OPPORTUNITIES TO REDUCE POLLUTION AT C.T.E. ROVINARI USING WET DESULPHURIZATION

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Abstract. The paper presents the characteristics of the wet method of flue gas desulphurization and the advantages of this method over other methods.
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1. INTRODUCTION

Burning of fossil fuels leads to release large volumes of gaseous sulphur oxides into the atmosphere. After chemical precipitation and transformations in the atmosphere these oxides became the acidic precipitation source, a form exercising destructive action on the perennial vegetation on the ground. At the same time, under specific conditions (high temperature and pressure, the presence of moisture, together with ash particles) which characterizes the motion of the flue gases from the combustion plant to the chimney, gaseous oxides exert a strong corrosive action on the equipments that make up the flue gases circuit. This fact leads to the increasing of the equipments wear. In the first stage, sulphur dioxide gives rise to sulphuric acid, which is converted to sulphuric acid by oxidation under the influence of solar radiation.

The polluting action of H_2SO_4 is exercised in the form of acid rains, which represents the main generator of „forest death“ in the industrialized countries of Western and Central Europe. Entering the zonal atmospheric circulation, SO_2 exerts its pollutant effect not only in the region or country in which it is generated, but also in other regions or countries located in the direction of prevailing winds. This process is favored by the construction of tall chimneys (200 ÷ 250 m height) through which the exhaust gas having a high temperature (160 ÷ 175°C) and a high exhaust speed, are driven by the means of high chimneys having an average height of twice the chimney height (about 500 m from the ground). The origin of sulphur in coal is diverse and can be grouped as follows: organic sulphur, sulphur in sulphides (pyritic) sulphur in sulphates and mineral sulphur.

Organic sulphur, $S_{0,}$ is made up of sulphur existing in coal in the form of various organic combinations. It represents between 30% and 70% of the total sulphur content, being higher when the total sulphur content of the coal is lower. Sulphur from sulphides (pyritic), Ss is made up of sulphur in the form of chemical compounds of mineral mass as monosulphides and disulphides. Sulphur in sulphates, SSO4, consists of sulphur in the form of chemical compounds as soluble or insoluble sulphates in the mineral mass. Sulphur of sulphides and sulphur of sulphates is mineral sulphur.

From the point of view of combustion, sulphur may be combustible or non combustible. Combustible sulphur, S_C is made up of organic sulphur and sulphur of sulphides; non combustible sulphur, S_A is the sulphur of sulphates and the latter remains in the ash after combustion.

2. MEASURES TO REDUCE THE SULPHUR OXIDES EMISSIONS

Reducing the emissions of sulphur oxides from the boiler may be achieved by:

– retention of SO_2 is made by burning fuel with calcium-based additives even in firebox;

– Late procedures (post combustion): SO_2 retention is done after the fire box, on the flue gas stream to chimney.

These are:

– dry processes, which ensure a physical binding (adsorption) of sulphur oxides;

– wet processes leading to a chemical binding (absorption) of sulphur oxides in an aqueous solution or a suspension;

– semi-dry processes. It is used as additive an alkaline solution binding SO_2 both physically and chemically, and the product is presented as a dry format;

General technologies for the flow of gas desulphurization (FGD) using wet processes are:

– washing using limestone;
– washing using hydroxide of sodium;
– washing with ammonia;
– washing with hydrogen peroxide;
– washing with sea water;
– washing with alkali;
– others.

In this paper we talk about the technology of the flow gas desulphurization using limestone. Recent developments of alkali processes that allow the use of limestone instead of expensive sorbent with lime and gypsum production can resume the use of this system.

Wet scrubbers with lime / limestone are the mostly used FGD (desulphurization of flue gas) systems, representing 80% of the total installed FGD capacity. Figure 1 shows the schematic diagram of the wet flue gas desulphurization plant used in CTE Rovinari using lime / limestone. Limestone is generally used as a reagent as it is present in large quantities in many countries and normally three to four times cheaper than other reagents. Lime is commonly used as a reagent in older plants due to its better reactivity with SO_2.

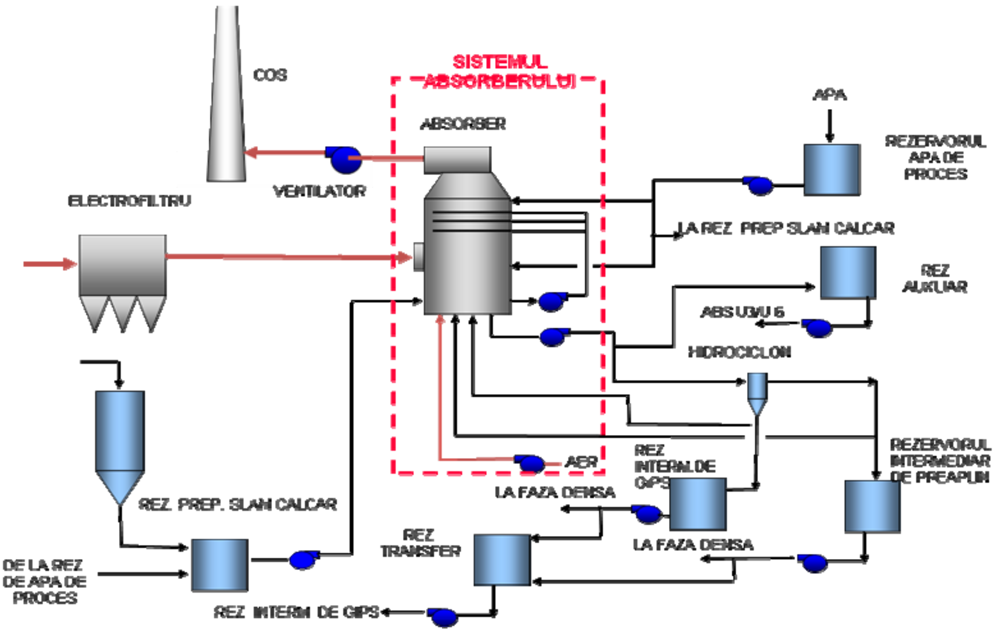

Fig. 1. Schematic diagram of the system for wet flue-gas desulphurization.

Wet FGD process does not essentially differ from the conventional one. Figure 1 schematically represents a wet FGD system, the sequence of chemical reactions in the system being the following:

$$SO_2 + H_2O \rightarrow H_2SO_3 \quad (1)$$

$$H_2SO_3 + 0.5O_2 \rightarrow H_2SO_4 \quad (2)$$

$$CaCO_3 + H_2SO_4 + H_2O \rightarrow$$
$$\rightarrow CaSO_4 \cdot 2H_2O + CO_2 \quad (3)$$

An alternative sequence of reactions leading to the same result is as follows:

$$SO_2 + H_2O \rightarrow H_2SO_3 \quad (4)$$

$$CaCO_3 + H_2SO_3 \rightarrow CaSO_3 + CO_2 + H_2O \quad (5)$$

$$CaSO_3 + 0{,}5O_2 + 2H_2O \rightarrow$$
$$\rightarrow CaSO_4 \cdot 2H_2O + CO_2 \quad (6)$$

3. PRESENTATION OF THE DESULPHURISATION PLANT

Limestone powder as reagent is used to be reacted with SO_2 in the flue gases, reaction which has as secondary resulting product the gypsum (dehydrated calcium sulphate). This will be disposed with slag and ash using the dense fluid method to Girla deposit.

It is used a spray tower type absorber to achieve intimate contact between gas and liquid required to achieve high efficiency of SO_2 removal.

The flue gas enters the absorber, where goes up by several levels of counter-current spraying. SO_2 and other acid gases (e.g. HCI, HF) are absorbed by the washing slurry, which falls in the lower part of the tank known as the reaction tank. Here, ground limestone is added to neutralize and regenerate the washing slurry. In each stage of the process reactions may be grouped into three categories: gas-liquid reactions, liquid-liquid reactions and liquid-solid reactions.

The wet gas desulphurization systems include the following main areas:

– the absorber systems;
– the gas route system
– the limestone supply / storage / preparation system;
– the system of the limestone solution distribution;
– the system of the gypsum primary dewatering;
– the transfer of the gypsum slurry to the dense phase
– auxiliary systems.

Absorber is a vertical vessel where the flue gases are subjected to a chemical treatment process; it is also called Open Spray Tower (OST). Flue gas flow coming from the after boiler circuit and treated gas leaving the absorber are discharged into the atmosphere through a chimney. Absorber area includes the following equipments:

– absorber recirculation pumps;
– the oxidation air blowers;
– levels of washing and spray nozzles;
– droplet separator;
– flow makers reaction tank;

Limestone storage silo is designated to receive, store and measure the limestone dust. Limestone discharge line consists of a storage silo and loading and unloading facilities (metering). Limestone powder is dosed from the silo through a rotary vane and weighed using feeder weighing scale.

Limestone powder is discharged in the slurry preparation tank where lime is mixed with process water in order to obtain the required solids (limestone) concentration. The lime slurry is then sent to the absorber by the absorber feed pumps.

The gas flow system is derived from the primary circuit of the boiler. The gas flow system includes relevant pipes and the fan. During normal operation, cleaned gases are evacuated into the atmosphere through another chimney. Below we develop a case study on the desulphurization plant from CTE Rovinari using lime / limestone.

Figure 2 shows the desulphurization plant applied to groups 3 and 6.

Oxygen is injected in the form of compressed air, finishing the reaction of gypsum washing and forming. The wet FGD using limestone is currently operating at many power plants.

Comparing the two tables below data, the efficiency of this method operation may be seen through the SO_2 emission for the boilers where this method is not used than those where it is used. So, it may be seen the sharp decrease of SO_2 emissions from a maximum of 6569.15 mg/Nm^3 recorded for the group 5 in September 2012 at a minimum of 163.1 mg/Nm^3 recorded for the group 6 in January 2012.

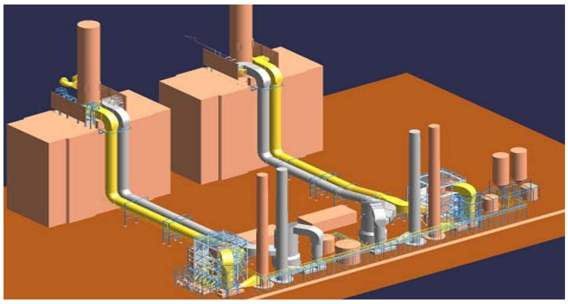

Fig.2. Presentation of the desulphurization plant.

Table 1. **SO_2 emission for the groups 4 and 5 without desulphurization from CTE Rovinari in 2012**

Group 4	SO_2 mg/Nm^3	Group 5	SO_2 mg/Nm^3
January	4580.13	January	4595.92
February	4918.88	February	5454.19
March	4743.83	March	5730.9
April	4130.28	April	stopped
May	4480.56	May	5063.38
June	4976.9	June	5134.38
July	4951.88	July	5169.25
August	0	August	4794.63
September	0	September	6569.15
October	0	October	6042.31
November	0	November	6028
December	0	December	5774.81
Annual average	**4683.2**	**Annual average**	**5486.99**

Table 2. **SO_2 emission for the groups 3 and 6 with desulphurization from CTE Rovinari in 2012**

Group 3	SO_2 mg/Nm^3	Group 6	SO_2 mg/Nm^3
January	244.6	January	163.1
February	247.9	February	309.3
March	195.5	March	280.6
April	228.6	April	258
May	229.9	May	256.4
June	226.4	June	271.1
July	254.3	July	258.2
August	277.5	August	275.9
September	281.3	September	312.7
October	268.4	October	323.6
November	264.2	November	321
December	284	December	429
Annual average	**252**	**Annual average**	**293.2**

Wet desulphurization system was chosen for the following reasons:

1. Limestone is a cheap absorbent:
   – found abundantly,
   – easy to handle
2. Gypsum is used in the cement industry:
   – used as a building material;
   – easy to store;
   – non-toxic;
   – easy to handle.
3. Desulphurization system is simple:
   – easy to operate and maintain;
   – very safe;
   – very effective.

4. CONCLUSIONS

Considerable advantages of wet desulphurization processes compared to those of the dry processes are the high efficiency of retention of SO_2 and use of cheap substance.

Flue gas desulphurization may be done by several methods using wet scrubbers. The method is more effective than dry desulphurization because the degree of SO_2 retention is higher. Desulphurization with limestone is the most used because limestone is found in large quantities and is cheap. The final product after desulphurization is gypsum, which may be sold. The gypsum deposited in ash deposits fixes the ash. So, it is avoided the ash engaging in the air as frequently happens in Rovinari.

In conclusion, for environmental protection and environmental performance, all power plants should take steps to minimize the emission of pollutants.

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