; 17- emission electrode; 18 - shaker electrode deposition; 19 - outlet connection; 20 - access door ; 21 - shaker emission electrodes; 22 - frame support; 23 - mantle of protectio; 24 - shaker actuation system of emission electrodes.

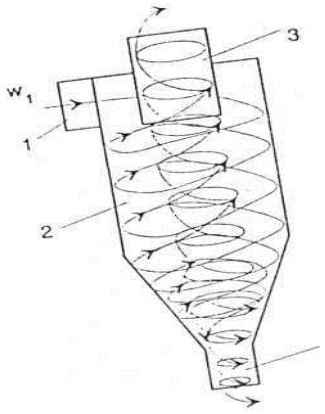

Fig.3. The function of a cyclone scheme: 1 - crude gas inlet;
2 - cylindrical housing; 3 - purified gas outlet tube; 4 - dust discharge tube

Mechanical separators not stop fine dust. Table boilers burning coal on the grate mechanical cyclone technology is used as the amount of fly ash is relatively low (20 % of the coal ash is compared to 80 % for pulverized fuel supply).

Combined control technique should be taken into account when calculating the investment costs. Operating costs include the energy required to remove collected ash pneumatic or hydraulic and electrical energy to compensate for pressure loss of gas flow equipment.

Maintenance costs are considered low, giving stability of all components. Life may be limited due to the high risk of erosion (Eurelectric, 2001). Wet scrubbers have been used in high pressure and temperature combustion, for example, in applications such as gas steam combined cycle with an integrated gasification (IGCC) and pressurized fluidized bed combustion (PFBC).

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a) Venturi scrubber is the most common wet scrubber dust . In Venturi scrubbers , scrubbing liquid is introduced evenly from the top of the converging section as shown in Figure 4 .

Watering flue gas makes fine dust particles are gathered into larger and heavier droplets, are easily captured separation plant. Pressure drop and efficiency are dependent on the velocity of the flue gases through the venturi scrubber. In order to effectively adaptations operation at low boiler loads, some venturi devices are designed with more extremities that can be operated close to a constant pressure drop, flow rate independent of the gas flow (load boiler). The device is followed by a separating section for removal of entrained droplets .

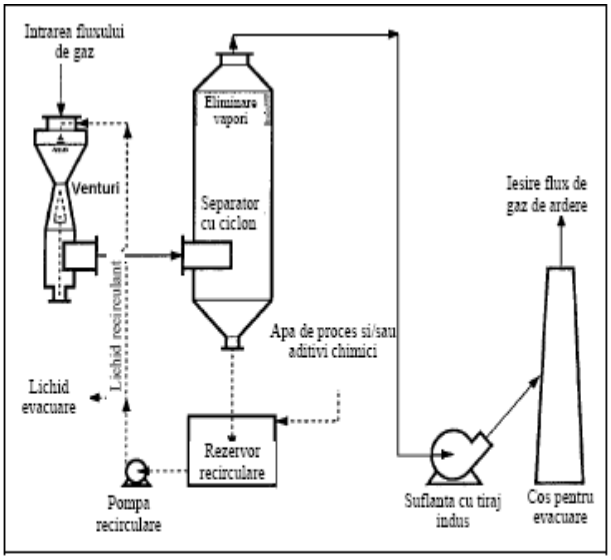

Fig. 4. Typical flow diagram of the system Venturi (Ciemat, 2000)

b) *Bed scrubbers* - separation yield is good when processing moderate dust loadings , the technique is not very suitable for fuels with high ash content. The investment costs are high , and include reactor, a possible injection system adsorbent and a waste water treatment plant. Operating costs are also significant , which refers mainly to the consumption of water and energy costs.

By making a comparison between the main methods of dusting (tabelul1) can

- Electrostatic filters (ESPs) with electrodes rigid / fixed are the most widely used technologies : have a relatively simple, easy to repair and operate and are able to complete automation of the process of dusting .
- The choice between using electric filters or baghouses generally depends on fuel type, plant size, type and configuration of the boiler.

Both devices have a high efficiency particulate matter , which can be further

conclude the following :

For removal of ash , fabric filter techniques are applied in only a few plants in South Africa, USA, Australia and Poland. ESP plus FF are also used to reduce PM10, PM2.5 and mercury. For specific coal use SO3 injection in combination with ESP is performed to reduce particulate emissions.

improved by making the combustion gas .

- Wet scrubbers for dust retention are used less than the electrostatic and bag filters . They may have a high energy consumption and low efficiency for retaining fine dust compared to electrostatic and bag filters . This is not the case of wet scrubbers used for desulfurization having an additional impact in reducing dust emissions .

Table 1. Characteristics of the main methods of dusting

Electrostatic precipitators (ESP)	**Baghouse (textile)**	**cyclones**	**wet scrubberVenturi**
Retention efficiency 96.5 to 99.95%; Scope of solid fuels; Working temperature: 120/220 ° C - cold ESP 300 - 450 ° C - hot EF Energy consumption of electrical capacity 0.3 ÷ 1.8%; Pressure drop 1.5 ÷ 3 (10^2 Pa); residue: Fly ash; Flue gas flow > 200000 m^3 / h.	Retention efficiency 96.6 to 99.95%; Scope of solid fuels; working temperature 120-200 ° C; The energy consumed 0.4 to 0.7%; The pressure drop 5 to 20 (10^2 Pa); residue Fly ash; Flue gas flow < 1.100.000 m^3 / h; Market opening 10%.	- Have limited performance and may be used only with with other techniques; - Their efficacy is naturally limited to between 85-90%; - Lowest cost of investment of all dust extraction equipment	Retention efficiency 98.5 to 99.9%; Energy consumption of electrical capacity > 3%; Report liquid / gas - 0.8 ÷ 2 l / m^3; Pressure drop - 30 ÷ 200 (10^2 Pa); residue Sediment fly ash / sludge; High capital costs and operation; High energy consumption.

In 2013 there was a decrease in the number of exceedances of the limit values. The particulate matter was no exceeding in all three places, but the most polluted city remains the cleanest Rovinari and Targu Jiu. For dispersion of the TSP, which had been

- Class II - Particle diameter d = (2,5 - 10) μm (7%);
- Class III - Particle diameter d = (10 - 50) μm (82%);
- Class IV - Particle diameter l d > 50 μm (8%);

divided into four classes granulometrice:
- Class I - Particle diameter d < 2,5 μm (3%); surface parameters influencing

Powder particle size distribution class that allows for average size and specific sedimentability and living organisms (Figure 5).

The averaghe size:

$$d_m = \frac{1}{100} \cdot \sum_{i=1}^{4} \frac{d_{i+1} + d_i}{2} \quad [\mu_m]$$

$$d_m = \frac{1}{100} \cdot \left(\frac{0+2,5}{2} \cdot 3 + \frac{2,5+10}{2} \cdot 7 + \frac{10+50}{2} \cdot 82 + \frac{50+60}{2} \cdot 8 \right) = 29,475 \quad [\mu m]$$

Table 2. Distribution of powder particle size classes

Class grading	**class limits d_i - d_{i+k} [μm]**	**weights**	
		Partial [%]	**Cumulative [%]**
I	0 – 2,5	3	3
II	2,5 -10	7	10
III	10 – 50	82	92
IV	> 50	8	100
Total / Average		100	

Specific surface area:

$$S_P = \frac{\alpha}{d_m \cdot \delta} = \frac{10}{d_m \cdot 10^{-6} \cdot 2100} \quad [m^2/kg]$$

$$S_P = 161,55 \quad [m^2/kg]$$

Where:
α - coefficient of form (α = 10 for particles of irregular shape);
δ - power plant ash density (δ = (1800-2200) [kg/m3]).

The high degree of dispersion, surface area and adsorption of pollutants in the form of aerosols, adds these harmful particles.

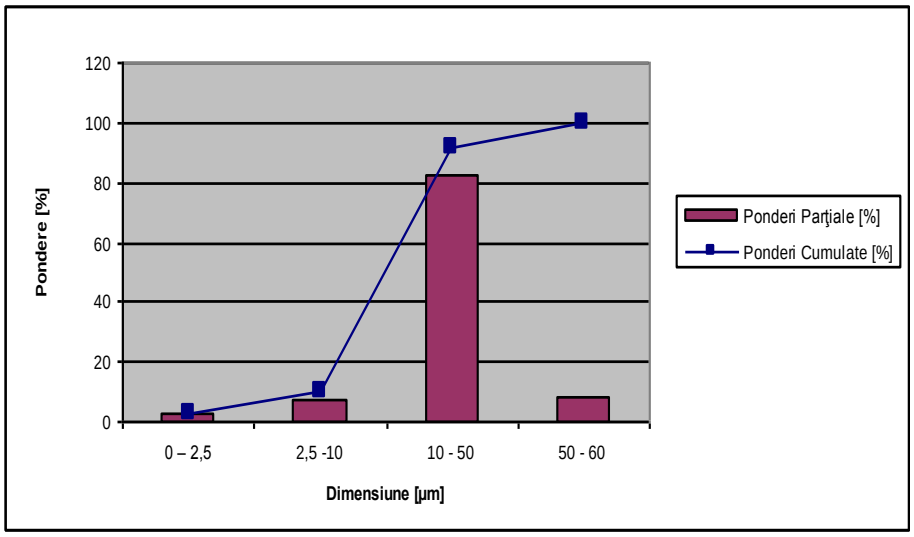

Fig. 5. The characteristic size of particulate matter

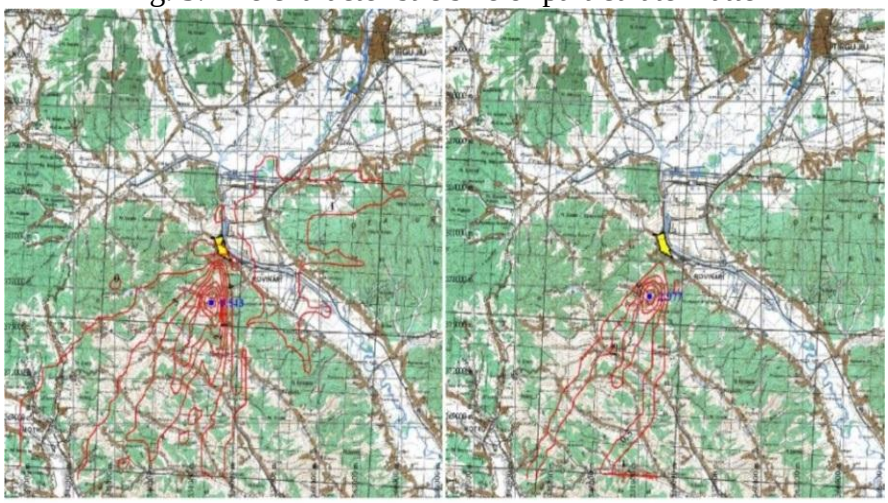

Fig. 6. Isolines of maximum daily concentrations (left) and annual (right) PM10

CONCLUSIONS

Industrial dusts (powders) are particularly toxic (if they contain compounds of Pb, Cd, P) and noxious mechanical alterations causing respiratory tissue. Aerosols are a class of liquid pollutant solid particles dispersed in a gaseous medium - air. Effect of PM10 (particles having aerodynamic diameters less than 10 m) on human health, particularly the respiratory system is affected by particle size and chemical composition.

Large particles are stopped in the nostrils, where it adheres to the mucus or throat, causing irritation of the airways, but where they can be removed. Particles smaller than 2.5 μm reach the alveoli where products are and where they can pass into the blood, causing inflammation and poisoning, depending on chemical composition.

Are particularly affected people with cardiovascular and respiratory diseases, children, the elderly and asthmatics. Emphasizes particulate pollution asthma symptoms such as cough, chest pain and difficulty breathing.

Environmental projects undertaken in the last three Oltenia Energy Complex applied best remediation technologies, clean coal technologies: desulphurisation plant flue gas exhaust systems slag and ash in the sludge injection of urea (experimental) the energy agricultural land circuit issued its technological (370 hectares received for teaching); will continue the annual program of plays, the ongoing work for another 400 hectares.

Among future investments, in addition to those required to complete started projects within the deadlines imposed, shall allocate funds for the development of solar parks and the use of biomass in order to reduce the influence of CO2 in operating costs. CE Oltenia is the only energy producer in Romania has implemented desulphurisation of combustion and exhaust in dense slurry of ash and slag resulting from the combustion of coal.

Disposal facilities in dense slurry ash and slag were placed in service from 2009 to Rovinari. The last such installation was commissioned in 2013 at Turceni. The installation as impact reducing the amount of SO2 emitted in the atmosphere to produce a MWh, thereby decreasing the desulphurisation 16 kg with 610 grams of desulfurization. By upgrading electro, reduced dust concentration from 1.25 kg to 0.04 kg sw dust / MWh. By fitting silencers and sound absorbing panels reduced noise levels below 65 decibels allowed, and by modernizing energy groups for increased efficiency and reduced emissions of greenhouse gases from about 1.07 tons of

group number 6 on Thermal Power Rovinari to reduce NOx emissions and ecological reconstruction by playing in the forest or

Estimated in late 2013 CE England produced a quantity of electricity of about 12 TWh, with lignite production of 23 million tonnes and an estimated gross profit of about 300 million lei, of which operating profit - 157 million and profit from financing activities of 143 million .

For the next period, the company's strategy for the modernization of four mechanical and electrical rotor excavators Rovinari careers Eastern Pinoasa Tismana Tismana I and II, and the rehabilitation and modernization of integrated technology at Jilt Sud.

Oltenia Energy Complex (CEO) will invest to upgrade and rehabilitate the energy block number 5, from Branch Electrocentrale Rovinari energy group 330 MW lignite, which will be rehabilitated and upgraded electrostatic.

The work consists of replacing the current electro technical solution that reduced the dust content (dust) in the flue gas to a CO2 to 0.915 tonnes CO2 / MWh.

Also, all energy units complying with the NOx emission limit (500 mg / Nmc).

maximum of 300 mg / Nm3, with a new solution that would ensure a reduction in the concentration of particulates in the flue gas below 50 mg / Nm3, in accordance with the requirements of environmental legislation, namely Law 278/2013.

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