Power recovery turbines in underground mines

Information from Andritz Hydro

In South Africa the exploration of minerals such as gold and platinum from constantly increasing depths have changed the climatic mining conditions.

Working temperatures underground can go up above 40°C in the stoping areas and working without cooling is impossible. Over the years de-centralised cooling production has made way for a central refrigeration plant on the surface. The advantages of locating the refrigeration plant on the surface are:

- Lower building costs.
- Lower ambient temperature and therefore lower cooling costs.
- Lower maintenance and operation costs.

The cooling water from central refrigeration plants on the surface is brought down to cool down the temperature at the working levels which may be 1500 to 3000 m below ground.

The disadvantages of the central refrigeration plant installed at the surface are however the high-energy costs caused mainly by the pumping of warmed-up water back to the surface. A further disadvantage is the temperature increase of the cooled water on its way from the surface to the underground sites. The temperature increase is caused by the change from potential to thermal energy through friction in the pipe column. The temperature increase of the cooling water can be approximately 2,33°C per 1000 m. It is of no consequence if the potential energy is changed continuously along the pipe column or at the end by a throttling valve or dissipater.

For the reduction of energy costs and the friction losses power recovery turbine units can be installed. The potential energy of the cooled water flowing in the pipe column is converted into mechanical energy in the turbine. A part of the energy required to pump the warmed-up water back to the surface can so be recovered.

Advantages of the method are:

- High energy recovery (turbine efficiency over 90 %) over a wide capacity range with max. diff. head.
- No headloss in the turbine intake, as no throttle valve is required. (The installation of a throttle valve upstream of a reverse running pump causes head loss of up to 5% an intake due to the generation of noise and vibration.)
- Less noise, vibration and cavitation than in a throttle valve or reverse running pump.

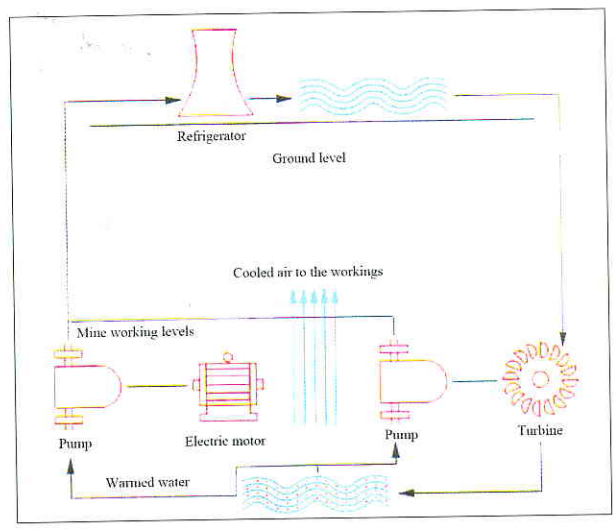

Fig. 1: Advantages of the power recovery turbine.

Fig. 2: Turbine components ready for shipment to Elandsrand mine. Output 3830 kW, head 620 m, speed 1500 rpm.

- Loss-free flow and level control over the total capacity range, and simple process control.
- Energy recovery down to about 15% of plant capacity.
- Smooth operation over a wide capacity range.
- Investment cost savings since no throttle valve, overrunning clutch, possibly bigger motor, surge drum or regulating devices are required.

A further advantage of the turbine solution is the reduction of the unwanted temperature increase of the cooling water from 2,33 to 0,33°C per 1000 m head hence reducing the cost of chilling.

A report written in 1976 by A Whiller from the Enviromental Engineering Laboratory concluded that "the cost benefit of such systems arising partially from the reduced temperature-rise in situations where cold water is sent underground from surface would more than justify the installation cost."

Since 1978 more than 50 turbines with a combined capacity of over 65 MW have been installed underground in the various mines in South Africa.

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