vedanta sesa goa iron ore

Beneficiation Study on Black Mountain Mines Zinc tailings for Iron Recovery

Introduction

During some internal discussion with Black mountain, zinc international team, we came to know about the presence of iron content in zinc tailing. It was felt that Sesa Goa Limited can help Black mountain to conduct a bench scale study on the recovery of magnetite (iron ore) from their zinc tailings.

The BMM delivered a total of three sample bags of bulk 100kgs quantity to SGL for test work.

NOTE- These test work results are purely based on the sample submitted by BMM. For any project feasibility it is always advisable to go for representative sampling of tailing dam /dump.

Test work

We started with

1. 100% chemical analysis ,
2. Physical size distribution
3. Fractional analysis
4. Davis tube test work.(as received sample& for different size fractions)-
5. LIMS Test work (as received sample & for different size fractions)
6. WHIMS test work at different intensities.(as received sample& for different size fractions)

Physical and Chemical studies

Zinc tailing samples supplied by BMM, SOUTH AFRICA was mixed thoroughly and sampled. A representative sample was prepared by standard techniques and analyzed for its chemical contents. The received sample was subjected to wet size analysis .The table 1 shows the size and chemical analysis of each size. Table 2 shows chemical characteristics of the sample.

Table 1: Physical size Distribution& fractional analysis.

Sieve size	wt.%	Fe%	Sio2%	Al2o3%	Feo%	Mn%
+1mm	0.47	11.92	65.64	5.81	9.20	0.43
-1 +32 #	0.93	11.92	65.93	4.08	7.90	0.30
-32 +60 #	2.44	10.93	61.97	4.31	10.06	0.63
-60 +80 #	3.19	24.95	41.70	5.06	19.69	0.86
-80 +100 #	11.19	25.23	41.03	4,51	17.39	0.96
-100 +150#	13.58	38.97	25.19	3.98	24.00	0.92
-150 +200 #	14.66	44.58	20.56	4.12	24.29	1.11
-200 +250 #	14.87	50.47	15.54	3.76	24.72	0.79
-250 +325 #	2.63	46.54	19.60	3.79	22.99	0.66
-325 +400 #	3.40	50.61	16.89	3.14	24.72	0.74
-400 #	32.63	45.42	20.27	3.85	24.00	1.09
Total Head	100.00	41.15	24.81	3.50	22.71	0.96

The Table no.1 indicates that 80% of the material is below 100#.The data indicates that iron content as well as Feo is lower in coarser fractions (above 60#) compared to finer fraction. The received sample contains 100% below 2mm size.

Table 2: Chemical analysis of sample from BMM (As received)

	Fe%	SiO2%	Al2O3%	FeO%	Mn%	Na2O%	K2O%	TiO2%	CaO%	MgO%	P%	S%	LOI%
1	42.91	22.39	2.31	28.05	0.900	0.041	0.219	0.137	0.625	0.910	0.154	2.170	1.54
2	40.12	24.68	2.50	29.05	0.840	0.049	0.237	0.141	0.613	0.902	0.148	2.160	2.47
3	37.88	27.86	3.14	28.07	0.920	0.043	0.236	0.160	0.623	0.892	0.145	2.080	3.02
	40.28	**25.01**	**2.65**	**28.39**	**0.89**	**0.044**	**0.231**	**0.146**	**0.620**	**0.901**	**0.149**	**2.136**	**2.35**

The table 2 shows that sample contains 41.0% of Fe with high silica 26% and alumina around 3%.

As we have got facilities to analyses only for ferrous material so nonferrous materials like copper, zinc, lead & silver are not analyzed. In some samples sulphur content is beyond determinable limits.

Davis Tube Tester

The Davis tube tests help to evaluate theoretical grades & recoveries attainable by magnetic separators. These test results can be compared with actual LIMS data. DTT tests are carried out on as received & grinded samples at different magnetic field strengths. The results are tabulated in the tables.

Figure: Davis Tube tester in operation at SMRDC.

1. DEVIS TUBE TEST WORK (As Received sample)

GAUSS	As Received sample	Yield%	Fe recovery%	Fe%	Si02%	Al2o3%	Feo%	Mn%
AT 800 GAUSS	Magnetic concentrate	60.63	87.06	61.26	8.59	1.71	30.18	0.98
	Non magnetics	39.38	12.94	14.02	47.49	8.16	11.21	1.64
	Total calculated feed	**100.00**		**42.66**	**23.91**	**4.25**	**22.71**	**1.24**
AT 2000 GAUSS	Magnetic concentrate	58.13	86.06	62.38	6.80	1.42	30.32	1.01
	Non magnetics	41.88	13.94	14.02	47.69	8.49	12.07	1.54
	Total calculated feed	**100.00**		**42.13**	**23.92**	**4.38**	**22.68**	**1.23**
AT3500 GAUSS	Magnetic concentrate	58.75	86.94	62.94	6.86	1.38	30.46	0.98
	Non magnetics	41.25	13.06	13.46	47.98	8.13	11.21	1.32
	Total calculated feed	**100.00**		**42.53**	**23.82**	**4.16**	**22.52**	**1.12**

2. DEVIS TUBE TEST WORK(Different grinded fractions)

Feed Grinded to -100#

Gauss	Feed Grinded to - 100 #	Yield%	Fe recovery%	Fe%	Si02%	Al2o3%	Feo%	Mn%
AT 800 GAUSS	Magnetic concentrate	55.25	86.29	65.75	3.89	1.13	31.33	0.60
	Non magnetics	44.75	13.71	12.90	47.59	7.93	8.91	1.35
	total calculated feed	**100.00**		**42.10**	**23.45**	**4.17**	**21.30**	**0.94**
AT 2000 GAUSS								
	Magnetic concentrate	54.98	88.84	66.73	3.40	0.93	30.18	0.59
	Non magnetics	45.03	11.16	10.23	49.23	8.42	8.91	1.28
	total calculated feed	**100.00**		**41.29**	**24.03**	**4.30**	**20.60**	**0.90**
AT3500 GAUSS								
	Magnetic concentrate	56.68	87.51	65.33	4.66	1.33	32.62	0.55
	Non magnetics	43.33	12.49	12.20	48.65	7.92	8.05	1.06
	total calculated feed	**100.00**		**42.31**	**23.72**	**4.19**	**21.98**	**0.77**

Feed grinded to -150# size

Gauss	Feed Grinded to - 150 #	Yield%	Fe recovery%	Fe%	Si02%	Al2o3%	Feo%	Mn%
AT 800 GAUSS	Magnetic concentrate	54.38	86.17	66.73	3.35	1.19	31.90	0.59
	Non magnetics	45.63	13.83	12.76	48.46	8.32	8.91	1.24
	total calculated feed	**100.00**		**42.11**	**23.93**	**4.44**	**21.41**	**0.89**
AT2000 GAUSS								
	Magnetic concentrate	53.98	87.03	67.43	2.79	0.93	31.33	0.59
	Non magnetics	46.03	12.97	11.78	49.33	8.39	9.20	1.87
	total calculated feed	**100.00**		**41.82**	**24.21**	**4.36**	**21.14**	**1.18**
AT 3500 GAUSS								
	Magnetic concentrate	54.88	88.15	67.71	2.23	1.57	32.19	0.56
	Non magnetics	45.13	11.85	11.07	48.46	8.75	8.33	1.71
	total calculated feed	**100.00**		**42.15**	**23.09**	**4.81**	**21.42**	**1.08**

Feed grinded to -200# size

Gauss	Feed Grinded to - 200 #	Yield%	Fe recovery%	Fe%	Si02%	Al2o3%	Feo%	Mn%
AT 800 GAUSS	Magnetic concentrate	56.25	86.78	67.29	2.34	0.88	29.46	0.57
	Non magnetics	43.75	13.22	13.18	43.44	8.13	11.78	1.34
	total calculated feed	**100.00**		**43.62**	**20.32**	**4.05**	**21.73**	**0.91**
AT2000 GAUSS								
	Magnetic concentrate	59.25	88.44	67.85	2.21	1.08	32.48	0.58
	Non magnetics	40.75	11.56	12.90	48.27	9.44	12.21	1.73
	total calculated feed	**100.00**		**45.46**	**20.98**	**4.49**	**24.22**	**1.05**
AT 3500 GAUSS								
	Magnetic concentrate	58.03	89.04	67.57	1.89	1.76	30.90	0.57
	Non magnetics	41.98	10.96	11.50	46.14	8.69	11.07	1.42
	total calculated feed	**100.00**		**44.03**	**20.46**	**4.67**	**22.58**	**0.93**

Findings of Davis tube tester

- Material can be beneficiated with magnetic separators.

Magnetic separation of zinc tailings by LIMS (Low Intensity Magnetic Separator)

As received zinc tailings was subjected to wet magnetic separation in low intensity drum magnetic separator of magnetic intensity 800 Gauss with feed percentage of solids maintained at 25% by weight. The magnetics and non-magnetic fractions generated at each stage were collected, filtered, dried, weighed and sampled for chemical analyses. The results are tabulated in Table4A.

Figure: Bench scale LIMS test work at SMRDC.

Table 4A
Three test works on As Received sample.

Test 1	Yield%	Fe%	Fe recovery%	Si02%	Al2o3%	Feo%	Mn%	S%
Magnetic fines	51.17	64.62	79.97	5.51	1.28	30.90	0.89	1.06
Non magnetics	48.83	16.96	20.03	45.47	7.96	15.95	1.34	3.03
total calculated feed	**100.00**	**41.35**		**25.02**	**4.54**	**23.60**	**1.11**	**2.02**
Test 2								
Magnetic fines	56.67	63.64	85.09	6.56	1.22	31.33	0.87	1.03
Non magnetics	43.33	14.58	14.91	47.30	8.89	13.22	1.41	3.42
total calculated feed	**100.00**	**42.38**		**24.21**	**4.54**	**23.48**	**1.10**	**2.07**
Test 3								
Magnetic fines	55.00	65.33	84.94	5.02	0.86	30.90	0.61	1.12
Non magnetics	45.00	14.16	15.06	48.27	8.59	11.07	1.46	3.55
total calculated feed	**100.00**	**42.30**		**24.48**	**4.34**	**21.98**	**0.99**	**2.21**

Findings on LIMS Test work with as received sample

- It is clear that a + 62% Fe can be attained with overall Fe unit recovery at around + 80%.
- With as received sample test work LIMS magnetics has an average Fe 64.53%, silica 5.70%, & alumina 1.12% with mass yield of 54.28%.
- The average Fe recovery in the magnetics is 83.33%.
- Sulphur content is high in the magnetic. Average sulphur is 1.07%.
- The non-magnetic has an average mass yield of 45.72% with Fe unit recovery loss of 16.67%.
- The non-magnetics has an average Fe of 15.23%.with Feo 13.41%.

Way forward

- To reduce sulphur & Mn content in the final product. The received sample ground to different size fractions and testing it in the LIMS.
- Possibility to recover salable fines from non-magnetics of LIMS. Non magnetics tested in Davis tube tester at higher magnetic field strength(3500 gauss)
- Check the Behavior of as received and grinded fractions at higher magnetic field strengths using wet high intensity magnetic separators.(WHIMS)

LIMS test work on Grinded samples

As received zinc tailing sample grinded to below 100 #, 150# & 200# and batch tests were conducted on each fractions using laboratory LIMS drum at field strength of 800 gauss at 25% w/w feed dilution with water. The magnetics and non-magnetic fractions generated at each stage were collected, filtered, dried, weighed and sampled for chemical analyses. The results are tabulated in table 4B.

Table 4B

SIZE		Yield%	Fe%	Fe recovery%	Si02%	Al2o3%	Feo%	Mn%	S%
100#	Magnetic fines	54.64	65.87	85.81	3.79	1.15	31.47	0.63	1.13
	Non magnetics	45.36	13.12	14.19	50.78	8.57	12.79	1.29	3.45
	total calculated feed	100.00	41.94		25.11	4.52	23.00	**0.93**	**2.18**
150#	Magnetic fines	52.73	65.59	84.66	4.03	1.80	31.47	0.63	1.08
	Non magnetics	47.27	13.26	15.34	51.17	8.73	12.07	1.38	3.22
	total calculated feed	100.00	40.85		26.31	5.08	22.30	**0.98**	**2.09**
200#	Magnetic fines	56.36	63.50	85.71	4.88	1.67	30.47	0.56	1.11
	Non magnetics	43.64	13.68	14.29	51.75	8.92	11.78	1.54	3.45
	total calculated feed	100.00	41.76		25.33	4.83	22.31	**0.99**	**2.13**

Findings

- There is no much reduction in sulpher content in the magnetic concentrate.
- Grinding of the material is not reduces Sulpher content as grinding is physical separation process. It needs chemical separation process.
- There is slight reduction in Mn but not up to the expected level.
- There is an improvement in Fe recovery and Fe grade compared to as received sample test work

Non magnetics of LIMS fed to Davis tube.

As non-magnetics of LIMS are showing high Feo content (10 to 12%), so the non-magnetics of LIMS are subjected to Davis tube test at magnetic field strength of 3500 gauss to evaluate the possibility of recovering the paramagnetic Fe in the form of Hematite.

	Yield%	Fe%	Fe recovery%	Si02%	Al2o3%	Feo%
Magnetic concentrate	31.95	39.25	71.07	26.16	5.00	24.14
Non magnetics	68.05	7.50	28.93	55.50	8.73	7.19
total calculated feed	100.00	17.64		46.13	7.54	12.61

Findings of above test.

- Magnetic concentrate Fe content is just 39.25% & silica remains high 26.16%.
- Low mass yield.
- Further test work is needed after grinding the non-magnetics which may liberate Fe.

Wet High Intensity Magnetic Separator.

Similar test works are carried out on wet high intensity magnetic separator to see the behavior of as received and grinded samples at higher magnetic field intensities. The results are tabulated in the tables.

Figure: WHIMS in operation at SMRDC.

WHIMS test work on as Received samples

GAUSS	As Received sample	Yield%	Fe recovery %	Fe%	Si02%	Al2o3 %	Feo%	Mn%
AT 1500 GAUSS	Magnetic fines	68.97	90.04	54.68	13.85	2.61	27.45	0.81
	Middling's	6.43	3.13	20.42	41.51	7.25	12.79	1.56
	Non magnetics	24.61	6.83	11.62	52.29	7.61	7.90	1.09
	Total calculated feed	**100.00**		**41.88**	**25.09**	**4.14**	**21.70**	**0.93**
AT 5000 GAUSS	Magnetic fines	85.07	96.82	45.03	19.40	4.34	25.00	1.00
	Middling's	7.20	2.14	11.75	57.82	6.43	8.33	1.35
	Non magnetics	7.74	1.04	5.31	72.11	4.64	5.17	0.57
	Total calculated feed	**100.00**		**39.56**	**26.24**	**4.51**	**22.27**	**0.99**

WHIMS test work on Grinded samples

GAUSS	-100#	Yield%	Fe recovery %	Fe%	Si02%	Al2o3 %	Feo%	Mn%
AT 1200 GAUSS	Magnetic fines	57.25	74.85	50.04	14.47	4.05	27.16	0.83
	Middling's	3.52	3.59	39.11	25.48	5.43	23.71	0.91
	Non magnetics	39.23	21.55	21.03	47.11	5.20	14.08	0.86
	Total calculated feed	**100.00**		**38.28**	**27.66**	**4.55**	**21.91**	**0.84**
AT 5000 GAUSS	Magnetic fines	69.37	90.64	48.08	16.72	3.95	26.30	1.08
	Middling's	5.44	4.08	27.62	36.49	6.35	19.11	0.83
	Non magnetics	25.19	5.28	7.71	60.52	5.66	7.19	0.71
	Total calculated feed	**100.00**		**36.80**	**28.83**	**4.51**	**21.10**	**0.97**

GAUSS	-200#	Yield%	Fe recovery %	Fe%	Si02%	Al2o3 %	Feo%	Mn%
AT 1200 GAUSS	Magnetic fines	57.57	87.86	53.55	12.31	3.26	27.45	0.72
	Middling's	6.90	2.07	10.51	54.44	7.04	9.05	0.88
	Non magnetics	35.53	10.07	9.95	54.35	6.29	7.90	1.20
	Total calculated feed	**100.00**		**35.09**	**30.15**	**4.60**	**19.23**	**0.90**
AT 5000 GAUSS	Magnetic fines	79.01	94.09	51.45	14.94	3.26	27.30	0.72
	Middling's	4.15	1.71	17.80	43.82	7.70	14.51	1.18
	Non magnetics	16.84	4.20	10.79	53.48	6.45	10.35	1.11
	Total calculated feed	**100.00**		**43.21**	**22.63**	**3.98**	**23.92**	**0.80**

Findings of Wet High Intensity Magnetic Separator.

- At higher magnetic field strength yield % is good & is in the range of 65 to 75%.
- Iron content remains low in magnetic fines it is varying from 45 to 55% Fe & silica remains high.
- Due to higher Feo content in the feed, WHIMS drum matrix's gets chocked

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FINAL CONCLUSIONS OF TEST WORK.

LIMS test work on as Received sample

- Recoveries are good with an average 53-54% mass yield and Fe unit recovery of 82-83%.
- Iron content in zinc tailings enriched from 42.01% to 64.53% Fe.
- Silica reduced from 24.57% to 5.70%.
- Alumina reduced to 1.12%
- Proposed flow sheet is designed and attached based on these test results.(without Grinding)

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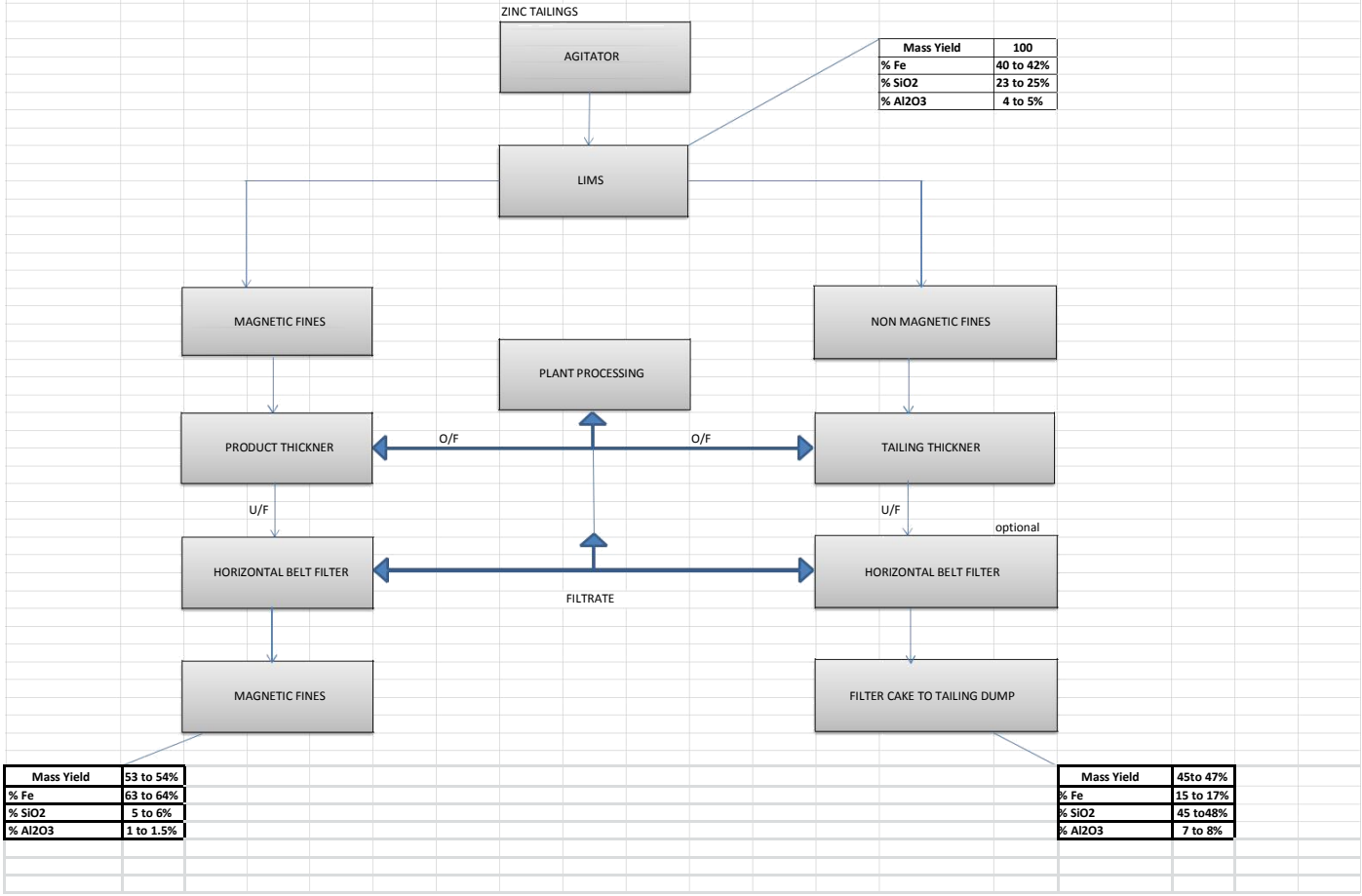
PROPOSED FLOWSHEET FOR MAGNETITE RECOVERY FROM ZINC TAILINGS, BMM, SOUTH AFRICA



Mass Yield	53 to 54%
% Fe	63 to 64%
% SiO2	5 to 6%
% Al2O3	1 to 1.5%

Mass Yield	45to 47%
% Fe	15 to 17%
% SiO2	45 to48%
% Al2O3	7 to 8%