

Beneficiation of a limestone sample – A case study at NML

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ABSTRACT

Limestone deposits are widely distributed in India but high grade deposits are confined to Rajasthan, Gujarat and Jammu & Kashmir. Limestone is mainly used in the manufacture of cement, steel and chemical industries. High grade deposits are depleting and the requirement of the industry has to be met by beneficiating the low grade deposits.

The paper deals with the results of froth flotation studies carried out on a limestone sample from Kota, Rajasthan. The sample analysed 41.45% CaO and 13.52% SiO₂. Flotation experiments were conducted at different feed sizes, reagent dosages and cleanings. The final concentrate obtained at 86.2% -105 μm size analysed 50.15% CaO, 5.01% SiO₂ by using 3.6 kg/t sodium silicate and 1.0 kg/t oleic acid adopting flotation with four cleanings.

INTRODUCTION

Limestone deposits have a large spread in the geographical distribution and geological formations ranging from pre-Cambrian to tertiary periods and the notable deposits are found in Madhya Pradesh, Uttar Pradesh, Orissa, Andhra Pradesh and Gujarat^[1]. Limestone finds many uses like as a basic raw material for the production of cement and chemical industries and as a flux in the Iron & Steel Industry. The industrial specifications of the limestone^[2] are given in Table 1. Chemical industry requires high purity material and the high grade deposits are fast dwindling due to rapid consumption by the industry and the requirement of the industry is being met either beneficiating the low grade deposits or by imports. The later option is a costly proposition and hence the former option is widely accepted.

At National Metallurgical Laboratory, Jamshedpur, considerable research has been done on various types of limestone samples from different parts of the country. The limestone sample from Kota, Rajasthan has chosen for discussion in the present paper.

Table 1: Industrial specifications of Limestone

Industry	Constituents (%)						
	CaCO ₃	CaO	SiO ₂	Insols.	MgO	Fe ₂ O ₃	Al ₂ O ₃
Steel:							
BF	90.0	-	-	6.0	4.0 (max.)	-	-
SMS	-	49.0- 53.0	1.8 (Max)	4.0	-	-	2.0- 4.0
Cement	-	42.0 (Min)	12.0- 16.0	-	4.0 (Max)	-	1.0- 2.0
Chemical:							
Calcium							
Carbide	95.0- 97.0	-	1.0- 3.0	-	0.5	-	-
Bleaching							
Powder	96.0	-	Upto 1.5	-	2.0	-	-
Soda Ash	90.0- 99.0	-	Upto 3.0	-	0.0	-	-
Glass	-	55.2	-	-	-	0.04	-
Paper	-	45.0	-	-	3.0	-	-

SAMPLE

About 100 kg. of limestone sample from M/s. Shriram Cement Works, Kota, Rajasthan was received at National Metallurgical Laboratory, Jamshedpur for beneficiation studies. The sample received was free from fines and clayey matter. The lumps were hard, compact and whitish grey in colour.

Microscopic studies indicated that calcite was the predominating mineral associated with quartz, mica and minor amounts of limonite. Locking and liberation studies indicated that below 105 μm size calcite was liberated from the associated gangue.

Complete chemical analysis of the Head sample is given in Table 2.

Table 2: Chemical analysis of the sample

Constituents	Wt.(%)
CaO	41.5
SiO ₂	13.5
Al ₂ O ₃	4.0
Fe ₂ O ₃	2.5
MgO	1.9
LOI	36.6

RESULTS AND DISCUSSION

Initial flotation studies were conducted to determine optimum feed size for flotation. For this purpose 0.5 kg. of representative portions of 2 mm was taken and ground in a rod mill for different lengths of time. Each of the ground material was treated in a Fagergren Flotation Cell and the flotation conditions were given in Table 3. The concentrate of each of the experiment was subjected to four cleanings with 1.2 kg/t. of sodium silicate. The flotation results are presented in Table 4 to 6.

Table 3 : Flotation conditions

Quantity of the material taken for each experiment	.....	0.5 kg
Type of the flotation cell	.....	Fagergren Cell
Grinding mill	.....	Denver rod mill
Pulp density	.....	65% for grinding
Water	.....	Tap water

Reagent	Conditioning Time (mins.)	Roughing Process (kg/t)	Cleaning Process (kg/t)	Flotation Time (mins.)
Sodium Silicate	3	2.4	1.2	-
Oleic acid emulsion	2	1.0	-	2 for each cleaning

Table 4 : Flotation results at 75.5% -105 μ m

Products	Wt.(%)	Assay (%)		Dist. (%)	
		CaO	SiO ₂	CaO	SiO ₂
Cl. Conc.	20.6	46.10	5.80	23.2	8.6
Cl. Tails-IV	13.5	45.30	9.06	14.9	8.8
Cl. Tails-III	16.2	44.20	9.84	17.5	11.4
Cl. Tails-II	15.7	44.80	11.20	17.1	12.6
Cl. Tails-I	19.7	42.70	14.80	20.5	20.9
P. Tails	14.3	19.60	36.68	6.8	37.7
Head (Calc)	100.0	41.02	13.93	100.0	100.0

From Table 4 it can be observed that the silica was reduced to 5.80% in the cleaner concentrate. Further experiment was conducted at 86.2% -105 μ m and the results are tabulated in Table 5.

Table 5 : Flotation results at 86.2% -105 μ m

Products	Wt.(%)	Assay (%)		Dist. (%)	
		CaO	SiO ₂	CaO	SiO ₂
Cl. Conc.	49.9	50.15	5.01	59.0	18.9
Cl. Tails-IV	8.0	46.20	9.63	8.7	5.8
Cl. Tails-III	6.0	44.88	10.64	6.3	4.8
Cl. Tails-II	9.2	42.11	12.46	9.2	8.7
Cl. Tails-I	12.8	37.56	17.96	11.3	17.4
P. Tails	14.1	16.70	41.41	5.5	44.4
Head (Calc)	100.0	42.45	13.19	100.0	100.0

It was noted that the silica was lowered to 5.01% and CaO was upgraded to 50.15% with an yield of about 50.0% in the cleaner concentrate. The flotation experiment was further conducted at 92.0% -105 μ m size and the results are given in Table 6.

Table 6 : Flotation results at 92.0% -105 μ m

Products	Wt.(%)	Assay (%)		Dist. (%)	
		CaO	SiO ₂	CaO	SiO ₂
Cl. Conc.	33.5	50.50	4.85	40.1	12.4
Cl. Tails-IV	10.6	47.24	8.18	11.9	6.6
Cl. Tails-III	13.5	45.39	9.03	14.5	9.4
Cl. Tails-II	13.2	42.09	11.46	13.2	11.5
Cl. Tails-I	17.6	37.51	16.83	15.7	22.6
P. Tails	11.6.	16.79	42.39	4.6	37.5
Head (Calc)	100.0	42.15	13.10	100.0	100.0

It was observed that finer grinding show marginal reduction in silica content with an adverse effect on the yield.

CONCLUSIONS

The limestone sample from Kota, Rajasthan was analysed 41.45% CaO, 13.52% SiO₂. Calcite was abundant mineral associated with quartz, mica and minor amounts of limonite as gangue minerals. The locking and liberation studies indicated that the calcite was liberated from the gangue at a size below 105 µm size.

The gravity methods of separation as a pre-concentration method didn't yield encouraging results and hence froth flotation technique was chosen to reduce the silica content. Flotation studies indicated that at a grind of 86.2% -105 µm size, a concentrate obtained analysed 50.15% CaO, 5.01% SiO₂ with an yield of about 50.0%. The concentrate thus obtained was quite suitable for the use in the industry.

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