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THE CHARACTERIZATION STUDIES OF DIATOMITE DEPOSITS FROM MAMAGAN AREA OF IRAN FROM BENEFICATION POINT OF VIEW

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ABSTRACT The occurrence of huge reserves of dıatomıte deposits have been reported from different parts of Iran, specially at the Mamaghan area which is very high grade in nature, but can not be directly used as filter aid or filter and the like because of impurities present

For the mıneralogıcaİ composition the nature of skeleton, chemical characters and the mesh of grind which play vital role in finding out suitable beneficıatıon techniques the samples were subjected to detailed mıneralogıcaİ, and microscopic studies, sieve analysis, liberation studies and chemical analysis The results obtained are not only encouraging but also form original and distinct contribution from the beneficıatıon point of view in genera! and that of Mamaghan area m particular

1 INTRODUCTION

Dıatomıte deposits, the skeletal remains of tiny aquatic plants called diatoms, are found m many parts of the world but, only a few deposits are of commercial value They are plants related to the algae family (Roskill, 1990) and are different from most plants in that they have a siliceous shell The accumulation of such shells is the basis of mineral dıatomıte (Stroebel et al, 1979), which qualifies as a mineral of organic origin in much same way that aragonite and collophane do (Frederic et al 1975)

The silica of the fossilized diatom skeletons resembles opal or hydrous silica in composition (S1O2 - n H-.0) (Cummins, 1960) and is of acute biological significance, for both cell wall component and basic life process, without which cell development ceases (Arehart, 1972) In addition to bound water (3 5-8%) the siliceous skeleton contain small amounts of alumina and iron and some limes these minerals are associated with many of the contaminant!« and totally believed to be 0 2 - 1 5% There are variable amounts of lock forming minerals that were syngenetically deposited or precipitated with the diatom frustulcs Sand clay carbonates and volcanic ash dre typical common contaminants and others like feldspar mica amphiboles pyroxenes rutile and zircon which aie the results of weathering are transported and subsequently redeposited surrounding İİL land masses Because ol these impurities silica content may range from 58 lo 91% ol thü dry product

Hie objective of dıatomıte beneficıatıon ıs to make it into pioducts for vuıious applıcalıons such as filters and many others This is achieved through characterization studies such as mıneralogıcaİ composition, nature of the skeleton, mesh of grind and other parameters Since the particulate shape and structure of the diatom skeleton is the physical property that most distinctly sets dıatomıte apart from other forms of silicate and for which its uniqueness is most responsible, great care is to be taken during milling and processing to preserve this structure (Frederic et al 1975) But other comminution equipment commonly used in the processing of other industrial minerals (ball mills) would destroy the delicate structure and would render it useless for such applications as filter aids, filters and many others The general specification of dıatomıte for filter aid is as follows (Smha 1986, Roskill, 1990)

SiO;,-90%(Approx)
Sp Gr - *2* 34 ü/cm^1
Colour while
Dry loose density - 65-80 gm/litre
wettability - Fasıly dıspersıble
pH-9-10 5
Moisture - 0 *»(%)
T lowrate - 4 5 ^5 (ml/Sec)
Clarny-60 90%(Appiox)
particle size - 0 01 0 OS (mm)
Surface area- 10-30 (m /g)

However the dıatomıte deposits of Mamaghan area which ıs situated in western south of *Tabriz* city with aboul 800000 tons reserve lack the above specification and thus need characterization studies which play vital role in finding out suitable beneficıatıon techniques

The diatomite deposits of Mamaghan area have not been subjected 10 benefiuation studies so far However the detail beneficıalıon studies have been carried out by the author recently (Rezaı el al, 1996) This paper deals with the characterization studies and the results obtained are discussed in appropriate pai is oi the papei

2 EXPERIMENTAL METHODS

2 1 Sample preparation

A part of the bulk sample (600 kg, dry) received was subjected to size reduction very carefully in a hammer crusher in closed circuit with a single deck screen to give a crushed product of - 6 mesh (ASTM) fraction The sampling techniques» like Jones riffles and coning and quartering methods adopted and representative samples prepared for further studies

2 2 Chemical analysis

The sample for head assay was obtained by coning and quartering and rotary sampler T he product was ground in an elect! ic pulverizer machine to obtain a product of- !00 mesh size and kept in an oven at constant tempeiature (loi"*,) lor S hours The results of chemical analysis are tabulated in Table 1

Table I Chemical analysis oi diatomite sample

Constituents	Weight %
SiO	XX Mi
Al O	2 02
le O	1 12
C.ıU	1 12
Mao	1 M
Ni (i	1) XI)
k O	1)27
! 0 !	Î44
O ihn s	(1 (H

2 i PetrogidpliK studies

In beneiiuaiion studies the pétrographie investigation pl iys an im poturu l0lC especially when ore and ganjaiı minerals arc transpaient Apart from the volunietnt pmpnrtion ol the ore and gangue mmcials and ıhı. ^ladc ollıu tlıaraclerıslıcs such as gram size icstuie and iimrgrown aie equally important ioı ıhı. benelıtıaiıon studies I he thin sections ol di,iu)innc au pupiied and suh|ccted m peliogiaphic simlios I he modal pmpoilion and grain si/c ol ilu ııımcıa! (ivcragc ol 20 thin sections) are given in I able 2 Microphotographs are illustrated m Fig I

Table 2 The modal analysis and grain size of the constituent minerals

SI-No	Mineral	nlodal percentage	Grain size (Micron)
1	Diatomite	45	20-200
2	Quarlz(Frcc)	5	10-100
3	Feldspar	8	20-150
4	Iron oxide	2	<I50
5	nine	6	<150
6	Hornblend	T	10-100
7	Albitc	3	20-150
8	Calcilc	3	50-150
9	Amphiboles	3	<150
10	Others	-	-

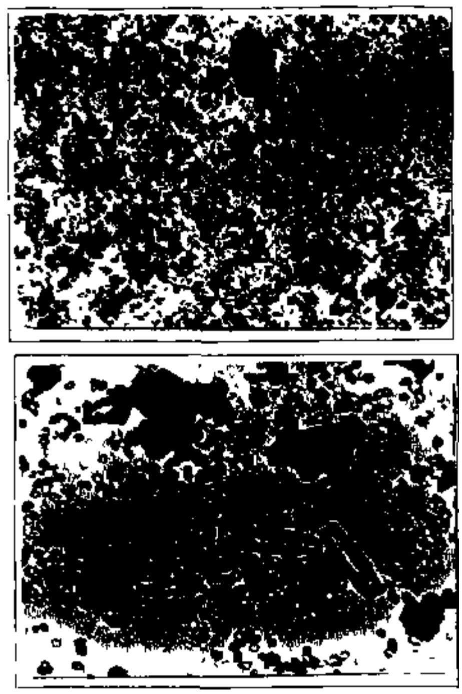

Fig I Microphotographs of diatomite (20 - 150 mesh) and some of impurities (quartz, feldspar, etc) (X400 upper and X 480 lower)

The microscopic studies also reveal that more than 62% of the diatomite skeletons are unbroken (Fig 2) and liberation size is supposed to be almost below 200 mesh On the other hand, most of the skeletons seem to be free from impurities and these specific features must be taken into account while considering them as filter aids and filters

2 4 X Ray diffraction studies

It is not only used for identification of minerals and their crystalline character but also for assessing the abundance of each mineral phase in multiple mixture It is even more important when the constituent minerals are fine and superfine in nature In order to confirm the minerals identified by pétrographie studies, the powder X-Ray difTractogrammes have been obtained for the sample ground to - 200 mesh employing a Phillips powder diffraction unit From the XRD studies it is possible lo know that the sample contains diatomite feldspar ıllıte quartz, albite and calcite in the order of abundance

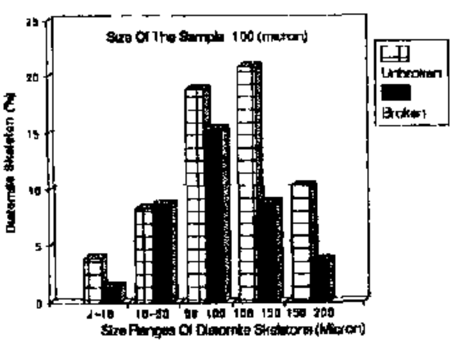

Fig 2 Percentage of broken and unbroken of diatomite skeletons in uncrushed samples

2 "i Particle size analysis

It is used m benefıcıatıon both to determine the efficiency of comminution equipmeni and also a yard stick for assessing the degree of ground product to know the optimum liberation we

The representative samples have been subjected to particle size analysis in five sepaialc stages as follows (I*18 3)

I-dry analysis
2- wet analysis
3- wet analysis with agitating Ilıt pulp in warm water tor halfan houı
4 wet analysis dl pH 3 for hall an hour
5 wet analysis .ti pi I -3 for »ni, IIOLII

The -400 mesh fractions from each stage were subjected to subsieVe analysts using laser particle sizer and the size distribution (for second stage in Fig 3) is illustrated graphically in Fig 4

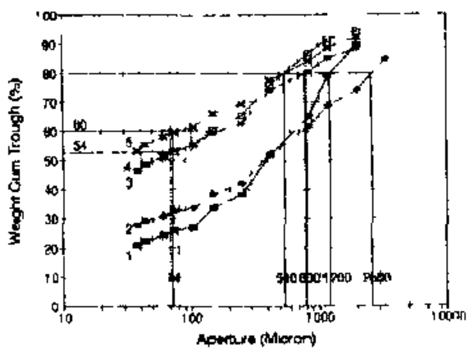

Fig 3 Size distribution plots for feed sample up to 400 mesh fractions

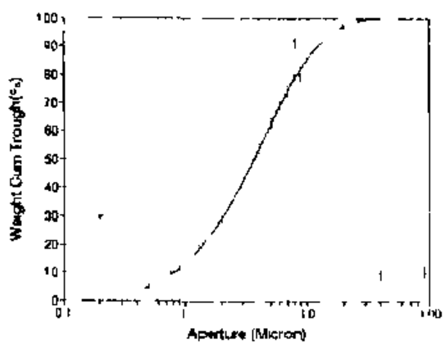

Fig 4 Subsıeve analysis with laser particle sizer

Fig "Î shows that more than 50% of the sample is finer than 200 mesh without destroying the diatomite structure specially, when the pulp is agitated before sieve analysis On account of delicate skeleton during the comminution process, this is to be taken into account while deciding the comminution circuits

2 6 Sink and float tests

In order to determine the degree of liberation of diatomite (with sp gr 2 2 g/cm[1]) from those of quartz (2 *àS* g/cm"), feldspar or albite (2 6 g/cm[3]), and other impurities heavy liquid tests have been carried out on sieve si/e fractions obtained by sieve analysis (Second stage in Tig 3) using TBE as a heavy liquid and acetone as a solvent, (both of which are supplied by Merck company)

Table 3 Sink and float tests on different size fractions

Mesh	Weight%	(%)		Mineralogical analysis by XRD **and** microscopic studies	
No	retained	Sink	float	Sink	**float**
8	14 92	0 40	99 6	A.QÄF	D
10	11 02	2 10	97 6	A.QAF	D
16	5 ^2	2 70	97 3	A.QAF	D
20	7 20	4 20	95 8	A,QAIo	D
35	9 19	120	98 8	A,QAF,Io	D,S
60	10 11	170	98 3	Q,AÄIo,I	D,S
100	3 66-	1 87	98 13	Q,AÄIo,l	D.S.O
140	4 74	145	98 55	Q,AÄIo	D,S,0
200	1 32	1 58	98 42	QAH,Io	D
250	1 38	1 00	99 00	A.QÄIO	D
325	1 96	1 79	99 20	A,Q,H,Io	D
400	1 40	1 20	98 80	A,Q,H,Io	D
.400	27 76	140	98 60	A,Q,H,Io	D

A= Albite Q= Quartz H= Hondblend F= Feldspar 1= Hlite Io= Iron oxide D= Dıatomıte 0= Impunties associated with D S= Impunties inside the skeletons C= some black particles (Volcanic ash, organic means and)

The preliminary studies showed that liquid with Sp Gr of 2 1 g/cm^s, remains supreme among others (2 2, 2 3, 2 4, 2 5 and 2 7 g/cm^3) therefore the liberation tests have been earned out on each size fractions and both sinks and floats are collected separately and analyzed by XRD and microscopic studies (Table 3) and some of the microphotographs are illustrated in Fig 5 (for both sink and float of-200 mesh fraction) Liberation seems to be beyond 200 mesh

2 7 Determination of other parameters (pH, Sp Gr, Bulk density and Moisture)

In order to determine the degree of acidity or alkalinity of the sample, pH tests have been earned out with distilled water and calcium chloride, the results of which are represented in Table 4 The table clearly shows that the pH of the sample is low in order to meet the specification requirements Similarly the Sp Gr, bulk density and moisture content was found to be 2 1 g/cm^3, 0 55 g/cm^3 and 1 8%, respectively, using standard tests

Fig S Microphotographs (X200) on -200 mesh fraction The sink portion, contains impurities like feldspar quartz, albite (upper), and float contains almost dıatomıte (lower)

Table 4 Results of pH tests

Particle Size -»	-2mm	-38(1
media *i*		
water	78	7.5
calcium chloride	75	74

3. RESULTS AND DISCUSSION

Table 1 presents high percentage of SiC«2but, it does not totally belong to diatomite. Pétrographie investigation shows that about 5% of SiOi is belong to free quartz and few percent to clay and other silicates (Table *2)*

Most of the skeletons are free from other impurities and pétrographie studies shown that if the sample is ground to -200 mesh with correct control of crushing and grinding it would be possible to get a nch product for further processing (Fig. 1 and 2)

Sieve analysis (Fig 3) clearly shows that if the further treatment is in wet condition more than 50% of the -200 mesh material can be obtained without using any gnnding equipment The pétrographie studies are supplemented with sink and float tests and it was noticed that most of the sinks, finer than 200 mesh are gangue minerals and float portions are almost diatomite with only little impurities present (Fig-5)

4. CONCLUSIONS

The authors have drawn the following conclusions The diatomite deposits of Mamaghan area of Iran was subjected to characterization studies and found that.

1- Though the percentage of SlO2 is above 88% it does not totally belong to diatomite but it is in the form of clay or other silicates which can be easily liberated with other impurities at finer size fractions (-200 mesh)

2- Most of the diatomite skeletons are free from impurities and they are not broken much, this is to be taken for their further uses as filter aid and filters

3- By agitating the sample for one hour it is possible to get more than 50% of the (-200 mesh) material without using any comminution circuits in wet conditions.

4- The pétrographie studies are supplemented with sink and float teste and at finer size (-200 mesh) most of the float portions are pure diatomite, these results are also supplemented with XRD and microscopic studies.

5- Since r.o.m diatomite commonly contains about 40-60% moisture, primary crushing followed by a simultaneous milling (-200 mesh) and drying by which the particles of diatomite are carried in a stream of hot gases through series of fans, cyclones, separators and a baghouse may result in the separation of diatomite from other impurities

6- With considering the nature of impurities, the mesh of grind, the grain size of the minerals, surface properties and their zero point of charge, it would be possible to predict the separation of such impurities by indirect flotation technique too.

REFERENCES

Arehart, JL. 1972 *Diatomite and silicon, sea frontiers,* vol 18(2) 90-94

Cummins., A.B 1960 *Diatomite.* Industrial minerals and rocks, 3rd Edn. 303-314

Fredne, L and Kadeg, JR 1975, *Diatomite.* Industrial minerals and rocks vol 2. 677-700

Rezai B and Salan, M. 1996 *Benefication of diatomite* - Amir Kabir university of technology. ReportNo(4)-1-15.

Roskill 1990 *The Economics of Diatomite,* 6 th Edn, 1-109

Strobel, AT and Goodwin, J.A 1979, *Diatomaceous earth mining and processing transactions* (272) 1860-1863.

Sınha, R.K *\9Z6Jndustrial minerals,* 2nd Edn, 151-156