BENEFICIATION OF DOLOMITE AND MAGNESITE

DOLOMITE

DOLOMITE is important raw material for the refractory industry and also for the extraction of magnesium metal. Silica is the normal gangue mineral and is separated by froth flotation only. Only one sample was tested for beneficiation.

The sample was received from M/s. TISCO Ltd. from Orissa and consisted of 12 to 75 mm lumps having the following analysis.

Constituent	*Assay %*
CaO	28.60
MgO	20.20
SiO_2	4.22
Al_2O_3	1.34
Fe_2O_3	0.74
P	0.025
S	0.12
CO_2	45.00

Mineralogical examination of the sample revealed presence of fine grained dolomite in intimate association with quartz, mica and felspar; gangue and dolomite were liberated at 100 mesh size.

Flotation tests conducted under the optimum conditions of 80%−200 mesh feed, 0.68 Kg/tonne of sod. silicate, and 0.44 kg/tonne of sod. oleate yielded a concentrate assaying 2.7% insol. After one cleaning, the product analysed 30.4% CaO and 21.25% MgO with 1.75% insol. Cationic flotation tests using amine 220, at PH 9.7, the dolomite concentrate (flotation tailing) analysed 2.7% insolubles.

MAGNESITE

This is important raw material for the manufacture of refractory bricks for use in the metallurgical industry.

Large deposits of magnesite are located in the Salem district of Tamil Nadu. Workable deposits are also found in Uttar Pradesh and Rajasthan. Beneficiation tests were conducted in NML on different samples of magnesite and the results are recorded as follows:

A. TAMIL NADU (SALEM) MAGNESITES

Sample No. 1

The sample was received from M/s TISCO & Kricher and Banner of Didiers to reduce the insolubles to less than 1.5%. The sample composed of 50 mm lumps to fines and analysed as follows:

Constituent	*Assay %*
MgO	41.51
SiO_2	2.85
Fe_2O_3	0.33
Al_2O_3	0.41
CaO	0.60
CO_2	48.76
LOI at 350°C	1.73

Mineralogical examination of the sample indicated presence of magnesite in association with quartz, mica, talc and felspar, from which the magnesite was liberated at 3 mesh size.

Heavy liquid separation tests conducted with the −3+20 mesh sized portions at sp. gr. 2.75 yielded a sink product assaying 1.32% SiO_2. Similar test with −14+200 mesh sized feed yielded a combined concentrate assaying 0.31% SiO_2 with 49.8% yield.

HMS tests with−3+10 mesh portion using Galena suspension in water at sp. gr. 2.65, produced a sink product assaying 1.27% SiO_2 with 40.53% yield. Flotation tests with the combined feed of HMS rejects and —10 mesh portion using 0.5 kg/tonne of sod. oleate and 0.12 kg/tonne of pine oil, after two cleanings yielded a concentrate assaying 1.1% SiO_2 with an additional yield of 30%.

Straight flotation tests employing 0.45 kg/tonne of sod. oleate 0.12 kg/tonne of pine oil, with one cleaning yielded a concentrate assaying 1.48% SiO_2 with 73.5% yield.

Sample No. 2

A 100 tonnes sample was received from M/s TISCO Ltd. to produce a concentrate for use in the manufacture of refractories. The sample consisted of 65 mm lumps to fines and analysed as follows:

Constituent	*Assay %*
MgO	45.90
CaO	0.72
CO_2	49.50
SiO_2	3.00
Al_2O_3	0.94
Fe_2O_3	0.36
S	0.07

Examination of the sample under microscope indicated the presence of quartz, serpentine, hornblende and mica and gangue with magnesite and were liberated at 100 mesh size.

Flotation tests employing 92% −200 mesh feed, 0.75 kg/tonne of sod. silicate, 0.3 kg/tonne of sod. oleate and 0·07 kg/tonne of pine oil yielded a concentrate assaying 2.0% SiO_2 with 92.0% yield. After two cleanings the product analysed 0.90% SiO_2 with 70.0% yield.

Cationic flotation tests employing 0.5 kg/tonne of NaOH, 0.75 kg/tonne of Do-Decyl amine and 0.07 kg/tonne of pine oil yielded a magnesite concentrate (tailing) assaying 1.15% SiO) with 70.0% yield. Cleaning of the float and combining the cleaner tails (magnesite conc.) improved the yield to 82% with 1.18% SiO_2 in it.

Sample No. 3

The sample was received from M/s. Dalmia Magnesite Corporation to reduce the silica content to 1.5% or less. Complete analysis of the sample was as follows:

Constituent	*Assay %*
MgO	45.31
CaO	1.46
CO_2	48.50
SiO_2	3.91
Al_2O_3	0.30
Fe_2O_3	0.55
S	0.12

Mineralogical examination revealed the presence of quartz, serpentines, felspars and ferro-magnesian minerals as gangue, which were liberated at 35 mesh size.

Under the optimum conditions of 76% −200 mesh feed, 0.5 kg/tonne of sod. silicate, 0.55 kg/tonne of sod. oleate and 0.02 kg/tonne of pine oil, a magnesite concentrate resulted assaying 2.73% SiO_2 with 88.6% yield. After two cleanings using 0.2 kg/tonne of sod. oleate during the first cleaning only, the product analysed 1.39% SiO_2 with 71.0% yield.

Similar test employing 0.1 kg/tonne of sod. silicate during cleaning, yielded a concentrate assaying 1.4% SiO_2 with 73.4% yield. Cationic flotation tests were not fruitful.

Sample No. 4

The sample was received from M/s. Belpahar Refractories Ltd. to examine the possibilities of reducing the SiO_2 content to 2% by crushing and sizing. The sample analysed as follows:

Constituent	*Assay %*
MgO	44.90
CaO	0.39
CO_2	47.76
SiO_2	4.10
Al_2O_3	0.22
Fe_2O_3	1.30
S	0.01

Chemical analysis of the various sized products from 50 mm to −150 mesh size indicated silica variation from 2.64% in the coarsest lumps to 14.76% in the −65+150 mesh portion.

Crushing to 25 mm followed by sizing produced various products ranging in silica content from 2.0% in −25 mm to 11.44% in −65 +150 mesh size. Similar tests after crushing to 12 mm size, indicated the variation from 2.20% silica in +12 mm to 9.84% silica in −65+150 mesh portion.

Sample No. 5

The sample was received from M/s Dalmia Magnesite Corporation, The sample composed of −3 mesh fines and analysed as follows:

Constituent	*Assay %*
MgO	45.86
CaO	0.87
CO_2	48.10
SiO_2	3.90
Al_2O_3	0.22
Fe_2O_3	1.30
S	0.01

Chemical analysis of the various sized products from 50 mm to −150 mesh size indicated silica variation from 2.64% in the coarsest lumps to 14.76% in the −65 +150 mesh portion.

Crushing to 25 mm followed by sizing produced various products ranging in silica content from 2.0% in +25 mm to 11.44% in −65+150 mesh size. Similar tests after crushing to 12 mm size, indicated the variation from 2.20% silica in +12 mm to 9.84% silica in −65+150 mesh portion.

Sample No. 5

The sample was received from M/s. Dalmia Magnesite Corporation, The sample composed of —3 mesh fines and analysed as follows:

Constituent	*Assay %*
MgO	45.86
CaO	0.87
CO_2	48.10
SiO_2	3.90
Al_2O_3	0.21
Fe_2O_3	0.54
S	0.224
P	0.028

Examination of the sample under microscope revealed the presence of the gangue minerals like quartz, serpentine, felspars and magnetite which were liberated at 100 mesh size.

Flotation tests under the optimum conditions of 96% —200 mesh grind, 0.75 kg/tonne of sodium silicate and 0.75 kg/tonne of sodium oleate produced a concentrate assaying 2.1% SiO_2 with 93.8% yield. This product after one cleaning analysed 1.05% SiO_2 with 77.6% yield. Additional cleaning improved the grade to 0.73% SiO_2 with a yield of 70.6%.

Cationic flotation test employing 0.4 kg/tonne of Armeen 12 with one cleaning of the float yielded a combined magnesite conc. (tails) assaying 0.72% SiO_2 with 81.2% yield.

Dead burnt magnesite

A sintered/dead burnt magnesite sample was received from M/s. Salem Magnesite (P) Ltd.,—Bombay for the reduction of silica content to less than 3%. Complete chemical analysis of the sample was as follows:

Constituent	*Assay %*
MgO	85.7
SiO_2	8.6
Fe_2O_3	1.1
Al_2O_3	2.1
CaO	2.4
LOI at 900°C	0.1

Examination of the sample under microscope indicated the presence of periclase, iron bearing spinel, forsterite and traces of cristobalite.

Heavy media Separation tests conducted at 3.1 sp. gr. produced a sink product assaying 6.18% SiO_2 only. Magnetic seperation tests with sized —10 mesh feed produced a combined non-magnetic product assaying 7.63% SiO_2. Anionic and cationic flotation tests produced concentrates respectively analysing 8.6% SiO_2 and 9.89% SiO_2. From the test results it may be noted that it was difficult to reduce the silica content to 3%.

B. KARNATAKA MAGNESITE

1. Kadakola Magnesite

The sample was received from M/s TISCO Ltd., for the reduction of silica content to less than 2.0%. The sample consisted of 100 mm to 15 mm lumps and analysed as follows:

Constituent	*Assay %*
MgO	38.40
CaO	2.00
CO_2	42.58
SiO_2	14.70
Al_2O_3	1.10
Fe_2O_3	0.09
S	0.03

Microscopic examination revealed the presence of the gangue minerals quartz, mica, amphiboles and some opaque minerals, which were liberated from magnesite at 65 mesh size.

Flotation tests employing 81.8% —200 mesh grind, with 1.0 kg/tonne of sod. silicate, 0.5 kg/tonne of sod.

oleate and 0.02 kg/tonne of pine oil produced a concentrate assaying 8.2% SiO_2 with 79.0% yield. After two cleanings using 0.5 kg/tonne of sod. silicate and 0.1 kg/tonne of Katha at each stage, the cleaner concentrate analysed 1.73% SiO_2 with 48.2% yield. Cationic flotation tests were not encouraging due to low yield.

C. U. P. MAGNESITE

1. Pithoragarh Magnesite

The sample was collected from Chandak, Pithoragarh area in U.P. and was received from M/s Orissa Industries Ltd., Rourkela, to reduce the SiO_2, CaO and Al_2O_3. The sample consisted of 20—120 mm lumps and analysed as follows:

Constituent	*Assay %*
MgO	43.65
CaO	3.01
SiO_2	0.99
CO_2	47.12
Al_2O_3	2.10
Fe	1.42
S	0.32
P	0.23

Examination of the sample under microscope revealed the presence of dolomite, calcite, talc, chlorite, iron oxides and pyrites.

Flotation concentrate produced under the optimum condition of 45.8% —200 mesh grind, 1.0 kg/tonne of sod. silicate, 0.75 kg/tonne of sod. oleate and 0.02 kg/tonne of pine oil—analysed 0.37% SiO_2 with 92.7% yield. After two cleanings using 0.25 kg/tonne of sod. silicate in each stage, the product analysed 0.35% SiO_2 with 73.2% yield. Use of Katha during the cleanings, reduced the CaO content from 3.11% in the rougher concentrate to 2.15% in the cleaner conc. with a yield of 67.8%.

Tabling flotation and magnetic separation tests conducted with a view to reduce the iron content were not successful. Washing tests did not help in reducing the alumina content of the sample.

1a. Pithoragarh Magnesite

The sample weighing about 8 tonnes was received from M/s. Orissa Industries Ltd., Rourkela for beneficiation studies. The ore in its as received state contained lumps of 100 mm to 400 mm and analysed as under. Complete chemical analysis of the sample was as follows:

Constituent	*Assay %*
MgO	42.21
CaO	4.04
SiO_2	1.31
Al_2O_3	2.23
Fe_2O_3	2.07
Total Fe	1.45
LOI	48.41

Minerological examination of the sample revealed that ferron-magnesite was the chief ore mineral followed by minor amounts of dolomite, calcite, talc, apatite etc. Iron is contributed by pyrite, pyrrhotite, goethite etc. Quartz, chert and sericite were also observed.

Chemical analysis of the sized —4 mesh products indicated that all the products coarser than 100 mesh did not show any difference in MgO contents but the —100 mesh fines analysed 39.90% MgO.

Heavy media separation tests at sp. gr. 2.8 to reduce the CaO content were not successful. Flotation tests with a feed passing 50% through 200 mesh screen using oleic acid emulsion and sodium silicate 1 kg each per ton produced a concentrate assaying 43.05% MgO 3.62% CaO and 1.17% SiO_2. The grade of the concentrate improved to 43.7% MgO 0.7% SiO_2, 2.93% CaO, and 1.4% Al_2O_3 after two cleanings with an overall MgO distribution of 67.2%. Flotation tests aiming at separation of talc from the feed were not successful. Use of alum as depressant for calcite yielded a grade of 43.7% MgO, 0.74% SiO_2 and 2.52% CaO, but the MgO distribution was only 45.4%. Direct magnetic separation and reduction roast followed by magnetic separation were not helpful in further reduction of iron content from the concentrate. This might be due to the fact that most of the iron was present in a chemically combined form.

D. RAJASTHAN MAGNESITE

The sample was received from the Director of State Mining and Geology Department, Rajasthan to reduce

the silica content to below 2%. The sample consisted of 100 mm to 15 mm lumps and analysed as follows:

Constituent	*Assay %*
MgO	41.49
CaO	3.65
CO_2	43.80
SiO_2	9.78
Al_2O_3	0.59
Fe	0.65
S	Trace.

Mineralogical examination of the sample indicated the presence of the gangue minerals like quartz and minor amounts of talc, chlorite, mica, pyroxene, lateritic and ochery minerals, which were liberated at 100 mesh.

Rougher flotation concentrate obtained under the optimum conditions of 58.6% —200 mesh grind, 1.0 kg/tonne of sod. silicate, 1.0 kg/tonne of sod. oleate and 0.02 kg/tonne of pine oil-analysed 4.9% SiO_2 with 73.9% yield. This product after three cleanings using 0.25 kg/tonne each of sod. silicate lactic acid and katha during first cleaning analysed 2.08% SiO_2 with 40% yield. Regrinding the rougher concentrate to 100 mesh followed by two cleanings produced a concentrate assaying 1.63% SiO_2 with 37.6% yield. Cationic flotation tests and gravity separation tests did not give any encouraging results.

TABLE 4.2—SUMMARY OF RESULTS OF BENEFICIATION OF MAGNESITE

State and Locality (1)	Assay % Feed (2)	Beneficiation Method (3)	Assay % Conc. (4)	Yield Wt. % (5)	Remarks (6)
Dolomite (Tisco)	28.6 CaO 20.2 MgO 4.22 SiO_2	Roughing and cleaning	30.4 CaO 21.25 MgO 1.75 Insol.	84.0	
Tamil Nadu					
Salem Magnesite I	44.51 MgO 2.85 SiO	Roughing and cleaning	1.48 SiO_2	73.5	
II	45.9 MgO 3.00 SiO_2	Roughing and two cleanings Cationic flotation with one cleanings	0.9 SiO_2 1.18 SiO_2	70.0 82.0	
III	44.9 MgO 4.1 SiO_2	Crushing and sizing at —12 mm +65	2.2		only screening
IV	45.86 MgO 3.90 SiO_2	Roughing and one cleaning Roughing and two cleanings	1.05 SiO_2 0.73 SiO_2	77.6 70.6	
-do- (Dead burned)	85.7 MgO 8.6 SiO_2	H.M.S. Mag. separation	6.18		
Karnataka					
Kadakola Magnesite	38.4 MgO 14.7 SiO_2	Roughing and two cleanings	1.73 SiO_2	48.2	
Uttar Pradesh					
Pithoragarh—I	43.65 MgO 0.99 SiO_2 3.01 CaO	Roughing and cleaning with Katha	0.35 SiO_2 2.15 CaO	67.8	
—II	42.21 MgO 4.04 CaO 1.31 SiO_2	Roughing and two cleanings	43.7 MgO 2.93 CaO 0.7 SiO_2 1.4 Al_2O_3	67.2	
Rajasthan					
	41.59 MgO 9.78 SiO_2	Roughing regrinding and cleaning with Katha and Lactic acid	1.63 SiO_2	37.6	

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