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[1.] Mustafa IMAMOVIĆ, [2.] Šefket GOLETIĆ

EFFICIENCY WET GAS CLEANING ON THE METALLURGY'S FACILITIES

[1-2.] UNIVERSITY OF ZENICA, FACULTY OF MECHANICAL ENGINEERING IN ZENICA, FAKULTETSKA 1, 72 000 ZENICA, B&H

ABSTRACT: On the metallurgical facilities (blast furnace, BOF steel plant ...) in the technological process is present occurrence of waste gases. This is actually a consequence of the process that occurs in these facilities. These gases carrying particulate matters, especially fine pieces ore, coke, lime, etc. For further use or releasing into the atmosphere, these gases in the further proceeding must be cooled and cleaned. One of the cleaning treatments is omission of gases through the wet flushing systems for the initial phase of treatment. The efficiency of this treatment is a function of various parameters. This paper gives the possibility for cleaning of gases and the results of the efficiencies that are achieved on wet gas cleaning systems. The results are presented in this paper can be used as a basis for process improvement, as well as for taking precise measures to improve the ecological parameters of the environment in which these facilities operate.
KEYWORDS: Wet flushing systems, particulate matters, treatment

INTRODUCTION

The metallurgical plants (blast furnace, BOF steelworks) in the technological process generate the waste flue gases, which composition and quantity depend on the nature of technological processes and raw materials. Emissions of waste flue gases are actually a result of processes and reactions that occur in these facilities. Raw materials charged into the blast furnace are: ore, coke, sinter and limestone, and output of matter are: pig iron, slag and waste flue gases. In BOF steel plant charged raw materials are: hot metal (pig iron), scrap, lime and gases (O_2 and A_r), and the output materials are liquid steel and waste flue gases.

Flue gases at both plants are polluted with a variety of solid particles. In order to further use (blast furnace gas) and release into the atmosphere (BOF gas) it is necessary to clean the gases that are by using certain technology reduce solid particles emission. In this process, gases pass through mechanical separators, electrostatic precipitators, fabric filters and wet flush to separate of solid particles from the flue gases. A very important stage of purification is in wet cleaning system in which off gases treatment is performed. The liquid is used in wet cleaning system for solids separation. These particles are usually less than 10 μ m, because other processes and equipment relatively easily remove the larger particles. In this paper, it is given analysis and procedure how wet gas cleaning system's can be used in blast furnace and BOF steel plant de-dusting systems. Theoretical considerations in this paper are complemented with practical results (actually measured) at Blast furnace and Steel plant in the company ArcelorMittal Zenica. The results obtained in this work can serve to better understand the role of wet gas cleaning system, as well as recommendations for further improvement of the metallurgical plants, in order to reduce as many emissions and particulate matter ambient air quality preservation.

COURSE OF TREATMENT AND EXHAUST GASES

- ***Purification of gases in the furnace***

Hot air, which is blown in the blast furnace, changing its composition and volume during the production process. Speed is high and carries the solid particles, especially fine pieces of ore, coke and lime.

Such a dirty gas passes through a dry dust collector (dusty bag) where the majority of heavy particles remain, and then the gas continues to move towards the wet cleaning system (venture-scrubber). Dirty water and gas are there in contact, and almost all the suspended particles are separated (more than 99%) and are taken with the gas into electrostatics precipitators. Filtrated gas after treatment in the electrostatics precipitators is used for hot stoves heating or for another use. Polluted water from the system Venture-scrubber at the same time contains high concentrations of suspended particles and 500-10000 mg/l and as such is sent to cleaning basins. It precipitated

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particles, and purified water is sent away to reuse the same technological process, or operation (Figure 1).

☐ ***Purification of gases in the BOF***

During blowing of oxygen in the BOF the large amounts of gases is developed. Such gases include CO maximum (55-80%) and a large amount of dust, which is mainly composed of metal oxides. The temperature of gases is up to 1700°C. These gases have to be cooled and cleaned before being discharged into the atmospheric air. Cooling (first phase) is done in waste heat boilers, and then gas are cleaned (second phase) in the specific technical systems for the gas cleaning. These systems consist of scrubber for separating coarse dust, venture tube system and scrubber for separating fine dust. Waste gases cleaned of dust and cooled by the water are exhausted thru the stack and released into the atmosphere.

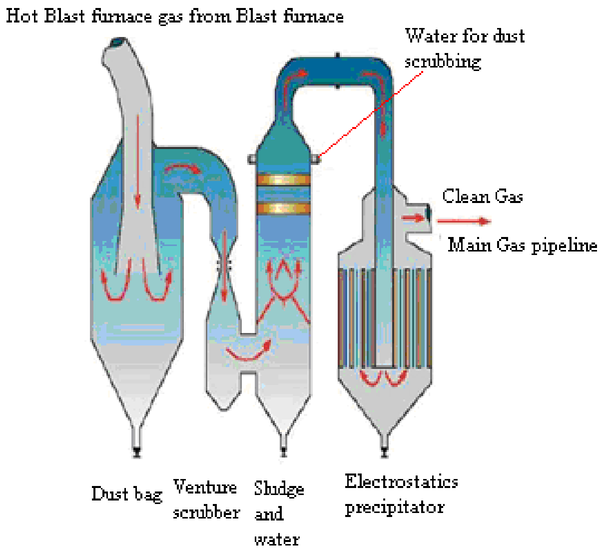

Figure 1. The flow of blast furnace gas purification

WET CLEANING PROCESS PROCEDURE

Technical systems for wet cleaning (scrubbing) are using liquid for the separation of polluting substances from gas streams. The liquid is flushed through the solid particles from the waste gas is done to separate: dissolve, and the accumulation of chemically reacting with pollutants. The result of flushing is separated contaminated water and gas with a significantly reduced amount of substance. Due to the structure, many types of flushing system are used. It can be designed to distinguish the forthcoming material particles from the gases such as dust, fly ash, metal oxides or separated gases such as sulfur oxides (SO_x) from gaseous streams flow to meet emission standards in the atmosphere. Washers of this type are used to control air pollution.

☐ ***Collection of particles concept***

In the flushing particles from waste gases, the main problem is the separation of particles that are less than 10 μm Larger particles is relatively easy to separate. The efficiency of wet flushing depends on knowing the size, composition and particle derivation. Figure 2 shows the size of some pollutants, as well as ways of removing substances from waste gases.

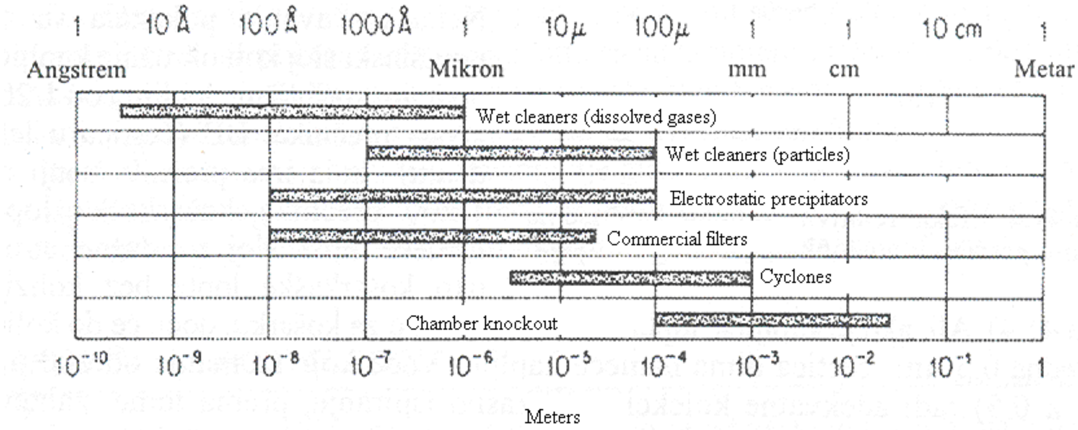

Figure 2. Particle size of air emissions

Apparently, the electrostatic precipitators can be very effective for removing substances from waste gases. It should be noted that, as fine particles in water (colloids) have static electricity voltage, the colloidal particles in the flue gases and dust have the same. If these particles do not have voltage, it can be freely subjected to voltage to support its removal in separators such as electrostatic precipitators. This concept determines the collection of particles.

☐ ***The flushing (wet cleaning system) principal***

The wet cleaning system producers are offering different types of these systems. They may have different shapes, sizes and performance capacities. Some are intended for the collection of particles, and some way to extract the chemical reaction. Particle size is one of the most important factors affecting the extraction efficiency where the larger particles are more easily distinguished. Particles less than a micron are very difficult to distinguish. All particles washers operate at the same aerodynamic principle.

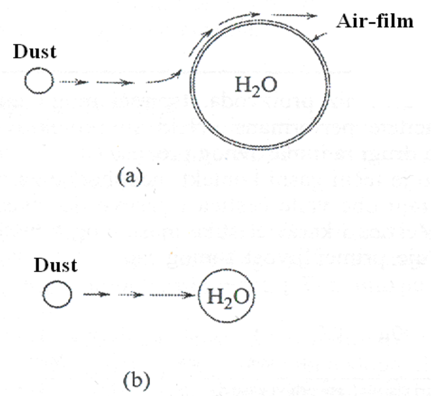

Figure 3. The effect of the relative size of droplets

The analogy is simple: if the water droplets sized basketballs were directed towards the particle accelerator, the tactical possibilities of collision would be small (Figure 3). When the droplet size is reduced to the approximate size of the particles, the chance of collision increases. Therefore, effectively flushing fluid required fineness reduction in relation to the size of particles to create a maximum contact with particles of acceptance.

☐ ***Categorization of wet flushing***

Wet washers are different methods for its efficient contact between the liquid and gas waste streams. Applied techniques involve injecting fluids into the collection chamber in the form of spray liquid intake. One of the ways to categorize the flushing of wet is its needs in relation to energy. Generally, flush with a little energy is used for separation of large particles. They are based on high ration liquid / gas and high contact time on the water washer to increase efficiency. Washers with high needs in the energy used to extract the very small particles (size 1 μ and smaller).

Another way of categorizing wet flushing based on their selection of the gaseous pollutants or particulate materials. Washers that are primarily intended to separation of gases called the transverse mass of washers, and they intended to separation of particles called particulate wet flushing systems. Therefore, washers can be gas absorbers, with the placenta, the placenta moving, turbulent contact absorbers (TCA), washers and wet particles are wet electrostatic precipitators.

☐ ***Venture washers***

Venture washers are one of the most commonly used flushing in the metallurgical plants. They are the most suitable for extracting particle size from 0,05 to 5 μm. Typical examples of the flue gases that occur in the blast furnace and BOF steel plant.

In Figure 4 gives a schematic representation of a venture flushing. High-speed gas flow in the narrowed part of the flushing makes the relative velocity between gas and liquid large enough to create good atomization of liquids, and to complete the collection of particles. The liquid droplets collide with the solid particles in the gas stream and converted into agglomerates due to higher specific gravity are extracted from gas streams. Purified gas stream passes through the separator to be separated added liquid. Thus, Venture washers require high-pressure drops and thereby the pressure drop must increase if the size of the particles becomes smaller in order to ensure a better binding and more efficient separation of particles.

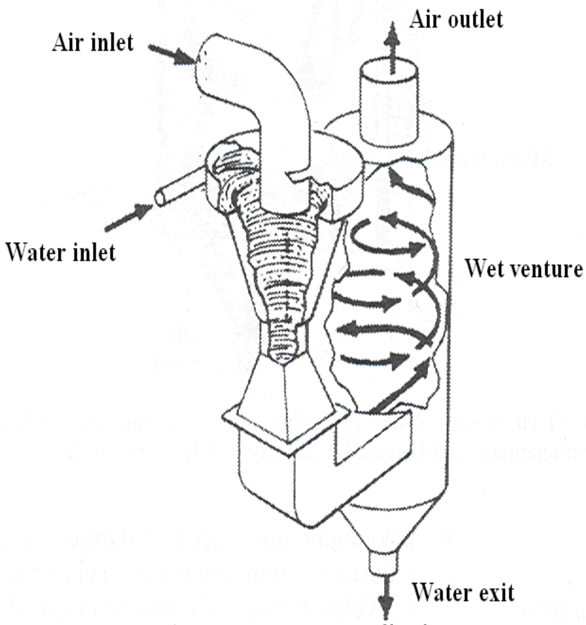

Figure 4. Venture flush

Venture washers can also be used to extract soluble gases. However, such applications are limited to situations in which small particles are also present, because the large energy requirement for flushing makes Venture expensive to control gaseous pollutants. Several modifications of the basic venture flushing meet specific requirements by size and type of particles that need to be set aside. There are low, medium and high-energy venture washers with energy needs that are directly related to pressure drop, which is necessary for submicron particles. Venture washers use several methods for the atomization of water for rinsing. There are washers with variable throat.

This allows efficient removal of dust, smoke, mist and dust components. This flush meets many needs in practice. Another type of flushing, a shown in Figure 4, where the water is supplied tangentially to the opening on top, then down the walls of the cervix in one continuous layer. On entering, the neck of fluid creates a curtain of liquid and gaseous streams. The effect of this gas atomized liquid curtain. Further effects and agglomeration occur in divergent part. This type venture flushing is recommended for the handling of difficult situations: separation of "sticky" particles from gases, recycling of wastewater where water reserves are limited and the recovery of process materials in a continuous form.

EXAMPLES OF THE FLUSH AND RESULTS OF EFFICIENCY OF WASTE GASE DE-DUSTING SYSTEM

Within the system for cleaning of waste gases on blast furnace and BOF steel plant in ArcelorMittal Zenica, the various devices for purification of waste gases were built because wet cleaning systems do not have satisfactory efficiency.

In Figure 5 and 6 they give examples of installed devices for the complete purification of flue gas furnaces.

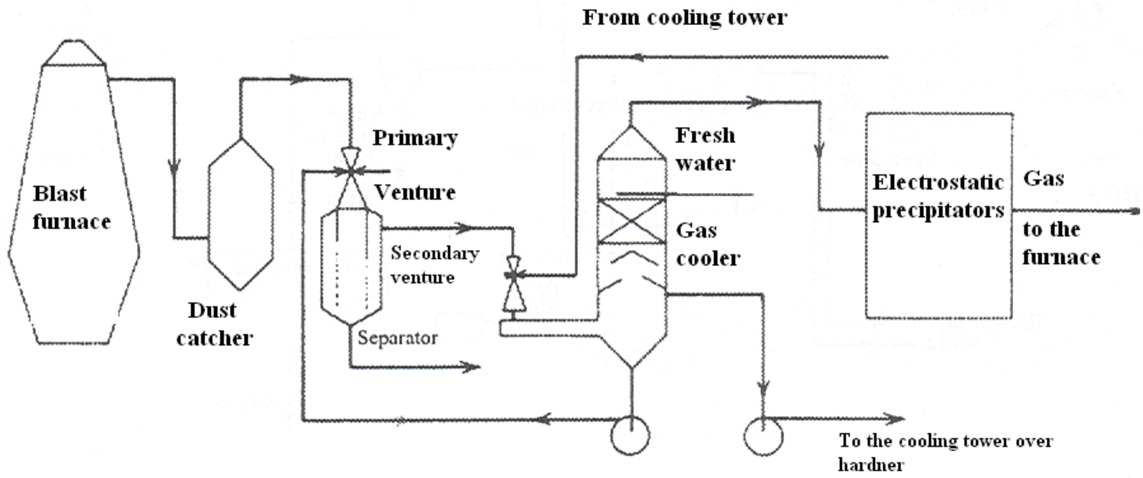

Figure 5. The system of flue gases in blast furnace

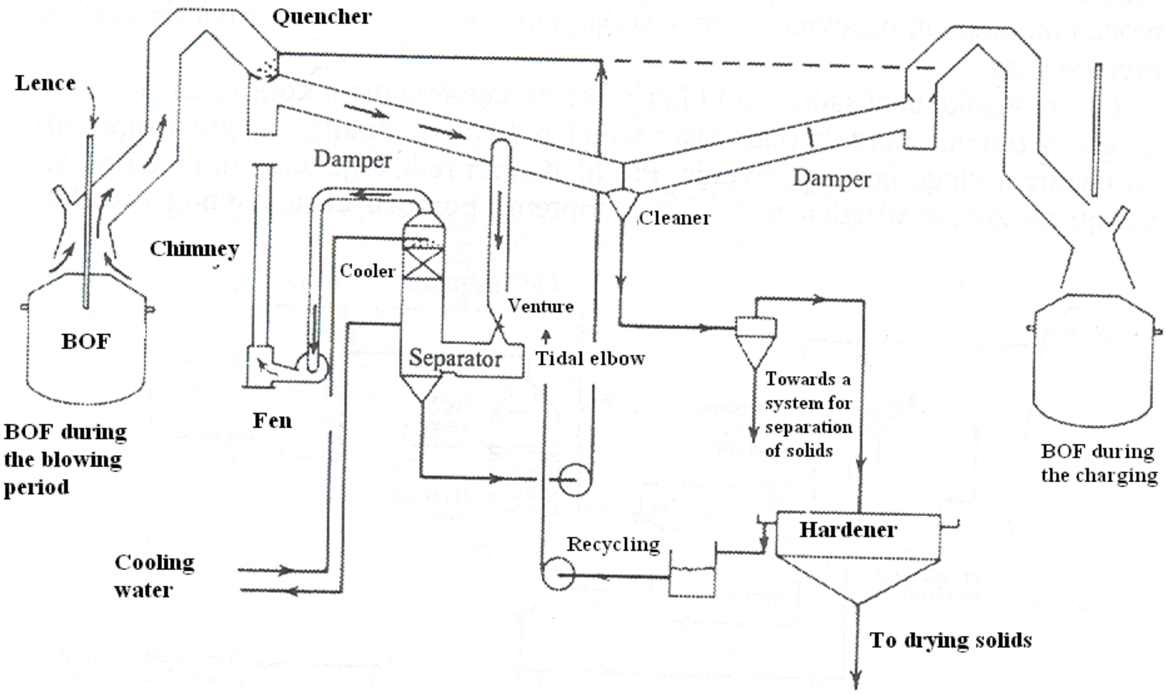

Figure 6. The system of flue gases at the BOF steel plant

In both cases de-dusting and cleaning of waste flue gases the venture flush is just one part of a complete system of treatment devices, but since its effectiveness depends directly upon the efficiency of the entire technical system for the treatment and the level of emissions of solid particles. It is located behind the device for rough treatment in which coarse particles are separated.

Results of de-dusting of flue gases that pass through dust collection equipment for blast furnace and BOF steel depend on the configuration of devices and processes that are happening in the above aggregate.

Significant role in this has a proper maintenance of equipment for cleaning of waste gases. Flue gases pass through a filtration system to release of contaminants, and water is also in the process of accepting these impurities themselves become contaminated. Of course, after that and the waste water is purified and reused in the same system.

Actual results treatment of flue gases, which are obtained and presented in the results of monitoring at the blast furnace and BOF steel plant ArcelorMittal Zenica and are given in Table 1 and 2. [2]

Table 1. Monitoring results in Blast furnace

	Arcelor - Blast Furnace				Generated:	3.04.2012
	Blast_FU SO_2	Blast_FU CO	Blast_FU CO_2	Blast_FU NOx	Blast_FU O_2	Blast_FU Dust
	class_Conc	class_Conc	class_Conc	class_Conc	class_Conc	class_Conc
Time	mg/m3iN	mg/m3iN	%	mg/m3iN.	Vol%	mg/m3iN
01:00	0.000	199.924	21.401	0.000	2.539	32.634
02:00	0.000	199.924	20.650	0.000	3.374	34.638
03:00	0.000	199.924	21.435	0.000	2.834	32.811
04:00	0.000	199.924	21.209	0.000	2.992	31.394
05:00	0.000	199.924	20.581	0.000	3.283	33.223
06:00	0.000	199.924	21.552	0.000	2.669	32.223
07:00	0.000	199.924	20.666	0.000	3.287	34.078
12:00	0.000	199.924	21.115	0.000	2.861	24.280
13:00	0.000	199.924	21.218	0.000	3.038	25.853
14:00	0.000	199.924	22.079	0.000	2.318	23.980
15:00	0.000	199.924	21.485	0.000	2.386	24.593

Table 2. Results of monitoring the BOF Steel plant

	Arcelor - BOF Steel Plant				Generated:	4.04.2012
	Steel SO_2	Steel CO	Steel CO_2	Steel NOx	Steel O_2	Steel Dust
	class_Conc	class_Conc	class_Conc	class_Conc	class_Conc	class_Conc
Time	mg/m3iN	mg/m3iN	%	mg/m3iN.	Vol%	mg/m3iN
01:00	28.888	112.932	7.932	19.935	17.778	30.082
02:00	22.676	68.520	10.051	23.914	17.016	23.612
03:00	28.949	89.033	8.912	25.807	17.529	30.991
04:00	22.273	92.066	9.855	26.994	17.162	25.558
05:00	23.087	59.030	9.355	21.442	17.224	29.640
06:00	29.153	0.000	12.752	30.568	15.894	14.846
07:00	15.027	0.000	12.595	14.624	15.958	11.431
08:00	384.352	0.000	0.952	0.000	20.652	140.537
09:00	G 1113.333	0.000	0.256	0.000	20.884	G 238.585
10:00	182.730	3.796	2.370	0.000	20.366	75.366
11:00	34.381	38.490	7.968	36.961	17.971	24.996
12:00	17.769	58.991	10.041	19.415	16.909	17.856
13:00	12.952	78.708	9.776	21.819	17.123	20.553
14:00	23.114	60.185	6.736	0.002	18.467	11.970
15:00	10.830	43.101	9.873	16.178	17.137	17.187
16:00	12.237	55.752	9.437	13.459	17.277	18.516

CONCLUSIONS

This paper presents a method and possibility of application of wet flush for purification of flue gases. It gives main features and results of application of flushing. It was also given the possibility of application of wet flushing the purification of waste flue gases in metallurgical production line for iron and steel industry (blast furnaces and BOF steel plant).

The paper also give results of monitoring emissions of pollutants on plants ArcelorMittal Zenica where they built these technical systems for the treatment of which consists of wet washers. These are all examples of good practice in metallurgy that can be applied to these and similar technological plants.

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