Adaptation: Particulate Emission Control at Lethabo Power Station

Since coal-fired power stations produce the bulk of electricity in South Africa through processes potentially harmful to the environment, Eskom continuously evaluates its electricity production processes to carefully manage its impact, through general environmental control measures and management processes, and continuous research into new technologies.

However, implementing improved technology must be balanced against the cost of producing electricity. If, for instance, desulphurisation plants were to be installed at all coal-fired power stations currently in operation, the cost of electricity would go up by approximately 20%. For the same cost, Eskom would be able to provide electricity for approximately 240 000 people in township areas. Nevertheless, all new plant will feature 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. It is unique in that it burns very low-grade coal with a calorific value of 16 MJ/Kg, with an ash content of up to 42%. The station burns approximately 50 000 tons of coal per day, producing almost 18 000 tons of ash. It is capable of producing 3 700MW of electrical energy at full load. Although other Eskom stations burn better quality coal with lower ash content, they still produce fly ash.

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. These remove 99,8% of the fly ash from gases released through the smokestacks.

Ash removal through electrostatic precipitators

The electrostatic precipitators operate on magnetism principles. The dust-laden gases pass through a chamber where individual dust particles are ionised by 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 below the electrodes.

An electrostatic precipitator consists of a large chamber, or 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, 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 for optimum efficiency.

A precipitator for a typical 600MW unit is of considerable size, as it has to handle gas at a rate of about 656m3/s. The plant is not capable of operating if the precipitators are 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.

Flue Gas Conditioning (FGC)

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. FGC at Lethabo has reduced particulate emissions from an average of 114 mg/m^3 to $55mg/m^3$, a percentage average of 99,98%.

Bag filters

Since 1994, some of Eskom's power stations have been retrofitted with bag filters which operate like large vacuum cleaners. There are 25 000 bags, each 8m long, which are fitted inside casings through which the ash passes and is collected in the bags. They are cleaned by pulsing with compressed air and the dust is collected in hoppers below.

The bags have a lifespan of approximately four to five years. Emissions on average are less than 20 mg/m³. Bags do fail randomly and require replacement to keep emissions below 50 mg/m³. They are pre-coated with lime to minimise acid attack. The plant runs 100% of the time and there is no possible bypass.

Environmental Management

The ash removed from the station is back-stacked into the mined area (open pit) or stacked on dumps. To ensure 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 remain uncovered. However, every effort is made to suppress the dust as the ash dries out.

An on-site irrigation system sprays water onto the ash until rehabilitation can be undertaken safely and effectively. These rehabilitation efforts result in the land ending up in a better state than it was before mining and ash stacking took place.

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