Pak J Sci Ind Res 2001 **44** *(2) 72-74*

Chemical, Mineralogical Characterization and Liberation Studies of Koh-i-Sultan Sulphur

I H Khan*, Fayyaz Mahmood and Mustansar Naeem

PCSIR Laboratories Complex, Lahore-54600, Pakistan

(Received 9 March 1999; accepted 24 August 2000)

Studies were undertaken on the sulphur samples from Batal area, District Nokkundi (Baluchistan) and the waste material from Quetta Sulphur Refinery which indicate the presence of sulphur contents from 17-50%. Chemical evaluation and liberation studies were carried out to determine the processing parameters for the upgradation of the sulphur samples. The studies revealed that fairly high-grade sulphur might be recovered from these samples.

Key words: Sulphur, Mineralogy, Liberation, Koh-i-Sultan sulphur, Upgradation.

Introduction

The aims of these studies were the evaluation of sulphur bearing materials and finding a suitable combination of parameters for upgradation (Khan and Qazi 1991) of sulphur so as to reduce bulk of gangue material. The waste material from sulphur refinery also contains the appreciable amount of sulphur which can be recovered by using appropriate method. The mineralogical investigation and nature of the waste material in order to determine the processing parameters can be exploited for the recovery of the sulphur.

Geology. Geology of the area shows that the sulphur occurs at Koh-i-Sultan as an extensive deposit on the Southwest flank of the volcano. The best rock for the sulphur minearlization is an ash flow tuff. The mineralization which ranges from 5-15 m in thickness is variable in grade having 60% and more sulphur. The upper part of the sulphur formation which has low sulphur contents is an ash flow tuff, which converting into a white, friable material of low density. At the base of sulphur deposit the formation changes abruptly to dense andesite.

Mineralogy. Mineralogy studies were undertaken on the samples taken from Kho-i-Sultan sulphur deposits at Batal designated as C1A, Nukkundi District in Baluchistan represented by C1B, sulphur refinery at Quetta (origination from Koh-i-Sultan) indicated by C1C while the sample taken from the sulphur containing material of sulphur refinery waste were represented by Bk.

Samples C1A is fine to medium grained having light yellow colour with subordinated off-white gypsum, light-grey highly altered tuff material is associated with the sulphur. Bright yellow sulphur crystals are present as fine dissemination the sample C1; B1 is of yellow colour associated with dark-grey tuff material. Off-white amorphous gypsum is present as gang mineral bright yellow sulphur is present in abundance. Discrete quartz grains are observed at a number of places the sample has relatively higher amount of sulphur contents.

The sample C1C is fine to medium grained having amount of gangue minerals in the form of gypsum and quartz. Thin lamellae of gypsum are intercalated with sulphur. It is a low-grade ash flow tuff counting relatively less sulphur in the form of dissemination while the sample BK is poor in sulphur contents having anormous amounts of gypsum, quartz and associated tuff material.

Experimental

The studies were undertaken on the following samples.

1. Koh-i-Sultan sulphur deposits at Batal (C1A)
2. Nukkundi District in Baluchistan (C1B)
3. Sulphur refinery at Quetta (Origination from Koh-i-Sultan) (C1C)
4. Sulphur containing material from the sulphur refinery waste (BK)

The samples C1A, C1B and C1C were mixed in equal weight proportion to make a composite sample and the sulphur containing material from the sulphur refinery waste marked as BK. The sampling was done by conning and quartering method and the samples were subjected to chemical evaluation, processing parameters for upgradation and recovery of sulphur. The sulphur assay was carried out for all the feed materials, products and intermediates using carbon tetrachloride as solvent in a soxhelt extractor (Maxwell 1968).

(i) *Chemical evaluation.* The samples were crushed and ground in a ceramic mill and were analysed for moisture (Lunge and Keenness 1924a) and % of sulphur on dry basis. For moisture determination the sample should not the crushed further

*Author for correspondence.

than to a coarse powder and this should be done as speedly as possible. At least 100g should be taken for the estimated in the case of ground sulphur; it is off course much easier to obtain an average and more finely divided samples. The sulphur analysis was carried out by soxhlet extraction using carbon tetrachloride as solvent. This was counter checked by dissolving the sulphur of the sample in carbon disulphide (Lunge and Keenness 1924b) filtering out the dissolved sulphur in a glass fitted crucible, washing the residue with carbon disulphide, drying and weighing. The moisture in composite sample is 2.20 where as it contains sulphur (dry basis) 32.8 (47%). The results are given in Table 1.

(ii) Grinding. Grinding studies (Qazi *et al* 1993) were accomplished to investigate the nature of liberation of locked sulphur particles from the gangue. Grinding was done in a ceramic mill. About 1000 g of -4 mesh sulphur bearing material was charged into the mill along with water to maintain the pulp density 40% solids. It was found that in a retention time 4 and 5 min over 80% of the material was ground to finer than 22 mesh and 32 mesh respectively (Fig 1). Size analysis of typical wet grinding tests for composite and BK1 samples are given in Table 2.

(iii) Liberation study. In laboratory, control grinding is done in dry state. The ground product of Kb and composite samples were screened.The liberation on of free sulphur particles of various size fractions were examined under stereomicroscope (Fig 2 and 3). The results of liberation studies are shown in Table 3.

The roll product sulphur bearing materials, composite and Bk was wet ground in a pebble mill for 5 min Fig 4. The pulp was wet sieved, various size fractions and the free sulphur grains counted microscopically on the basis of volumes are presented in Tables 4 and 5.

Table 1
Moisture of different samples

Sample	Moisture %	Sulphur % (dry basis)
C1A	2.71	17.52
C1B	0.86	50.32
C1C	1.49	32.41
BK1	2.95	22.11

Table 2
Wet grinding tests of composite and BK samples

Size		Cumulative percent passing	
Mesh BSS	Microns	Composite	Bk1
+30	595	80.89	83.78
44	355	65.04	64.24
60	250	52.74	53.28
85	178	43.95	42.70
100	152	37.28	36.25
150	100	28.23	26.04
- 200	76	22.83	08.78

Table 3
Liberation of sulphur on dry grinding

Particle size mesh (BSS)	Bk		Composite	
	Cum.wt.% retained Bk1	Free sulphur% (Vol.)	Cum.wt.% retained	Free sulphur% (Vol.)
+30	23.82	49.0	00.00	55.32
44	41.27	62.2	35.42	66.15
60	58.93	71.4	55.42	79.42
100	69.81	84.8	67.32	88.13

Table 4
Sulphur content in different size fractions of composite sample

Size fraction mesh (BSS)	Wt.% retained	Cum.wt.% retained	Free sulphur % (Vol.)
+30	17.32	17.32	72.32
44	15.23	32.55	81.92
60	13.61	46.16	87.08
100	15.72	61.88	92.65
150	08.64	70.52	98.33
200	16.65	87.17	100.00
-200	12.83	100.00	00.00

Table 5
Sulphur content in different size fraction of Bk sample

Size fraction mesh (BSS)	Wt.% retained	Cum.wt.% retained	Free sulphur % (Vol.)
+30	16.22	16.22	78.20
44	19.54	35.76	81.14
60	10.96	46.72	90.48
100	10.58	57.3	94.89
150	06.43	63.73	99.68
200	10.23	73.96	100.00
-200	26.04	100.00	00.00

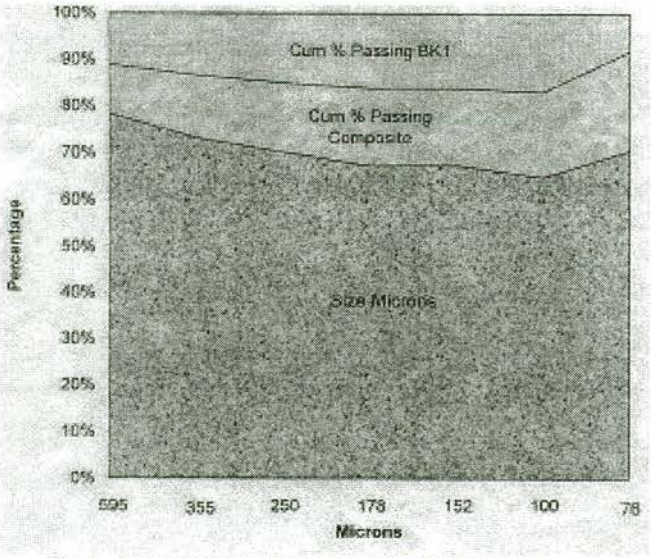

Fig 1. Wet grinding tests of composite & Bk samples.

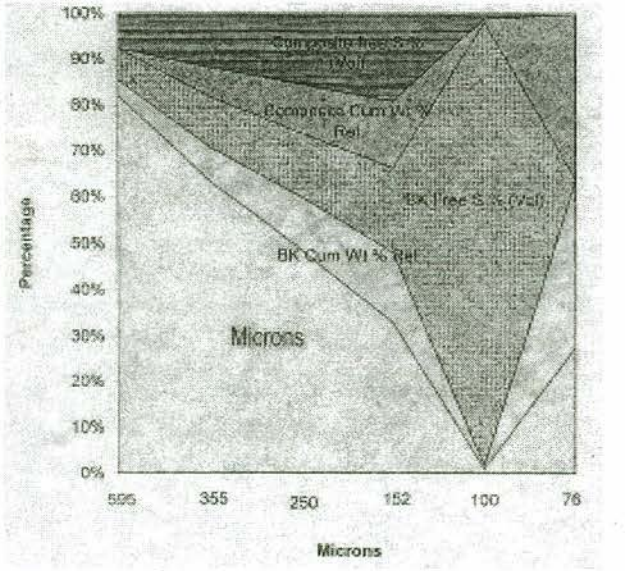

Fig 2. Liberation of sulphur on dry grinding.

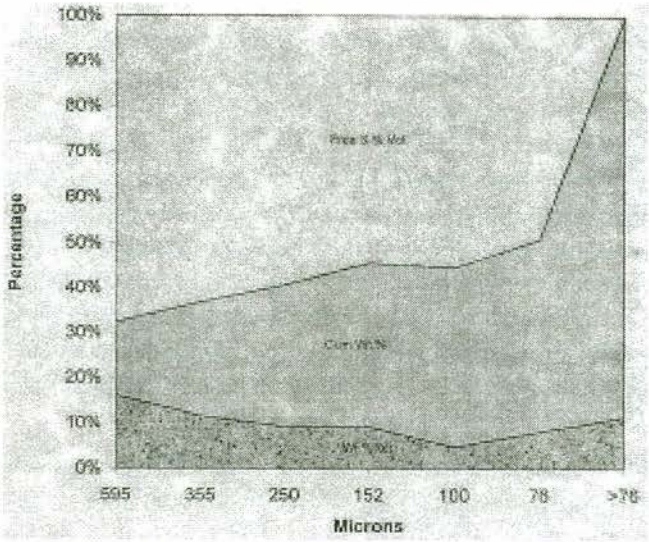

Fig 3. Sulphur contents in different size fraction of composite sample.

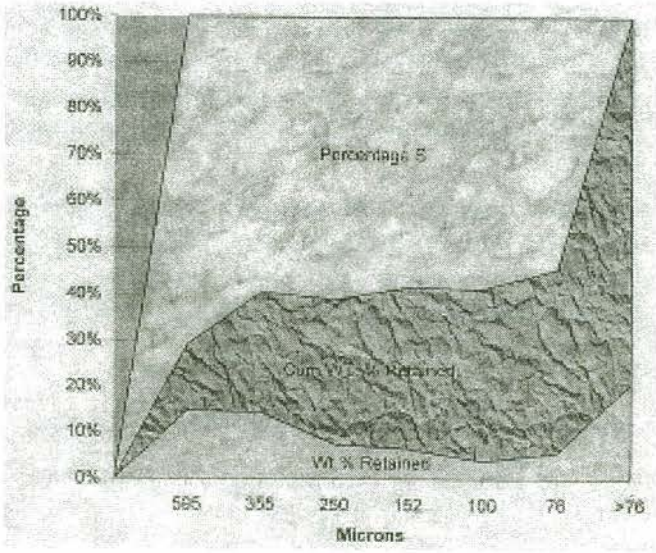

Fig 4. Sulphur contents in different size fraction of of Bk sample.

Discussion and Conclusion

The chemical evaluation of sample revealed that the sulphur contents varies generally from 17-50% (dry basis) while the composite sample has 32.8% sulphur. The mineralogical studies shows that in addition to ash flow tuff gypsum and quartz are the main gangue minerals associated with the sulphur. Liberation studies on controlled dry ground material indicate that about 80% sulphur was liberated at 60 mesh in case of composite sample while for Bk sample the material has to be ground finer than 60 mesh. These studies revealed that to obtain maximum recovery and grade the composite samples should be ground to 100 mesh. Therefore, the recommended parameters may be used for the optimisation of the conditions for the processing of these samples.

References

Khan I H, Qazi M A 1991 *Laboratory testing of Koh-i-Sultan sulpur ore samples*. PCSIR Laboratories, Quetta.

Lunge, Keenness 1924a *Technical Methods of Chemical Analysis*. Paternoster Row Edinburgh Twiddle Court. Gurney and Jackson Lons: 33, Vol.1, 2nd. ed. pp360,

Lunge, Keenness 1924b *Technical Methods of Chemical Analysis*. Paternoster Row Edinburgh Twiddle Court. Gurney and Jackson Lons: 33, Vol.1 2nd ed. pp362.

Maxwell J A 1968 *Rock and Mineral Analysis*. Inter Science Publisher, John Willey and Sons, N York/London/Sydney/ Toronto pp238.

Qazi M A, Saqib Ahmad, Mehdi Hassan, Khan I H, Shafiq Anwar 1993 Flotation studies of sulphur ore from batal deposits, Balochistan. *Pak J Sci Ind Res* **38** (8) 295.