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BENEFICIATION STUDIES ON COPPER ORE SAMPLES FROM RAJASTHAN (*).

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Copper is one of the important industrial metals in which India is deficient, with an annual production of only about 10,000 tonnes against her estimated requirement of 1,24,000 tonnes at the end of the fourth plan period. Due to increasing demand of this vital metal, intensive efforts are being made to raise the output to about 50,000 tonnes by the end of the fourth plan from the available workable deposits in the country. At present workable deposits of copper ore occur mainly in Bihar and Rajasthan. The deposits in Bihar are being worked by M/s. Indian Copper Corporation Ltd., who are raising their annual production from 10,000 tonnes to 16,000 tonnes. The copper ore deposits of Rajasthan are located mainly in Khetri, Dariba and Kolihan. Government of India has finalised setting up of an integrated plant to produce 31,000 tonnes of copper metal annually at Khetri which will include 10,000 tonnes from the adjacent mine of Kolihan.

The Ore Dressing Division of the National Metallurgical Laboratory right from its inception, is actively engaged in beneficiation studies on various types of low grade ores received from all over India and has developed suitable beneficiation techniques for different ores. To study the technical feasibility and economics of various treatment processes an integrated mineral beneficiation pilot plant of capacity 1 to 20 tonnes of ore per hour has been set up at the National Metallurgical Laboratory, where unique facilities are available for continuous treatment of any type of low grade ores.

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At the instance of the National Mineral Development Corporation, comprehensive beneficiation studies were undertaken in National Metallurgical Laboratory on low grade copper ores from Khetri, Kolihan and Ghatiwali Adit deposits of Rajasthan, with a view to producing copper concentrate suitable for smelting.

Copper ore from Khetri

Systematic studies employing batch as well as pilot plant tests were conducted on a bulk sample from Khetri assaying 0.8% Cu, 18.63% Fe, 3.08% S, 54.65% SiO_2, 9.62% Al_2O_3, 0.13 dwt/ton Au and 2.37 dwt/ton Ag. Quartz, chlorite, garnet and biotite were the principal gangue minerals in the sample. The sulphide minerals present in the sample in order of abundance were pyrrhotite, chalcopyrite and pyrite. Chalcopyrite was finely disseminated but was liberated at 150 mesh.

Optimum conditions for rougher flotation were obtained when a feed having 73.3% -200 mesh fraction was employed using 1.5 Kg/tonne of lime, 0.05 Kg/tonne of potassium ethyl xanthate and 0.025 Kg/tonne of pine oil. Lime was added as a depressant for pyrite-pyrrhotite to maintain the pH between 9.2 and 9.4. Flotation followed by two cleanings of the rougher float yielded a copper concentrate assaying 24.4% Cu with a recovery of 77.8%. Flotation of the ground middlings produced a second concentrate assaying 21.7% Cu with an additional recovery of 2.8% Cu. Aerofloat 238 and higher xanthates were found to be better collectors for chalcopyrite than ethyl xanthate. A pyrite pyrrhotite concentrate assaying 36.25% S with a recovery of 29.0% was produced from the copper tailings at a pH of 5.5 using sulphuric acid as pH regulator and potassium amyl xanthate as collector. Since the ore contained predominantly pyrrhotite, the possibilities of economically producing a high grade pyrite-pyrrhotite concentrate assaying over 46% S for acid manufacture from this ore are very remote. Based on the results of laboratory scale tests, pilot plant studies were undertaken with a 20 tonne bulk sample. Results of pilot plant studies were more or less similar to those obtained on a batch scale. The final copper concentrate obtained from pilot plant studies assayed between 19.0 & 27.0% Cu with recoveries ranging from 88.0% to 77% Cu. The flotation concentrate contained 1.6 dwt/ton Au and 22.8 dwt/ton Ag with recoveries of 30 and 25 per cent gold and silver respectively.

Copper ore from Shaft No. 3 Khetri

A second sample from Khetri assaying 0.79% Cu, 20.16% Fe, 2.85% S, 52.82% SiO_2, 10.2% Al_2O_3, 5.09% MgO, 0.08 dwt/ton Au and 1.7 dwt/ton Ag was also investigated in the Laboratory. The metallic minerals present in the ore in order of abundance were magnetite, chalcopyrite, pyrrhotite, pyrite and marcasite. Quartz and chlorite constituted the principal siliceous gangue in the ore. Chalcopyrite was well liberated below 150 mesh. The optimum grind for rougher flotation was found to be 69.5% -200 mesh. Roughing followed by three cleanings of the rougher float produced a final concentrate assaying 19.42% Cu with a recovery of 75.0% Cu. Pyrite-pyrrhotite flotation from the mixed copper tailings did not yield a satisfactory grade of concentrate. A series of batch scale two cycle locked tests were carried out to simulate continuous flotation conditions by returning the middlings to the circuit. Two cycle locked tests with two cleanings produced a concentrate assaying 14.98% Cu, 38.08% Fe and 39.54% S with a recovery of 75.9% Cu. This product is suitable for flash smelting for extraction of copper in the proposed plant at Khetri.

Copper ore from Kolihan

Flotation studies were undertaken on a low grade copper ore from Kolihan, Rajasthan. The sample as received assayed 2.69% Cu, 15.5% Fe, 8.2% S, 50.2% SiO_2, 8.9% Al_2O_3, 2.6 dwt/ton Ag and 0.19 dwt/ton Au. Mineralogical studies indicated that pyrrhotite and chalcopyrite were the chief sulphides present with minor amounts of pyrite. Bulk of the ore was composed of siliceous gangue, namely quartz and chlorite and liberation of chalcopyrite occurred at about 150 mesh size. The optimum grind for rougher flotation was found to be 52.2% -200 mesh. A copper float assaying 16.6% Cu with 97.4% recovery was obtained using 0.07 Kg/ tonne of potassium ethyl xanthate and 0.01 Kg/tonne of pine oil at pH 9.5. Reflotation of the rougher float produced a high grade copper concentrate assaying 27.4% Cu, 33.7% S, 31.6% Fe, 2.17% SiO_2, 1.42% Al_2O_3, 2 dwt/ton Au and 13.5 dwt/ton Ag with a recovery of 93.8% Cu. The recovery is expected to improve further in actual plant practice when the cleaner tailings will be recirculated. Pyrite-pyrrhotite flotation of the copper tailings yielded a concentrate assaying 38.0% S with a recovery of 40.4% S.

Copper ore from Ghatiwali Adit, Khetri

This sample assayed 0.99% Cu, 23.1% Fe, 6.08% S, 42.38% SiO_2, 0.14 dwt/ton Au and 2.26 dwt/ton Ag. Pyrrhotite and chalcopyrite constituted the chief sulphide minerals in the ore. Liberation of chalcopyrite from the siliceous gangue occurred at 150 mesh. Flotation followed by three cleanings of the rougher float produced a copper concentrate assaying 20.46% Cu, 33.3% Fe, 30.1% S with a recovery of 82.0% Cu. When the rougher concentrate was reground to 100% -200 mesh before cleaning, the grade improve to 29.12% Cu, 33.4% S, 31.1% Fe, 2.2 dwt/ton Au and 27.8 dwt/ton Ag with a copper recovery of 80.2%.

Conclusion:

Systematic flotation studies were undertaken on the low grade copper ore deposits of Rajasthan and optimum conditions determined for flotation. The results indicated that all the ore are amenable to beneficiation to make them suitable for copper extraction. Broadly based on the studies made in the National Metallurgical Laboratory on low grade copper ore deposits of Khetri, the Government of India is setting up a milling and extraction plant at Khetri which is being worked by M/S Hindusthan Copper Ltd.

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