



PARTICULATE EMISSION CONTROL AT A COAL FIRED POWER STATION

Introduction

Through the generation of electricity, Eskom makes a significant contribution to the quality of peoples' lives in Southern Africa.. Eskom continuously evaluates all the processes in the production of electricity to carefully manage their impact on the environment.

Coal-fired power stations produce the bulk of electricity in South Africa through processes that are potentially harmful to the environment. Over and above the general environmental control measures and management processes in place, continuous research is done to implement new and improved technology to minimise the power stations' impact on the environment.

It is important to strike a balance between implementing such technology and the cost of producing electricity. If, for instance, desulphurisation plants were to be installed at all the coal-fired power stations currently in operation, the cost of electricity would go up by $\pm 20\%$. For the same cost, one would be able to provide electricity for approximately 240 000 people in township areas. Nevertheless, all new plant constructed will have more efficient combustion processes and, in the case of Kusile Power Station near Witbank, flue gas conditioning.

Lethabo Power Station

Lethabo Power Station is one of Eskom's largest coal-fired stations. The station is unique in that it burns very low-grade coal with a calorific value of 16 MJ/Kg and an ash content of up to 42%. The station burns approximately 50 000 tons of coal per day, producing almost 23 000 tons of ash. The station is capable of producing 3 700MW of electrical energy at full load. Although other Eskom stations burn coal of a better quality with lower ash content, they still produce ash (fly ash), in smaller volumes though.

In keeping with national environmental legislation, electrostatic precipitators or bag filters are installed at all Eskom's power stations. The largest electrostatic precipitators of their kind in the world have been installed at Lethabo. The precipitators remove 99, 8% of the fly ash present in the gases that are released through the smokestacks.

Ash removal through electrostatic precipitators.

The electrostatic precipitators operate on principles of magnetism. The dust-laden gases pass through a chamber where the individual particles of dust are ionised as a result of a high voltage negative direct current (DC) field. The charged dust particles are removed from the gas stream onto the collecting electrodes. After being dislodged by intermittent blows on the electrodes - called rapping - the dust particles drop into dust hoppers situated below the electrodes.

An electrostatic precipitator consists of a large chamber (casing) in which the gas velocity is reduced to allow adequate time for the electrical field to remove the dust particles. The collecting electrodes are flat plates up to 10m in height which are suspended in the gas stream and spaced at intervals of approximately 250mm to form a number of gas lanes from one end of the chamber to the other.

Discharge electrodes, which carry the high-tension voltage to the magnetic field, are situated between the collecting electrodes. As dust also collects on the discharge electrodes, rapping gear is provided for both sets of electrodes.

The collecting electrode plates are not continuous from one end of the chamber to the other but are split into three or four "zones", each with its own rapping gear and separate high voltage equipment. This is because conditions may arise, because of an alteration in gas flow, which necessitate varying the frequency of rapping or the adjustment of the high voltage setting to give the optimum efficiency.

A precipitator for a typical 600MW unit is of considerable size, as it has to handle gas at a rate of about $656\text{m}^3/\text{s}$. The plant is not capable of operating with the precipitators out of service.

The efficient operation of a precipitator depends largely on the resistivity of the ash. Lethabo's poor quality coal has a low sulphur content of 0.6% causing significantly higher resistivity, which impairs ionisation in the precipitator.

At the moment, the only economically viable solution to the resistivity problem is to inject sulphur tri-oxide (SO₃). The SO₃ causes a sulphuric acid film to form on the surface of the ash. The acid film lowers the specific electrical resistivity of the ash and subsequently enhances the effectiveness of the precipitators.

The SO₃ stack emissions resulting from the injection are negligible and do not exceed the sulphur levels in ash produced from coal with higher sulphur content.

Principle of operation

SO₃ is produced when liquid sulphur (S) is burned to become sulphur dioxide – SO₂. The conversion to SO₃ takes place in a catalytic converter.

The SO₃ is injected into the flue gas ducting, upstream of the precipitator casings, via an arrangement of lances equipped with nozzles.

The installation of SO₃ conditioning at Lethabo is another milestone in Eskom's commitment towards a clean and healthy environment.

The effect of the injection of SO₃ at Lethabo was that the particulate emissions were reduced from an average of 114 mg/m³ to 55mg/m³, a percentage average of 99,98%

Bag filters

Since 1994, some of Eskom's power stations have been retrofitted with bag filters. They operate like big vacuum cleaners. The main difference is that the bags themselves are 8m long and there are 25 000 of them. The bags are fitted inside casings through which the ash passes and where it is collected in the bags. They are cleaned by pulsing them with compressed air, the dust being collected in hoppers below.

The 25 000 bags have a life span of approximately 28 000 to 30 000hrs (4 to 5 years). The emissions on average are less than 20 mg/m³. Bags do fail randomly and require replacement in order to keep the emissions below 50. The plant runs 100% of the time and there is no possible bypass. The bags are precoated with lime in order to minimise any acid attack.

Environmental Management

The ash that is removed from the station is back-stacked into the mined area (open pit) or stacked on dumps. To ensure that the ash "mountains" do not pose an environmental hazard, they are covered with layers of topsoil and planted with grass. While the power station is in operation areas where ash stacking is still in progress, are exposed, (uncovered). However, every effort is made to suppress the dust when the ash dries out. An on site irrigation system sprays water onto the ash until rehabilitation can be done safely and effectively. The rehabilitation efforts result in the land where mining/ash stacking takes place being in a better state than it was before these operations.

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