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Physical method of upgradation for low grade wolframite pre-concentrate from Degana, Rajasthan

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ABSTRACT

Tungsten is a strategic metal and mostly used in defence. It is also used in cutting tools, industrial, electrical, textile and leather sectors. India's tungsten reserves are very limited and the only workable deposit is restricted to Degana in Rajasthan. Tungsten deposit occurs in association with metamorphic rocks and granite igneous rock throughout the world. At Degana, two types of deposit are being worked at, one being quartz load wherein wolframite is mineralised in quartz vein and the other is finely disseminated tungsten mineralisation in the granite body. The sample under investigation belonged to off-grade tungsten pre-concentrate - 1 (PC - 1) produced at Degana Plant site, assaying 14.50% WO_3, 20.20% SiO_2 and 4.13% S. The objective of this study was to find the upgradation conforming to DMRL specification i.e. final wolframite concentrate with >65.0% WO_3, and S and SiO_2 <1.0% each. Detailed studies indicated that grinding the feed to 200 mesh followed by sulphide flotation at 4.5 and 8.0 pH and repeated vanning of non-sulphide could produce a vanner concentrate assaying 64.8% WO_3, 1.0% SiO_2 and 3.0% S with a distribution of 48.8% WO_3 in it. Thorough desliming followed by sulphide flotation and then treating on vanner times could produce a concentrate analysing 68.47% WO_3, 0.5% SiO_3 and 0.48% S which conforms to the DMRL specifications.

INTRODUCTION

Tungsten is an important metal which finds application in various crucial industries including defence, electrical, textile and leather. India is deficient in resources of high grade tungsten ore and as such most of its demand is met through imports. Available resources are very few and lean and that too confined to State of Rajasthan and Uttar Pradesh. In India, Hindustan Zinc Limited, Udaipur is

presently producing concentrate from the only working mines in the country at Degana. The two types of deposits are bearing worked at, one being quartz load where in wolframite is mineralised in quartz vein and the other is finely disseminated tungsten mineralisation in the granite ore body. At Degana wolframite concentrate is produced partly by handpicking and then by gravity treatment after preliminary crushing and grinding. During processing apart from DMRL's grade concentrate, some low grade concentrates were also produced at mines site. One of those concentrate formed part of our study at NML, Jamshedpur.

MATERIALS AND METHODS

The sample under investigation was one of the pre-concentrates obtained from Degana. The pre-concentrate sample assayed 14.50% WO_3, 20.20% SiO_2 and 4.13% sulphur.

Mineral characterisation study conducted on the sample indicated the presence of wolframite as the only mineral of economic importance. The sulphides were present in order of abundance as pyrite, pyrrhotite, chalcopyrite, sphalerite and arsenopyrite. The other metallic gangues present in the sample were magnetite, hematite and limonite etc. Quartz, topaz, mica and feldspar formed the silicate gangue. Liberation study indicated wolframite and silicate in fine interlocking state which warranted fine grinding.

Attempts were made to upgrade the sample by adopting gravity and flotation techniques and their suitable combination. Concentration by gravity (using Bartles Mozley Vanner) at finer size could separate silicate gangue whereas the sulphides were removed by flotation methods. All flotation tests work were carried out in Fagergren flotation cell in 500 gm batches. Potassium xanthate and pine oil were used as collector and frother respectively for floating sulphide. The effects of various process parameters were studied.

RESULTS AND DISCUSSION

Concentration of as Received Sample

Since as received sample contained approximately 43% -200 mesh so attempt was made to study its amenability for concentration at this size by adopting flotation and gravity methods. The sulphides were floated at acid and natural pH (4.5 and 7.5) to ensure removal of all sulphides and then the non-float was passed over Bartle Mozley Vanner to separate the silicates. The result are presented in Table 1.

Table 1: Results on as recived pre-concentrate sample

Products	Assay (%)			Dist. (%)	
	Wt.(%)	WO_3	SiO_2	WO_3	SiO_2
V.Conc	21.7	50.31	1.63	65.7	1.6
V.Tails	61.7	7.54	32.20	28.0	89.2
Sul.Float	16.6	6.85	12.40	6.3	9.2
Head (Calc)	100.0	16.69	22.30	100.0	100.0

The above results indicate that there is loss of value both in vanner tailings and sulphides though vanner concentrate analyses low in silica.This was attributed to the locking of wolframite with associated gangue minerals.

Beneficiation with Finely Ground Sample

Considering the unsatisfactory results with a feed with 43% –200 mesh and the need of fine grinding for a fair liberation of wolframite, experiments were carried out with sample ground to all passing below 200 mesh. The ground product was flotated to remove sulphides followed by further concentration using vanner. The experimental results are presented in Table 2.

Table 2: Results on pre-concentrate ground to 200 mesh

Products	Assay (%)				Dist. (%)		
	Wt.(%)	WO_3	SiO_2	S	WO_3	SiO_2	S
V.Conc.I	12.8	64.83	1.06	3.10	48.8	0.6	9.0
V.Conc.II	1.7	55.53	2.24	3.60	5.5	0.2	1.4
V.Cl.Tails	67.7	8.90	29.90	4.55	35.4	87.6	70.2
Sul.Float	17.8	9.83	15.10	4.80	10.3	11.6	19.4
Head (Calc)	100.0	17.01	23.10	4.39	100.0	100.0	100.0

The results shown in Table 2 indicate that due to an improvement in the liberation of wolframite at 200 mesh the concentrate assayed or 65% WO_3 but sulphur and silica content were relatively high. This may be due to be presence of fines and slimes resulted by the fine grinding of the sample and their poor separation characteristics by gravity and flotation methods.

Concentration using Deslimed Feed

Considering the detrimental effects of fines and slimes, experiments were carried out using thoroughly deslimed feed. Like the previous experiments the sand was floated for the separation of sulphides. The sink from the flotation

experiment was subsequently subjected to multi–stage cleaning using vanner. The experimental results are shown in Table 3. As it is evident from the data shown in Table 3, the final concentrate analysed 68.47% WO_3 with 46.9% recovery having silica and sulphur <1% each.

Table 3: Results on pre-concentrate using deslimed feed

Products	Assay (%)				Dist. (%)		
	Wt. (%)	WO_3	SiO_2	S	WO_3	SiO_2	S
V.Cl.Conc.	10.9	68.47	0.52	0.40	46.9	0.3	1.1
V.Cl.Tails	33.7	10.19	16.32	2.41	21.6	26.4	19.7
Slime	47.6	10.20	31.60	2.70	30.5	72.3	31.2
Sul. float	7.8	2.10	2.60	25.37	1.0	1.0	48.0
Head (Calc)	100.0	15.92	20.80	4.12	100.0	100.0	100.0

CONCLUSIONS

Bench scale beneficiation studies were carried out on off grade tungsten preconcentrate by physical methods. The petrological studies indicated the need of fine grinding for liberation of wolframite from the associated gangue minerals.

A combination of froth flotation and vanning proved helpful in concentration of the sample to the meet the required specification of the product. The final concentrate produced by desliming of the sample ground to below 200 mesh, flotation of the sand followed by multistage cleaning of the non-float assayed 68.47% WO_3 with silica and sulphur below 1% each.

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