IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 5, Issue 5, Oct - Nov, 2017
ISSN: 2320 – 8791 (Impact Factor: 2.317)
www.ijreat.org

Flotation Studies of low Grade Iron Ores of Kamatagi Area, Hunagund Schist Belt, Karnataka in Comparison With Goan Iron Ores, India.

Anand.V.Kulkarni[1], Rashmi.M.Upadhya[2], Sanjay.M.Hiremath[3], G.Subbarao[4]

[1] **Manager Geology,Hospet Steel Limited, Koppal, Karnataka.**

[2,3] **Department of Studies in Geology, Karnatak University, Dharwad, Karnataka**

[4] **Department of Civil Engineering, NNR Group of Institutions, Hyderabad, Andhra Pradesh.**

Abstract

The iron ore fines of Kamatagi, Karnataka and Codli, Goa area are found to be originated in different paragensis. An effort of beneficiation employing the technique of flotation has been made on these low grade non magnetic iron ores of Kamatagi and Codli area, to improve their quality and thereby increasing the economic value of these waste bye-products.

Keywords: *Blue dust, Flotation, Pelletisation, induration*

1. Introduction

The low grade iron ores of Kamatagi area,Huagund schist belt, Karnataka and iron ores of Codli mines ,Goa have been investigated for upgradation by flotation process. The occurrence of iron ores in both of these deposits differ in paragensis, as iron ores of Kamatagi area are derived from preexisting banded iron formations, where as the iron ores Codli are formed by the replacement of phyllites by iron oxide. Hence, an attempt has been made to beneficiate both the iron ore fines by flotation technique to make them suitable for ferrous industries. Both of these iron ores are of low grade in nature and do not have any market value. In order to check their suitability for flotation, many techniques have been adopted to determine the mineragraphy, petrography, chemical analysis, trace elements study and infra red study. Flotation involves the chemical treatment of ore pulp forming a stabilized froth, which is skimmed off while other gangue minerals remain submerged in the pulp, which is governed by multitude of physicochemical complexities.

2. Study area

In this attempt of comparative studies of iron ores of two different paragensis regions namely Kamatagi area covered under Hunagund taluk, Bagalkot District, Karnataka lying between longitude 75^0 40' to 75^0 55' East and latitude 16^0 5' to 16^0 15' North, falling under Survey of India toposheet 47 P/11,12 and 16 and similarly Codli deposits occurring between Dauconda in north and Quirapale in the south falling between longitude 78^0 8' E 15^0 21'N in the Survey of India toposheet number 48 I/3 in the state of Goa,India, have been carried out.

3. Methodology

Field investigations were carried out in both areas to understand the geology and representative samples were collected for flotation tests. The representative samples were initially checked for different constituents and liberation of Fe from undesired constituents. Samples were subjected to petrographic studies, mineragraphic studies, infra red spectroscopic (IR) studies, chemical analysis and comminution studies before subjected to floatation tests.

4. Results and Discussion

Geologically the Kamatagi hill ranges comprising of crystalline rocks belonging to Peninsular gneisses, adjacent to the area covered by iron ores and banded quartzites of Dharwar super group, which are overlain by Kaladagi group of rocks. Similarly Codli deposits of iron ore are present on the crust and on the dip and scrap slopes on low mounds. The blue dust types of iron fines are of porous nature and must have been formed due to residual concentration from the pre existing banded ferruginous quartzites.

The study of polished samples of Kamatagi area, shows different textural feature and minerals encountered magnetite, martite, hematite, speculrite goethite and limonite. Similarly the iron ores of Kodli area are made up of Hamatite, Magnetite, Limonite and Goethite. The iron ores of Kamatagi are not due to hydrothermal activity as there is no evidence of wall rock alteration and evidence of replacement of silica by iron is not noticed. The Kamatagi Deposits might have been formed due leaching of silica, redeposition of iron and residual enrichment. Similarly, the Codli iron ore deposits of Goa are found to be due to residual concentration by leaching down of silica and concentration of iron oxide and replacement of the associated phyllites.

The infrared spectra analysis studies of both iron ores are very similar particularly in the region 500 to1500 cm-1. The iron absorption are in the lower frequency region for hematite than for alumina. The strong bands in the region 1100 to 500 cm^{-1} with bands centered on 467,547 and 1029 cm^{-1} appeared to be characteristic of iron ores containing predominantly hematite, thus IR spectra of iron ores area very similar in the region of 1100 to 500 cm^{-1}. The silica separated from BHQ is comparable to those of alpha quartz with the bands occurring around 467 cm^{-1} .The band occurring around 1060 cm^{-1}, 1050 cm^{-1} and 1000 cm^{-1} are indicative for the presence of alumina.

The geochemical analysis of iron ores (Table-1) have Fe_2O_3, SiO_2, Al_2O_3 as dominant oxides in both the areas. Laminated lateritic and goethitic ores are of secondary nature, where as massive ore is primary. Nickel values are high in limonitic ores when compare to other types of ores. Heterogeneity in the content of trace elements like Cu, Ni, Pb in different iron ores is observed which may be due to leaching.

The liberation studies (Table 2, 3, 4 and 5) were carried out on both the iron ores of Kamatgi as well Codli areas. The results of partial chemical analysis of each sieve fraction indicates that the sieve fraction of -70 +100# of Codli ore and -150+200# of Kamatagi ore shows iron and gangue minerals completely liberated. Hence, these fractions were considered for floatation studies to separate iron minerals from associated gangue i.e., silica.

The iron samples of Kamatgai and Codli areas were subjected floation studies and experiments were conducted to optimize the collector dosage, where MIBC is used as frother and sodium silicate as depressant for silicate minerals. It is observed that in case of Kamatagi hematite ores, -200# gives more recovery compare to -140#. In case of Codli blue dust fines 0.05 kg /ton collector dosage, the Fe is 6.099% and recovery 71% . The reagents gave better results with Kamatagi ores when compared to Codli blue dust. In Kamatagi low grade iron ores have shown improvement from feed assay 58.43% Fe to 66.92% Fe in the recovered products, also BHQ of Kamatagi could be upgraded by flotation from 39.24 % Fe to 74.89%Fe recoveries by adding 0.020kg/ton collector dosage (Table 6 to 12).

5. Conclusions

A comparative study of beneficiation study employing flotation technique to upgrade the low grade iron ores of Kamatagi area, Karnataka and Codli, Goa were carried out. Assessing the mineragraphy, infrared absorption spectroscopic studies, geochemistry and floatation tests. Mineragraphic characteristic of both iron ore reveal hematite as primary mineral which is again conformed by geochemical analysis indicating dominance of Fe2O3 followed by SiO_2, Al_2O_3, CaO and MgO. The comminution studies revealed liberation Kamatagi ores in the size range of -150 to +200# and similarly Codli iron ore liberated in the size range of -70+100#. The low grade iron ores of Kamatagi are amenable for floatation studies. The fraction of -200# gives more recovery than -140# blue dust of Codli with 0.05kg /ton of collector dosage the recovery is 71%.

Acknowledgments

The authors thank to Chairman, Dept of Studies in Geology for providing all the necessary laboratory facilities to carry out this work.

Table-1: Details of Geochemical analysis showing major and trace elements content

Sample No & area	Formation	Fe_2O_3 %	SiO_2 %	Al_2O_3 %	CaO %	MgO %	LOI %	Cu	Ni	Zn	Mn	Pb
1-Kamatagi	BHQ	35.11	62.02	0.3	1.14	0	ND	1.74	1.80	2.11	10.51	32.08
2-Kamatagi	BHQ	39.26	60.79	0.94	0.71	0	ND	2.90	7.13	2.32	18.26	23.75
3-Kamatagi	Laminated ore	82.85	5.09	7.79	2.26	0	1.6	1.60	18.24	2.23	4.10	23.92
4-Kamatagi	Laminated ore	94.02	2	1.79	0.56	0.2	1.6	1.74	10.22	2.26	3.88	20.83
5-Kamatagi	Massive Hematite ore	98.67	3.2	1.86	0.85	0	1.2	0.20	2.47	1.95	3.47	20.83
6-Kamatagi	Massive Hematite ore	95.86	1	1.19	0.85	0	1.5	3.48	12.56	2.18	-	15.50
7-Kamatagi	Flakey ore	92.59	5.48	1.77	0.28	0.3	1.8	2.16	2.00	2.27	7.96	20.83
8-Kamatagi	Flakey ore	92.95	5.22	2.87	1.41	0.4	2.4	1.30	6.67	1.84	15.61	20.87
9-Kamatagi	Lateritic ore	81.15	11.58	4.31	0.28	0.2	4.8	3.75	11.33	4.78	20.20	54.67
10-Kamatagi	Lateritic ore	67.57	15.72	10.09	1.12	0	4.8	5.80	13.55	3.70	25.20	50.00
11-Kamatagi	Goethitic Ore	76.89	8.54	6.1	2.26	0.41	1.8	1.93	14.04	2.17	8.37	26.67
12-Kamatagi	Goethitic Ore	82.92	6.9	9.94	1.69	0	3.6	2.90	6.33	2.24	6.12	20.92
13-Codli	Blue dust	90.3	1.87	2.03	0.92	0.72	-	1.45	3.55	1.63	65.00	18.33
14-Codli	Limonitic Ore	82.38	3.78	6.72	0.77	0.46	-	4.35	31.11	2.10	35.71	14.33
15-Codli	Hematite ore	88.71	3.8	6.58	0.87	0.78	-	2.03	0.24	1.70	173.37	7.71

Table-2: Dry feed sieve analysis of Kamatagi iron ore

Mesh Size	Wt' retained in Grams	Wt'% retained	Cum Wt'% retained	Cum Wt'% passing
+20	0	0	0	100
-20+45	24.68	24.68	24.68	75.32
-45+70	17.39	17.39	42.07	57.93
-70+100	14.34	14.34	56.41	43.59
-100+150	14.95	14.95	71.36	28.64
-150+200	15.69	15.69	87.05	12.95
-200	12.95	12.95	100	0
Total	100			

```

Table-3: Dry feed sieve analysis of Codli iron ore (Blue dust)

| Mesh size | Wt' retained in Grams | Wt'% retained | Cum Wt'% passing | Cum Wt'% |
|---|---|---|---|---|
| +20 | 0 | 0 | 0 | 100 |
| -20+45 | 17.8 | 8.98 | 8.98 | 91.02 |
| -45+70 | 23.64 | 11.92 | 20.90 | 79.10 |
| -70+100 | 58.39 | 29.45 | 50.36 | 49.64 |
| -100+150 | 41.99 | 21.18 | 71.54 | 28.46 |
| -150+200 | 36.24 | 18.28 | 89.82 | 10.18 |
| -200 | 20.19 | 10.18 | 100.00 | 0 |
| Total | 198.25 | | | |

Table-4: Partial chemical analysis of sieve fractions of Kamatagi iron ore

| Mesh Size | Wt'% retained | Assay % | | Distribution % | |
|---|---|---|---|---|---|
| | | Fe % | $SiO_2$% | Fe % | $SiO_2$% |
| +20 | 0 | 0 | 0 | 0 | 0 |
| -20+45 | 24.68 | 60.87 | 11.13 | 25.73 | 21.31 |
| -45+70 | 17.39 | 54.8 | 16.28 | 16.32 | 21.97 |
| -70+100 | 14.34 | 55.48 | 15.33 | 13.63 | 17.06 |
| -100+150 | 14.95 | 58.16 | 14.27 | 14.9 | 16.55 |
| -150+200 | 15.69 | 59.42 | 11.53 | 15.97 | 14.04 |
| -200 | 12.95 | 60.66 | 9.02 | 13.45 | 9.07 |
| Total | 100 | | 100 | 100 | |
```

Table-5: Partial chemical analysis of sieve fractions of Codli iron ore

Mesh Size	Wt'% retained	Assay %		Distribution %	
		Fe %	SiO_2%	Fe %	SiO_2%
+20	0	0	0	0	0
-20+45	8.98	60.89	10.01	8.81	15.91
-45+70	11.92	61.24	9.58	11.76	20.22
-70+100	29.46	61.83	5.64	29.34	29.42
-100+150	21.18	62.87	4.31	21.45	16.16
-150+200	18.28	62.09	3.67	18.28	11.88
-200	10.18	63.17	3.56	10.36	6.41
Total	100		100	100	

Table-6: Flotation of Kamatgi low grade iron ore (140#)

Collector dosage	Products	Weight %	Fe %	Recovery Fe%
0.25 kg/t	Float-1	42.42	58.48	41.60
	Tail-1	57.48	60.58	58.39
	Calc (Head)		59.62	
0.50 kg/t	Float-2	57.50	57.92	55.94
	Tail-2	42.50	61.71	44.05
	Calc (Head)		59.53	
0.75 kg/t	Float-3	54.47	57.80	52.56
	Tail-3	45.53	62.39	47.43
	Calc (Head)		59.88	

Table-7: Details of Cleaner stage products of Kmatagi(140#)

Products	Weight %	Fe%	Fe recovery %
Bulk rougher tails	-	61.67	-
Cleaner tails-1	14.39	54.73	12.30
Cleaner tails-2	21.22	62.74	20.78
Iron concentrate	64.39	66.58	66.92

Table-8: Flotation of Kamatagi low-grade Iron ore (200#)

Collector dosage	Products	Weight %	Fe %	Recovery Fe %
0.25 kg/t	Float-1	55.45	59.18	54.39
	Tail-1		60.64	45.61
	Calc (Head)		59.83	
0.5 kg/t	Float-2	66.33	60.39	65.51
	Tail-2	33.67	62.62	34.49
	Calc (Head)		61.14	
0.75 kg/t	Float-3	61.50	58.67	60.22
	Tail-3	38.50	61.89	39.78
	Calc (Head)		59.90	

Table-9: Details of Cleaner stage products of Kmatagi (200#)

Products	Weight %	Fe%	Fe Distribution%
Bulk rougher tails	-	61.54	-
Cleaner tails-1	21.57	58.08	21.10
Cleaner tails-2	14.38	59.20	14.31
Cleaner tails-3	9.80	60.19	9.92
Iron concentrate	54.25	59.89	54.67

Table-10: Flotation of Kamatgi BHQ at different feed size

Feed size in mesh	Products	Weight %	Fe%	Recovery Fe%
-70+100	Float-1	32.69	53.64	38.92
	Tail-1	67.31	40.89	61.08
	Calc (head)		45.00	
-100+140	Float-2	43.57	58.23	47.75
	Tail-2	56.43	49.19	52.25
	Calc (head)		53.00	
-140+200	Float-3	51.96	61.44	52.81
	Tail-3	48.04	59.36	47.19
	Calc (head)		60.00	
-200+270	Float-4	53.24	63.96	55.06
	Tail-4	46.76	59.42	44.94
	Calc (head)		61.50	

Table-11: Flotation of Kamatgi BHQ at different collector dosage

Collector Dosage	Products	Weight %	Fe %	Recovery %
0.05kg/t	Float-1	48.08	63.91	55.03
	Tail-1	51.92	48.36	44.97
	Calc (head)		55.00	
0.10kg/t	Float-2	54.89	74.38	60.10
	Tail-2	45.11	60.21	39.99
	Calc (head)		67.50	
0.15kg/t	Float-3	63.53	75.19	67.60
	Tail-3	36.47	62.89	32.40
	Calc (head)		68.55	
0.20kg/t	Float-4	69.19	80.13	74.89
	Tail-4	30.81	60.34	25.11
	Calc (head)		74.00	

Table-12: Flotation of Codli Iron ore (Blue dust)

Collector Dosage	Products	Weight %	Fe %	Recovery %
0.05kg/t	Float-1	27.8	64.6	29.00
	Tail-1	72.2	60.99	71.00
	Calc (head)		62.00	
0.10kg/t	Float-2	28.0	65.5	29.58
	Tail-2	72.0	60.63	70.42
	Calc (head)		58.80	
0.15kg/t	Float-3	13.4	64.9	14.22
	Tail-3	86.4	61.5	85.77
	Calc (head)		59.65	
0.20kg/t	Float-4	14.0	65.1	14.81
	Tail-4	86.0	61.49	85.18
	Calc (head)		61.00	

References

[1] S.K.Banerjee, B.V.S.Yadavalli, G.V.Subramanya and P.I.A Narayanan," Beneficiation and Pelletisaion studies on iron ore fines from Pale mines, Goa, NML/IR/275/63, 1963.

[2] S.Biswas, et.al."Beneficiation on a low grade iron ore sample"M/S EMCO Goa Pvt .Ltd. NML/IR/905-76.

[3]Y.H.Desai, "Petrological and beneficiation studies of Limestone formations of Malkhed and surrounding areas, Gulbarga dist., Karnataka", Ph.D thesis, Gulbarga University, Gulbarga, Inida, 2001.

[4] T.Singh, et.al."Beneficiation of low grade lumpy ore from Codli mines" M/S Goa.Pvt .Ltd. NML/IR/851/71.1975

[5] W.I.Warhs, Principles of Flotation,Austr.Inst.Mining and Metallurgy. 1955.

[6] E.A.Alexandrov, "The Precambrian banded iron formations of the Soviet Union," Econ.Geol, vol.68, pp.1035-1062, 1973.

[7] V.Divakar,S.M.Naqvi,K.Satyanarayan and S.M.Hussain "Geochemistry and origin of peninsular gneisses of Karnataka"Geol,Soc.Ind.Vol.15(3),pp.270-274,1974.

[8] D.K Dutta et,al.,"Proceedings of International symposium on beneficiation and agglomeration (Eds)P.K.Jena et.al., IIM Bhubneshwar and RRL Bhubneshwar",pp.405,1986.

[9] E.A.Alexandrov,"The Precambrian banded iron formations of the Soviet Union ," Econ.Geol, vol.68,pp.1035-1062,1973.

[10] G.C.Amstutz., "Microscopy applied to mineral," Colo.School Mines. vol .56,pp.443-484,1961.

[11] A.V.Kulkarni,"Pelletisation of iron fines of Sandur Hospet Bellary sector, Umpublished Ph.D thesis submitted to Gulbarga University, Karnataka.2000.

[12] N.J.Beukes,"Precambrian banded iron formations of southern Africa,"Econ.Geol, vol.68,pp.960-1004,1973.

[15] H.N.Bhattacharya and A.P. Chattarjee, "Geology of the iron formations of Chitraduga greenstone belt,Karnataka,India" Indian ,Minerals,vol.44,pp.141-150.

[16] S.K.Banerjee,B.V.S.Yadavalli,G.V.Subramanya and P.I.A.Narayanan," Beneficiation and Pelletisaion studies on iron ore fines from Pale mines, Goa, NML/IR/275/63, 1963.

[17] C.Bryk and W.K.Lu, "Iron making and steel making," vol.12, No. 2, pp.70-74.

[18] E.N.Cameron, "Ore microscopy"Jhon Wiley and Sons, New York, 1961.

[19] R.Chester and H.Elderfield. "The infrared determination of total Carbonate in marine Carbonate rocks" Ore microscopy"Bull, America Assoc, Petrol, Geologists, vol.49, pp.258-276, 1966.

[20]M.N.Dastur. "The economic aspects of iron ore in India, 1964..

[21] T.C.Devaraju,K.S.Ananthmurthy and S.D.Khanadali "Iron formations of the Chiknayakanhalli schist belt,Tumakur dist., Karnataka State, India, In group discussion on Precambrian banded iron formations of India" Geol. Soc.Ind.Vol.15(3),pp.270-274,1985.