Beneficiation of Bababudan low grade megnetite ores — A technical appraisal

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The horse-shoe shaped Bababudan range of low grade magnetite ore deposits in the western part of Karnataka State, India, is distributed over a length of about 25 kms. The deposits have for convenience, been divided into three continuous blocks viz., Rudragiri, Attigundi and Mahal. The huge ore reserves, proximity to the Manglore Port for possible export of iron ore and connection with Bangalore and Manglore cities through national highways, make these deposits prospective for exploration.

The Phase-I exhaustive exploration studies, including beneficiation undertaken by National Mineral Development Corporation Ltd (NMDC) on the entire range of three blocks established the ore reserves of about 1350 million tonnes of which Attigundi block constituted of maximum reserves of 820 million tonnes.

Three major ore types viz., Soft Weathered Ore (SWO), Hard Weathered Ore (HWO) and Fresh Ore (FO) were identified in the deposits, based on the degree of weathering being maximum for SWO and minimum for FO. The proportion of FO was maximum in the Attigundi block compared to SWO and HWO.

The Attigundi block containing largest reserves, with minimum waste, less of oxidation, fairly long strike length and favourable location with respect to development of infrastructural facilities, etc., was selected out of the three blocks for further detailed investigation during Phase-II.

The investigation of the Attigundi block during Phase-II aimed at confirming the earlier findings and deriving additional data to perpare a techno-economic feasibility report. This investigation envisaged detailed beneficiation studies which were carried out at Research and Development Laboratories of National Mineral Development Corporation Ltd., Hyderabad.

Samples of three ore types received from Attigundi block for conducting detailed beneficiation studies, assayed 46.40 to 53.50%, 33.65 to 37.00% and 33.20 to 34.00% Fe for SWO,HWO and FO, respectively. In addition to ore type samples, three composite samples, representing first five years production (composite I), second five years production (composite II) and the entire Attigundi block (composite III), were prepared by mixing various ore types in different proportions. The composite I, composite II and composite III samples assayed 39.60%, 37.20% and 36.20% Fe, respectively.

The mineragraphic studies with ore type samples revealed the presence of magnetite, hematite (formed due to martitization) with minor amount of goethite as ore minerals and quartz as major gangue mineral with minor amount of silicates.

The liberation studies with ore type samples revealed that substantial liberation of quartz was achieved in the size range of 35 to 48 (Tyler) mesh (400 to 300 microns) and near complete liberation occured beyond 270 mesh (53 microns) size.

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The autogenous grinding employed for size reduction during Phase-I exploration was found to be unsuitable for HWO and FO types because of lower mill output and higher grinding energies. Since the Attigundi block is comprised mostly of HOW and FO types, it was decided to adopt stage crushing followed by conventional wet grinding for size reduction and liberation of iron values for beneficiation studies during Phase-II exploration.

Keeping in view the substantial liberation in the coarser size range and the abundance of magnetite, it was decided to adopt coarse grinding in rod mill followed by low intensity magnetic separation as the pre-concentration stage for rejecting substantial quantity of quartz with very little loss of iron values. The primary non-magnetic tailings were to be subjected to gravity separation for recovering the non-magnetic iron values. The second stage would consists of fine grinding of pre-concentrate in a ball mill followed by low intensity magnetic separation for achieving an acceptable grade of concentrate.

Extensive batch scale tests were carried out on the ore type samples to determine process parameters for subsequent pilot plants tests. Based on the batch scale tests, the optimum mesh of grind for coarse grinding of the 'as received' samples and fine grinding of the rougher magnetic concentrate was decided to be 35/48 mesh and 270 mesh respectively.

The stage crushing of the 'as received' sample to minus 10 mm size followed by rod mill grinding in closed circuit to minus 48 mesh followed by low intensity magnetic separation in the pilot plant, produced rougher magnetic concentrate with satisfactory grade and recovery. In case of composite III sample (representing the entire Attigundi Block of Bababudan Deposit) the rougher magnetic concentrate was 63.3% by weight and assayed 49.00% Fe with 86.4% recovery of iron values. A substantial quantity of gangue was rejected during the rougher concentration at a coarser size with a little loss of iron values, thus reducing the load on its subsequent fine grinding.

The gravity concentration by spiralling of the rougher non-magnetic tailings was found to be unsatisfactory. In case of composite III sample, the spiral concentrate, assaying 55.60% Fe and weighing 1.1% recovered only 1.7% iron units out of 13.6%. A few floatation tests carried out on the rougher non-magnetic tailing produced flotation concentrate weighing 8.2% and assaying 22.90% Fe with 5.2% iron units recovery out of 13.6%. So, it was decided to reject the rougher non-magnetic tailings.

The regrinding of the rougher magnetic concentrate in a ball mill in closed circuit, to a size finer than 270 mesh followed by low intensity magnetic separation on pilot scale produced a concentrate with acceptable grade and recovery. The concentrate in case of composite III sample assaying 67.60% Fe with 72.3% iron unit recovery was 38.4% by weight. The silica + alumina content was 4.27%.

Since the present market demand is for high grade concentrate having about 3% silica + alumina, efforts were made to reduce the gangue content by adopting two stage cleaning of the primary magnetic concentrate by low intensity magnetic separation after demagnetizing. The cleaner concetrate in case of composite III sample assaying 69.00% Fe wtih 70.2% iron unit recovery was 36.6% by weight. The silica + alumina content was 3.14%. The grade of the concentrate is expected to improve further on a commercial scale employing lower magnetic field intensity.

The basic design data such as Bond's Work Index, Filtration rates, Settling rates, Rheological characteristics, Circulating loads, Bulk density and Angle of repose, etc., was also collected during the pilot plant tests.

Based on the pilot plant test results, the beneficiation flowsheet for obtaining high grade concentrate from Attigundi Block of Bababudan deposit, involving the following steps were recommended.

— Crushing in 3 or 4 stages to minus 10mm size
— Rod mill grinding to minus 48 mesh size

— cobbing the rod mill discharge and rejecting the non-magnetic tailings

— Regrinding the rougher magnetic concentrate to about 98.0% minus 325 mesh size in ball mill followed by primary low intensity magnetic separation

— Two stage cleaning of the primary megnetic concentrate to produce a high grade concentrate

— Dewatering the concentrate

Acknowledgements :

The authors are grateful to Sri P. C. Gupta Chairman-cum-Managing Director to accord permission to present this paper. The authors are also thankful to Sri N. Neelakantan, Director (Planning) and Sri G. S. Ramakrishna Rao, Chief Mineral Dressing Engineer for their encouragement and keen interest in bringing out this paper.

DISCUSSION :

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Question : In many of the magnetite ores oxidation takes place and give rise to martite and maghemite formation. Regarding Bababudan what is the extent of martitization and whether any presence of maghemite is reported ?

Author : Martitization did take place and the hematite presant was the result of this martitization.

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Question : Since the sample is fairly liberated at 35 mesh, whether reduction roast followed by low intensity magnetic separation has been tried to avoid utilising all the processing equipments and the flow-sheet could be simplified ?

Author : Since the sample contained magnetite in abundance, there is no need for reduction roast.