Design and Implementation of Ventilation Systems of Some Large and Complex Zinc-Lead-Silver Mines in India: Benefits Accrued to the Country

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The paper discusses the design and implementation of ventilation systems of some large and complex zinc - lead - silver mines of our country and the challenges faced in this endeavour. In India, the zinc ore contains lead and silver as the secondary minerals. Along with the production of zinc metal from zinc ore, Hindustan Zinc Limited (HZL) recovers lead and silver as secondary products from the ore. It is to be noted here that total production in this sector comes from underground mining and during last 8-10years, HZL is mainly focussing on developing some underground mines comparable to best zinc mines of the world. It may be mentioned here that HZL is now the sole producer of primary zinc metal in India and presently operating 08 underground mines, viz. Rampura Agucha (RA), Sindesar Khurd (SK), Rajpura Dariba (RD), Mochia, Balaria, Baroi, Zawarmala and Kayad Mines. The author of this paper designed the ventilation systems of all these 08 mines and remained associated with HZL team for its implementation. The two largest mines amongst all 08 mines are Rampura Agucha (RA) and Sindesar Khurd (SK) mines with production of 4.93 MTPA (millions tonnes per annum) and 6 MTPA respectively. In order to cater the volume of production, close to 30 km of development in each of the two mines are completed in a financial year. It may be worth mentioned here that RA Mine is the second largest zinc metal producing mine in the world, whereas SK Mine is the largest producer of lead and second largest silver producing mine of the world.

The paper will briefly present the ventilation network modelling and design studies, and its implementation in one such mine, viz. RA Mine and it will also touch upon the development of ventilation system of SK Mine. In RA Mine, opencast mining activity continued up to a depth of 420m and just before 2-3 years of its exhaustion, the development of underground mining has been started with trackless mining system. Practically the underground mining started from a depth of 500m and the present depth of working is extending between 700m and 970m. Within next 5 years, the depth of workings will extend to 1.2km. The mine uses the largest size of LHDs with 20/21 Tonnes bucket capacity, 65 Tonnes capacity Low Profile Dump Trucks, multi-boom Jumbos, Passenger Carriers etc. The trackless vehicles used in RA Mine are the highest capacity of machines available in the international market and being used by a few leading metal mining companies in the world. At present RA Mine uses nearly 40,000 kW of diesel-powered engines running within the close underground space and adding quite a significant amount of diesel fumes in the ventilation system of the mine. The mine uses paste-fill technique for filling the voids in the stopped-out areas generating heat because of exothermic reaction. In addition, there is water percolation from the strata and the roadways are wet. The challenges of heat due to the depth of operation, longer length of development in every year creating freshly exposed surfaces, diesel fumes, heat from paste filling and water seepage are integrated to ventilation air flow model for designing the ventilation system of this mine. The field studies were carried out spanning over a month to collect all the field data for establishing the basic ventilation network model and subsequently validate this model. Further design of ventilation system has been carried out by this validated ventilation network model.

This paper will also describe the implementation of many other innovative thoughts in the design of the ventilation system and other systems of the mine, which will be of significant interest to the planners and practising engineers working in different sectors of mineral industry. The design and implementation of similar innovative thoughts in all the 08 mines of HZL benefitted the country, India to occupy 4th, 6th and 11th ranks in zinc – lead and silver metal production in the world.

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