Flotation studies on low grade magnesite deposits from Sujikonda near Daroji Bellary district, Karnataka state

* P. Gopala Reddy * R. Nijagunappa, * G. S. Kumar
* S. J. Gopala Krishna, * M. R. Patil and
* B. Somasekar

INTRODUCTION :

Magnesite, an important basic refractory raw material, has been in short supply in recent years. To find an alternative to high cost-low boron containing sea water magnesite, users have been looking more towards sources of a natural magnesite. Magnesite ($MgCO_3$) is commonly found in granular, compact earthy masses occurring as amorphous or crystalline deposits. The amorphous type of deposits are the most common variety found as veins in serpentine rocks. The low grade ores produced do not meet the chemical purity required by the consuming industries (Table—1). The low grade ores have to be upgraded by physical beneficiation methods to render them usable, besides, conserving high grade reserves of magnesite. In view of the proposed Vijayanagara steel plant in Toranagallu, the occurrence of Sujikonda magnesite deposit close to the steel plant attains greater significance. The magnesite deposit of Sujikonda area is of low grade with MgO = 29.60 wt.% ; CaO = 5.61 wt. %; SiO_2 = 3.84 wt. %; and R_2O_3 = 31.04 wt. %. In the present investigation the authors carried out experiments to understand the flotation behaviour of low grade magnesite.

Mode of occurence of Sujikonda magnesite :

The magnesite deposit of Sujikonda near Daroji occurs as veins in the south-eastern part of the Toranagallu ridge and are exposed for a length of about 7 km. The veins of magnesite range from a few millimeters to tens of millimeters in width and cut across the ferruginous quartzite and chlorite schist. At places the veins assume the form of boulders. Prospecting in this area indicated the veins are confined to a depth of only 4 to 5 metres from the surface.

Experimental study :

The representative sample of magnesite was crushed in jaw crusher, followed by size separation in a Ro-tap sieve shaker 300 to 53 microns. These were then analysed for magnesium, calcium, and silica. The study of chemical analysis indicates that the miximum concentration of MgO is in the $-250 + 150$ microns size range and the results are incorporated in Table—2. The specific gravities of the intergrown siliceous impurities and the values are very close. The maximum MgO concentration in the size range and the close specific gravity of the values and gangue led to the selection of flotation as a process for beneficiation.

FLOTATION STUDIES :

Procedure :

The flotation studies were carried out in 2-litre Denver-type cell at a pulp density 25% solids by wt., frother dosage 0.05 kg./ton, and conditioning and collection time 5 minutes were kept constant in all the experiments. Sodium oleate,

* *Department of Geology and Mineral Processing, Gulbarga University, P. G. Centre, Nandihalli - Sandur 583119, Bellary District, Karnataka State.*

terpineol, sodium silicate, and sodium hydroxide were used as collector, frother, depressant, and pH modifier respectively. The tests were conducted to study the effect of feed size variation, collector concentration, pH variation, and depressant variation on the recovery of MgO. The factorially designed experiments were also conducted to establish the interaction of the variables and optimise the parameters of the operation.

RESULTS AND DISCUSSION :

Effect of feed size :

Experiments conducted at pH 10, 0.5 kg/ton, of sodium oleate as a collector revealed that the recovery increased with the decrease in the particle size. The grade (% MgO) is poor for the size ranges −300 + 250 microns and −150+105 microns. The −250+150 microns size range gives better result as is evident from Table—3, Fig.—1-A both with respect to grade and recovery. Experimentation by factorial design on flotation of different ores has indicated that the size factor is highly significant. The fall in recovery at coarser sizes is due to incomplete liberation and smaller contact angle and too violent agitation.

Effect of collector concentration :

From the experiment conducted by varying the collector concentration (Table—4) with all other parameters kept constant, the recovery was found to increase with the concentration of collector (Fig. 1-B). However, statistically designed experiment revealed that the collector concentration is the second significant factor. The gradual increase in the recovery with the increase of collector concentration is due to the gradual increase in the contact angle, greater sorption at higher concentration due to rapid reaction, and rapid approach of the exchange adsorption equilibrium at higher concentration.

Effect of pH of the pulp :

Flotation experiments conducted at the pH levels of 8, 10, and 12 (Table—5) indicated that the recovery increases with pH values. The factorially designed experiments revealed the pH has little significance. The grade of concentrate increased with the pH upto 10 and declined at higher values (Fig. 1-C). Though the recovery was high at pH of 12, the pH of 10 was selected as one of the optimum conditions for obtaining the higher grade.

Effect of depressant :

Factorially designed experiments using tanic acid as depressant (0.1 kg/ton to 0.625 kg/ton) showed that the depressant has no significance in the recovery.

Statistical analysis of variables :

The variables and the levels for the three factor statistical analysis for two levels to investigate the effect of the variables on the recovery is given in Table—6. It is found that at constant particle size, the collector concentration is the only significant factor in the recovery, whereas, the pH and the concentration of depressant are of little significance. The maximum recovery was found at a pH of 12, 0.5 kg/ton of collector concentration, and without depressant.

Conclusions :

1. The investigation carried out on the Sujikonda magnesite suggests that the magnesite is amenable to flotation and by this technique the magnesite was upgraded by about 18% MgO with an appreciable reduction in CaO.

Feed	:	Concentrate
MgO : 22.57 %	:	40.98 %
CaO : 5.6 %	:	1.19 %

2. The optimum conditions determined from the flotation experiments are given below :

   i. pH of the pulp : ≤12 >10 (10 to 12)

   ii. Collector concentration : 0.5 kg/ton.

iii) Feed size : — 250 + 150 microns.

iv) Pulp density : 25 % solids by weight of ore.

v) Frother concentration : 0.05 kg/ton.

vi) Depressant concentration : 0.14 kg/ton.

vii) Collection time : 5 minutes.

viii) Conditioning time : 5 minutes.

3. The study suggests that the upgraded magnesite can be used for rubber industry.

Table — 1 : Specification for magnesite in rubber and refractory industry

Particulars	Rubber	Refractory (Steel)	Refractory (Basic)
MgO %	40—43 % (Min)	85% (Max.)	55% (Min.)
CaO %	1.0 % (Max.)	2.5% (Max,)	—
R_2O_3 %	0.1 % (Max.)	—	—
SiO_2 %	—	2.0% (Max.)	—
True Sp. Gr.	—	3.5% (Min.)	—
Cr_2O_3	—	—	6% (Min.)
Apparent Porosity	—	24% (Max.)	24% (Max.)
Refractoriness	—	1550°C (Min.)	1550° C (Min.)
Crushing strength (kg./cm^2)	—	—	400 kg./cm^2 .
Tolerance in size	—	± 1.5% of mm	—
L. O. I.	58% (Max.)	—	—

Table — 2 : Distribution of % MgO, CaO, SiO_2 and R_2O_3 at different sizes.

Sl. No.	Size in microns	MgO %	CaO %	SiO_2 %	R_2O_3 %
1.	+ 300	17.78	2.803	6.38	41.00
2.	– 300 + 250	20.16	5.048	4.32	25.74
3.	— 250 + 150	22.57	2.920	3.92	31.24
4.	— 150 + 105	18.55	4.476	7.24	28.96
5.	— 105 + 75	19.76	5.048	6.54	38.88
6.	— 75 + 53	13.71	5.608	7.70	29.10
7.	— 53	16.90	5.608	7.12	28.28

Table — 3 : Effect of feed size

Sl. No.	Feed size (in Microns)	'F' Feed wt. in gms	'C' Conc. wt. in gms	Tailing wt. in gms	'f'% MgO in feed	'c'% MgO in Conc.	%CaO in feed	%CaO in Conc.	% Recovery Cc/Ff×100
1.	–300+250	375	19	356	20.16	39.97	5.048	4.38	10.03
2.	–250+150	375	99	276	22.57	40.98	2.920	1.19	48.00
3.	–150+105	375	100	275	18.55	36.54	4.476	2.41	52.45

Table — 4 : Effect of collector concentration

Sl. No.	Conc. of Collector kg/ton	'F' Feed wt. in gms	'C' Conc. wt. in gms	Tailing wt. in gms	'f' % MgO in feed	'c'% MgO in Conc.	%CaO in feed	%CaO in Conc.	%Recovery Cc/ Ff×100
1.	0.1	375	88	287	22.57	41.99	2.290	1.90	43.0832
2.	0.3	375	99	276	22.57	40.57	2.290	1.78	47.3800
3.	0.5	375	103	272	22.57	40.91	2.920	1.16	49.7800

Table — 5 : Effect of pH

Sl. No.	pH	'F' Feed wt. in gms.	'C' Conc. wt. in gms.	Tailing wt. in gms.	'f'% MgO in Feed	'c' % MgO in Conc.	%CaO in feed	%CaO in Conc.	%Recovery C c/ Ff×100
1.	8	375	215	160	22.57	25.00	2.920	2.10	47.00
2.	10	375	272	103	22.57	40.98	2.920	1.19	49.72
3.	12	375	231	144	22.57	37.14	2.920	1.84	63.03

Table — 6 : Statistical analysis of variation of concentration of collector, pH of the pulp and concentration of the depressant by two factorial design methods

		Base (o)	High (+)	Low (—)	Step
Collector	a	0.03	0.5	0.1	0.2
pH	b	10.0	12.0	8.0	2.0
Depressant	c	0.3125	0.625	0.0	0.3125

Level	Code	%R	1	2	3	$3^2/8$ (Mean)	
— — —	1	40.3	87.30	188.92	389.84	—	
+ — —	a	47.0	101.62	170.88	36.48	166.35	Significant (Probable factor)
— + —	b	56.38	92.38	— 4.4	0.44	0.02	Insignificant
— + +	bc	45.28	78.50	40.88	−44.98	40.68	— do —
— — +	c	29.30	6.70	14.32	−18.04	40.68	Mean variance = 151.81
+ + —	ab	63.08	−11.10	−13.88	45.28	256.38	
+ — +	ac	35.70	33.78	−17.80	−28.20	99.40	
+ + +	abc	42.80	7.10	−26.68	− 8.88	9.86	

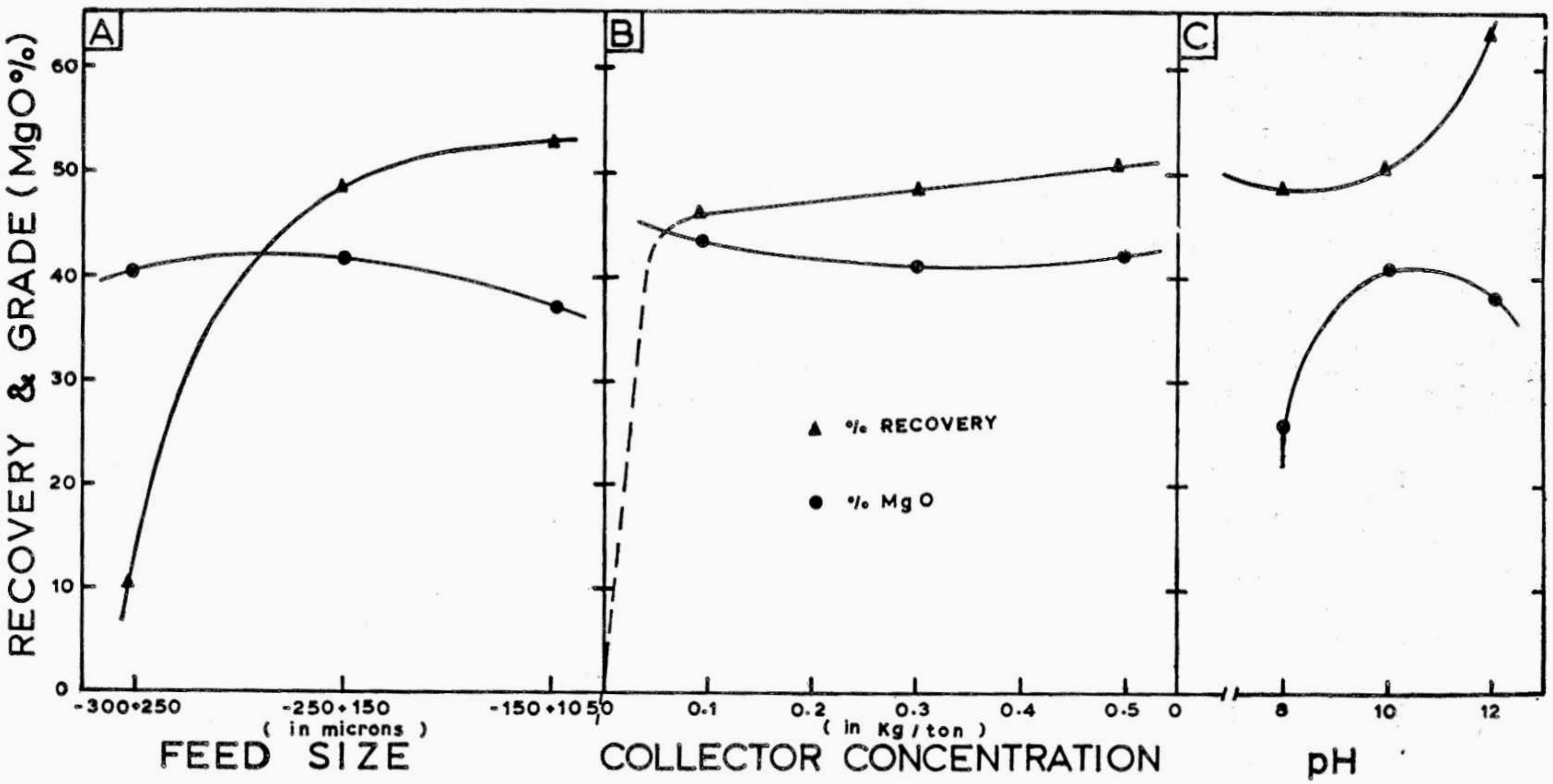
RECOVERY & GRADE (MgO%)
A
B
C
% RECOVERY
% MgO
-300+250
-250+150
-150+105
(in microns)
FEED SIZE
0.1
0.2
0.3
0.4
0.5
(in Kg / ton)
COLLECTOR CONCENTRATION
pH

FIG-1

D. P. Patil,
I. I. Sc., Bangalore

Question 1 : You told that the recovery is decreased due to the small contact angle ? How did you know that the contact angle is small ? If at all you measured the Contact angle, which method you have used ? I think contact angle of the order of 7° is sufficient to float the mineral even in turbulent conditions ? Please clarify,

Author : While studying particle size variation, we conducted few experiments to measure the contact angle by buble pick-up method. We found that recovery decreased at coarser sizes, it may be due to small contact angle. As you said the contact angle of the order of 7° is sufficient to float the mineral even in turbulent condition. In turbulent conditions the chances of collision are better than dilute suspension by more than a proportionate factor, because of the increased deviation in properties of the liquid from those of a perfect liquid.