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Study of Mechanical-Biosystemic Complications of Mazut and New Methods to Reduce Pollutants in Iranshahr Power Plant

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ABSTRACT: Reducing air pollutions due to the combustion of Mazut fuel is one of the essential requirements of the power plants to prevent environmental damages. On the other hand, toxic contaminations in the air combine with atmospheric precipitation and cause acid rain, and thus their damaging effects increase and their effects are greenhouse gas and global warming. This study investigates the mechanical and metallurgical properties of sediments ash due to the combustion of Mazut fuel on torch and superheater pipes of Iranshahr power plant as well as its pollutants. Then, the factors that cause environmental pollution involve sulfur and nitrogen oxides using Mazut fuel are studied. Also, new methods of reducing these contaminations such as nanotechnology and the best solution for reducing these pollutants and preserving the environment in the Iranshahr power plant are analyzed. By determining the ten main criteria, two methods of Mazut nano-emulsion and wet flue gas desulphurization method have been selected and are suggested to reduce the contamination of the Mazut combustion in Iranshahr power plant. In addition, with the feasibility of using new technologies, an ideal method for reducing the pollution caused by the combustion of Mazut fuel at Iranshahr power plant has been carried out.

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1. INTRODUCTION

During the combustion of Mazut, a number of side materials, including ash and flue gas, are produced. Ash causes mechanical and chemical damage to power plant components, and pollutants in flue gas threaten the environment. The ash precipitates on two parts of the power plant, namely the superheaters and torches. Due to this sediment, the thickness of the tube wall is increased and the heat transfer to the water is decreased, which reduces the thermal efficiency and corrosion of the boiler components. Also, the deposition of ash on the burner causes a defect in the combustion of fuel and contamination production. This makes it necessary to periodically repair and for a specified period of time. In order to prevent heat loss and corrosion because of produced ash due to the combustion of Mazut, a mechanical study of the ash created on the tubes and the burner will provide suitable information.

On the other hand, the increase of infected and critical days is a threat to the health of citizens, because the impact of pollutants and toxic substances and chemical pollutants that absorbs through breathing and even absorption of the skin is indisputable. Thus, pollution management and assessment of air quality are essential for preventing environmental damage [1]. There are three general strategies to reduce the pollution caused by the combustion of the Mazut fuel: 1) Reduction of sulfur in the fuel before combustion and with methods such as additives 2) During combustion and by changing the combustion process of Mazut and controlling it and producing less hazardous compounds 3- After combustion and with the purification of flue gas from combustion and reducing emissions. In the following, the methods of each of the three categories are studied.

The common methods for desulphurization are desulphurization by hydrogetization, molecular polymers usage, oxidation of sulfur with an oxidizing agent, ultrasonic oxidation desulfurization, clay usage, magnetic nanoparticles usage, and microwave catalytic thermal decomposition [2-3].

There are several types of combustion contamination methods, including advanced combustion to prevent NOx formation, moisture control using water or steam injection to reduce combustion temperature [4]. The emulsion fuel usage improves the combustion process and reduces pollutants and reduces energy consumption [5]. Compared to the conventional emulsion fuel, the particle size of the nano-emulsion fuel is very small and, consequently, the combustion is more stable and contaminants are reduced [6].

Flue gas desulphurization method is one of the most effective ways to reduce SOx [7]. Absorption of sulfur-containing gas done by a slurry of limestone or lime [8].

Therefore, the purpose of this paper was to investigate the mechanical properties of ash as well as the contaminants produced due to the combustion of Mazut at Iranshahr power plant. In the next section, the ashes of Mazut are analyzed and tested. In the following, it is tried to study the new method of pollution reduction by choosing the appropriate method for applying in Iranshahr power plant which is a comprehensive and complete evaluation of the three axes before combustion, during combustion, and after combustion.

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2. METHODOLOGY

Initially, experiments were carried out to investigate the general properties of the used Mazut and to evaluate the temperatures during the combustion process. These experiments were carried out in two replications. The Mazut fuel 2000 used in Iranshahr power plant, contains 3 wt% sulfur. Mazut density is 990 kg/m^3 and its thermal value is 41.7 MJ/kg. To test the mechanical properties of ash from Mazut combustion, samples of ashes were tested for compressive strength and impact tests. Pressure and impact tests were performed to determine the energy and energy needed to remove sediment. Hence, in this study, the impact test was used to assess the energy needed for this task. The basis of the impact test is to determine the amount of energy necessary to break the impact fracture. X-Ray Diffraction (XRD) spectroscopy was used to analyze the composition and crystalline structure of the ash on the samples of burner ash and superheater tubes. In each experiment, the homogeneous sample and the desired ash content were grown by the mill in a very fine powder and passed through a mesh of 200 (75 microns), and the three-gram sample was subjected to a bombardment of X-rays with a wavelength 100-0.1 Angstrom was placed. The device used to measure the emissions was a 350 XL Testo. In each test measurements of the pollutants at the outlet of the chimney are performed at the top of the tower.

3. DISCUSSION AND RESULTS

The results of the test of the pressure of the sediment of the burners and tubes indicate that the material tolerates up to 20 N and 200 N, respectively. The reason for the oscillation is that, with increasing force, the sample is slightly compressed. First, it suffers from very fine cracks, and then its intermolecular space is filled and its resistance increases. By comparing data it can be seen that the specimen on superheater pipes has a more compact structure than the sample on the burner thus withstands a greater amount of force than the sediment sample on the burner. The sediment generated in the combustion chamber of the power plant has a very crude and porous structure, while the pellets deposited on the tubes are more structurally than the burner sediments and have the laminar mode. Also, with the impact test, the failure of ash in burner and tube was studied. The impact test results indicate that the failure energy for sediments in pipe and burner 72 J and 9 J, respectively. The result of XRD spectroscopy from a sample of ash deposits on pipe indicates that the composition of these sediments contains materials such as vanadium, sodium, sodium cyanide, carbine, silicon carbide, silicon, and sulfur. Vanadium, which is a component of the ash constituents of the tube; is solid and insoluble in water and resistant to corrosion. The carbon element is the dominant component of the burner sediments. This material is the result of incomplete burning of heavy hydrocarbons and is mainly used in rubber products and inks for printers, See Fig. 1.

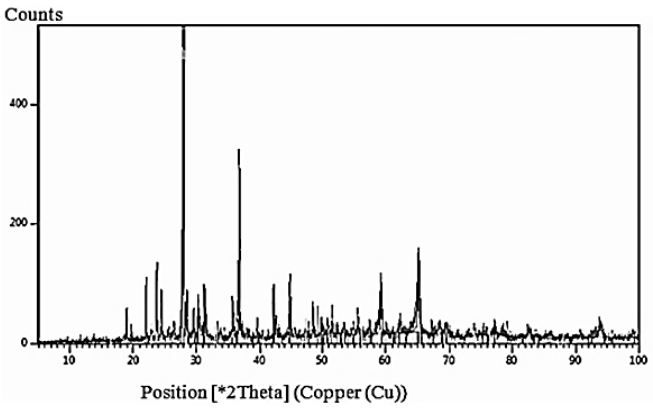

Fig. 1: XRD Spectrometric characteristics of ash on superheat pipes

To study the pollutants of Iranshahr power plant the percentage of each pollutant in the Iranshahr power plant is determined. The most pollutants due to the combustion of Mazut are Sox, Nox, and CO2. Here some ways studied to reduce pollution in order to reduce environmental pollution due to the combustion of Mazut at Iranshahr power plant. The method chosen should be able to reduce the pollution to the desired level, based on European and Iranian environmental standards. According to the type of Mazut used by the Iranshahr power plant, the Sox has been reported up to 1313 ppm, compared to that, should be reduced by 40% and 85%, respectively. The Nox has been reported up to 327.5 ppm that it is at the standard limit of Iran, but it has to be reduced by 39% to reach the European standard. The strategy and criteria for choosing pollution reduction methods are based on the European environment standard and the following priorities are made in the following order: 1. The selected method should be able to achieve the highest level of Sox reduction with a potential reduction of 85%. 2. The selective method should have the desired ability to remove Nox pollutants with a potential of 40%. 3. Ability to use in fuel condition of Iranshahr power plant like percentage of sulfur in Mazut; 4. Availability and cost of consuming materials and permanent independence on the supply of materials from abroad. 5. Having the best efficiency and having the least impact on combustion parameters and generating power. 6. It is compatible with the physical conditions and equipment of the Iranshahr power plant and the need for major reforms in the Iranshahr power plant is not subject to changes in existing equipment. 7. Having a history of successful testing in a power plant that is larger than Iranshahr. 8- With the mission of the Iranshahr power plant, the remaining space and available space in the Iranshahr power plant is compatible. 9- Ability to use in a variety of gas and Mazut fuels in the future. 10. No secondary problems such as corrosion or wastewater. Among the methods for controlling nano-emulsion of Mazut was used to reduce Nox and wet FGD to remove Sox. The two selected methods are including updated and commercialized methods worldwide [28, 29]. Investigation of selected methods for reducing contamination in laboratory scale was performed. Design of equipment and systems was carried out and then the amount of pollution was determined. The combination method of Mazut nano-emulsion and Flue Gas Desulphurization (FGD) is the best mode that simultaneously reduces both pollutants which complies with the European standard. Also, this combined method satisfies all of the ten orders. According to the price of a non-ionic surfactant, the finished product cost of the combined method is about 1.11

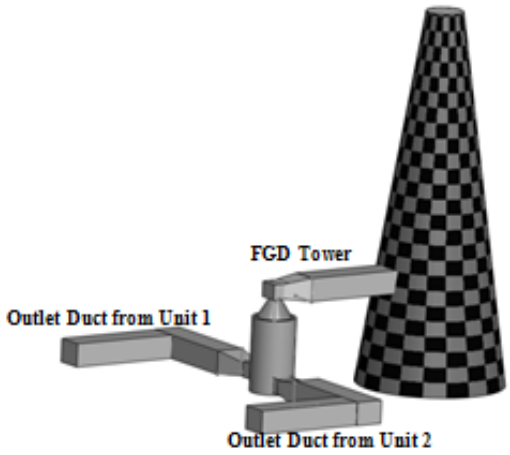

Fig. 2: Directing the flue gas of the two units to the FGD tower and then directing to the chimney

cents per kilowatt of production. The added cost, in case use of FGD method, is only 0.674 cents per kilowatt of power that is economical and could be the second option, See Fig. 2.

4. CONCLUSIONS

The mechanical and metallurgical properties of the sediment from the combustion of the Mazut fuel were investigated on the torch and superheater pipes of Iranshahr power plant. According to the issues discussed in this report, in order to achieve the European environmental standard, it is advisable to choose a combination of FGD and nano-emulsion Mazut at Iranshahr power plant. Considering that NOx emissions in Iranshahr power plant are close to Iran's standard, in order to reduce costs, a single FGD approach with the priority of removing SOx as the second option is proposed.

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