Energy saving, a breath of fresh air
Integrated Demand Management: Reducing power consumption in mine fans

With mines being reliant on electrically powered fans and pumps for their effective operation, Eskom’s Energy Efficiency Integrated Demand Management (IDM) competency has identified substantial opportunity for improvements in efficiency which readily translates into reduced power consumption, lowered operational cost and lower environmental impact. Working with mining ventilation and refrigeration specialists Bluhm Burton Engineering (Pty) Ltd (BBE) and Gold Fields, Eskom IDM has proved that through more efficient systems, these power savings can indeed be achieved, reducing costs and supporting profitable mining operations in the face of escalating energy costs.

Background and context

Mining operations are electrical energy-intensive with some equipment operating around the clock, stopping only for maintenance. An example of continuously operated and large energy consumers are the main ventilation fans. South African gold and platinum mining houses typically have numerous upcast ventilation shafts per mining business unit (servicing different shafts within the business units). Some business units can have a combined main surface ventilation fan base electrical load of between 20MW and 30MW operating continuously.

Because power consumption was not the main determining factor for the specification, purchase and operation of the main ventilation fans which manage air supply to particularly deep-level mining operations, the tendency was towards over-designing and running equipment at one setting only – that being full speed. However, with the cost of electricity set to increase substantially over the coming years on the back of steep economic growth, businesses of every kind are exploring methods for reducing their power consumption, and consequently their operational costs.

Where mines are concerned, a significant opportunity is presented in main fan stations which provide ventilation to underground workings. However, achieving efficiency gains relies upon investment in modern equipment which is capable of variable settings and improved manageability in order to deliver not just a steady stream of air, but to deliver just enough power to accurately address needs without wastage.

In the solution that it has provided for Gold Fields’ Kloof Mine, located near Westonaria in Gauteng, BBE provided insight into the considerations, equipment and costs necessary to achieve optimised operation of main fan ventilation systems. A target of roughly 25% improvement in power consumption, or 5,6MW saving out of a 22,8MW base load was set for Kloof Mine. Through the project, it has also confirmed that substantial power savings can be achieved in line with expectations.

The result of this exercise is a clearer notion of the activities and investments required to support improved Integrated Demand Management for a reduction in the overall operational cost of an industrial centre through lowered electricity consumption.

Project overview

Kloof Mine has five large surface main fan stations which provide primary ventilation to underground workings.

Capacity and scope

The main fan stations at Kloof Mine have an installed rated capacity of some 29 units of electric power (MWs), with 20MW being operational. The five main fan stations are distributed over a distance of about 20km.

Fan power is proportional to the cube of air flow. By reducing air flow by just 10%, the absorbed power will be reduced by approximately 30% (by taking into account mechanical and electrical efficiencies within the total installation, 25% absorbed power reduction can be realised). The fan absorbed power reduction can be achieved by the introduction of pre-rotation fan inlet guide vanes that could enable the flow through the centrifugal fan to be varied.

The unloading of the fans is achieved by the use of inlet pre-rotation guide-vanes allowing the ability to regulate fan performance and hence energy consumption. Each fan station is fitted with aerodynamically efficient inlet guide vanes which are electrically actuated. The effect of these modern pre-rotation guide-vanes allows unloading of approximately 75% to 70% of fan absorbed power with a negligible effect on fan efficiency.

Each fan station is equipped with a PLC unit which would implement fan station’s control strategies. All the fan station PLCs are linked to a central SCADA system via wireless radio link network. This centralised SCADA system is used to monitor the operation of the fan stations across Kloof mine. The monitoring system includes all critical fan station information as well as key ventilation monitoring sensors installed underground. The result is that the fan operation becomes ‘variable’ and enables the fan stations to meet underground air requirements accurately without consuming excessive power.

The monitoring facilities include specially developed software called VUMALive, which enables monitoring and analysis of the primary ventilation circuits (in terms of the underground airflow, barometric pressure, dry bulb and wet bulb temperatures) of the multiple shafts.

Savings that justify capital investment

On completion of the Kloof Mine project, an independent third party has measured the power savings achieved. While the baseline measured in the process dropped to 20MWe, savings of 5MWe were recorded within the expected reduction in power consumption. With the project capital expenditure estimated at some R14 million, the savings in electricity cost (at 2009 prices) is calculated to be US$630,000, which translates to R4,7 million (at R7,5/$). Given that the electricity price is set to escalate steeply, the project will pay for itself within three years or less.

As a consequence of the proven success of this project, further initiatives are underway to implement similar systems at similar mines, both within the Gold Fields stable, as well as at other mining companies.

Energy Services Companies (ESCos) are available to investigate if similar savings opportunities exist in your business. To participate in the drive towards energy efficiency contact Eskom IDM or an ESCo directly (ESCo list available from the IDM website). Or call the Eskom Contact Centre on 08600 ESkom (08600 37566) for more information. A comprehensive overview on current Eskom IDM programmes is available on the website, visit www.eskom.co.za/idm.

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