18 Bentonite

Bentonite is essentially highly plastic clay containing not less than 85% clay mineral, montmorillonite. Bentonite is of a great commercial importance possessing inherent bleaching properties like fuller's earth, hence, it is known as bleaching clay. There are two types of bentonites; namely, swelling-type or sodium bentonite and non-swelling-type or calcium bentonite. Sodium bentonite is usually referred to simply as bentonite, whereas calcium bentonite is called Fuller's earth. The commercial importance of bentonite depends more on its physico-chemical properties rather than its chemical composition. Excellent plasticity and lubricity, high dry-bonding strength, high shear and compressive strength, low permeability and low compressibility make bentonite important. Bentonite is valued in foundry sand binding, drilling mud, iron ore pelletisation and as waterproofing and sealing agent in civil engineering. Processing is a prerequisite for bentonite marketing. Bhavnagar and Kachchh districts of Gujarat and Barmer district of Rajasthan are the major producers of bentonite. Sporadic occurrences are reported in Jharkhand. Both activated and granular bentonite are produced in the country. Bentonite is exported in unprocessed (crude) as well as processed (including activated) forms.

RESOURCES

Total resources of bentonite in the country as per UNFC system as on 1.4.2005 are about 531 million tonnes out of which 25 million tonnes are categorised as reserves. Bulk of the resources i.e., 423 million tonnes (80%) are in Rajasthan, 97 million tonnes (18%) in Gujarat and the remaining in Tamil Nadu, Jharkhand and Jammu & Kashmir. About 9 million tonnes, 55 million tonnes and 19 million tonnes resources are placed under drilling fluid, foundry and poor/blendable grades, respectively. Substantial quantity (448 million tonnes or 84%) of total resources are placed under 'unclassified' and 'not known' categories. The reserves/resources of bentonite as per the UNFC system as on 1.4.2005 are furnished in Table - 1.

EXPLORATION AND DEVELOPMENT

DMG, Rajasthan conducted Regional Mineral Survey on 205 sq km area, Regional Geological Mapping on 15 sq km area and Detailed Geological Mapping on 2 sq km area n/v Mokhab, Amardhan-ki-Dhani, etc. in Barmer district in 2006-07 to explore bentonite and other industrial minerals. About 0.5 m thick bed of bentonite was found exposed below overburden of sandy soil and alluvium due north of Mokhab.

In 2007-08, exploration for bentonite was conducted n/v Bhadka, Akli, Nimbsar, etc. by way of Regional Mineral Survey over 350 sq km area, Regional Geological Mapping over 15 sq km area and Detailed Geological Mapping over 3 sq km area. Bentonite depisits were noted n/v Akli, Thumbli, etc.

Table - 1 : Reserves/Resources of Bentonite as on 1.4.2005 (By Grades/States)

(In tonnes)

Grade/State	Reserves			Remaining resources							Total resources (A+B)
	Probable		Total (A)	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
	STD121	STD122		STD221	STD222						
All India : Total	**11415982**	**13644526**	**25060508**	**3067**	**65200**	**26519818**	**225744237**	**227450576**	**25730000**	**505512898**	**530573406**
By Grades											
Drilling fluid	-	-	-	-	-	-	-	9303460	-	9303460	9303460
Foundry	592570	3565120	4157690	-	65200	420000	-	50468524	-	50953724	55111414
Poor/blendable	-	-	-	-	-	-	-	18530969	-	18530969	18530969
Unclassified	2126060	609406	2735466	3067	-	13583818	5302333	14957585	-	33846803	36582269
Not known	8697352	9470000	18167352	-	-	12516000	220441904	134190038	25730000	392877942	411045294
By States											
Gujarat	-	12460170	12460170	-	-	2163813	1904	81927561	-	84093278	96553448
Jammu & Kashmir	-	-	-	-	-	-	-	147400	-	147400	147400
Jharkhand	-	609406	609406	3067	65200	-	-	134000	-	202267	811673
Rajasthan	11415982	574950	11990932	-	-	24356005	222017000	139423096	25730000	411526101	423517033
Tamil Nadu	-	-	-	-	-	-	3725333	5818519	-	9543852	9543852

Figures rounded off.

PRODUCTION

Bentonite is a minor mineral declared under Mines & Minerals (Development & Regulation) Act, 1957.

The value of bentonite produced in India in 2006-07 at Rs. 11.5 crore increased by 86% from that in the previous year. Gujarat continued to be the leading State which alone accounted for 93% and Rajasthan for the remaining share of 7% in the total value of production of bentonite (Table - 2).

Table - 2 : Production of Bentonite 2004-05 to 2006-07 (By States)

(In Rs. '000)

State	2004-05	2005-06	2006-07(p)
India	**83739**	**62198**	**115592**
Gujarat	77684	60548	107509
Rajasthan	6055	1650	8083

Source: *State Governments.*

MINING & PROCESSING

Bentonite is exploited mainly from manual mines. The bentonite deposit is very close to the surface and mined to a depth of 25 metres. A few mine owners in Kachchh and Bhavnagar districts of Gujarat deploy shovels and dumpers for mining, haulage, etc. Working of bentonite often involves selective mining, blending and processing to achieve the required grade.

The processing involves drying, grinding, sizing and at times use of additive for cation exchange. The mined material is first graded and sun-dried before pulverisation. Bentonite is processed generally by simple milling techniques that involve removal of water and volatile matter like carbon dioxide, if present, and grinding it to the appropriate sizes. Small amounts of chemicals like soda ash are added sometimes before grinding to control the properties of bentonite. Raw bentonite when delivered to the processing plant contains 25 to 40% moisture. It is, therefore, dried in dryers and the dried clay is ground in roll and hammer mills or other pulverisers and screened. Most of the bentonite is ground to approximately 90% finer than 200 mesh. For insecticide purpose, bentonite is made in the form of granules.

In case local supply of bentonite is not available, synthetic bentonite can be prepared from fuller's earth; i.e., calcium bentonite, by treating it with anhydrous soda ash.

USES & SPECIFICATIONS

Bentonite has high swelling properties along with good viscosity and liquid limit. These properties are highly valued in most of the industrial applications. Sodium bentonite is well suited as a binder in the preparation of pellets, and in foundry and oil - well drilling mud. Bentonite also acts as a suspending agent in oil - well drilling fluids. Bentonite exhibits good green strength along with high hot and dry strength which helps in preventing moulds from breaking or cracking during the pouring or cooling processs in the foundry industry. Owing to high green strength resulting from its property to absorb and then release moisture, bentonite is used in iron ore pelletisation. Sodium-based bentonite of 75 mm size finds suitability in iron ore pelletisation for bonding by user industries.

Bentonite has also remarkable colloidal and waterproofing properties. Bentonite gels are used as a carrier for a number of cosmetic preparations, toothpastes, creams, etc. Bentonite is also used in chemical, rubber, insecticide & pesticide industries and in civil construction works. Bentonite in the form of fine powder free from dirt and other foreign matter and of least swelling property is used in ceramic industry.

The specifications of bentonite for chemical & rubber and oil - well drilling industries vide BIS Specification IS:6186-1986 (Second Revision) are given in Table-3. Specification for foundry industry vide IS:12446-1988 are furnished in Table- 4. Specifications for ceramic industry vide IS:12621-1988 are given in Table - 5.

Table - 3 : BIS Specifications of Bentonite in Chemical, Rubber and Oil - Well Drilling Industries {IS:6186-1986 (Second Revision, Reaffirmed 2003)}

Sl. No.	Characteristic	Industry		
		Type 1 Chemical & Rubber	Type 2* Oil well drilling	
			High grade	Offshore grade
1.	Moisture, % by mass			
	a) Minimum	5.00	-	-
	b) Maximum	12.00	12.00	12.00
2.	pH	9.00 to 10.50	-	-
3.	Gel formation index	To pass test	To pass test	To pass test
4.	Swelling power	To pass test	-	-
5.	Fineness			
	a) Dry - To pass through 150 - micron IS sieve, % by mass, minimum	-	98.00	98.00
	To pass through 75 - micron IS sieve, % by mass, minimum	95.00	90.00	-
	b) Wet - Retained on 150 - micron IS sieve, % by mass, maximum	0.01	-	-
	To pass through 45 - micron IS sieve, % by mass, minimum	90.00	98.00	-
6.	Viscosity at 30^0 C, centipoise, min.			
	a) Apparent	-	15.00	-
	b) Plastic	-	6.00	-
7.	Filtration loss, ml, maximum	-	15.00	15.00
8.	Sand content, % by mass, maximum for rubber industry only	-	2.00	2.00
For Rubber Industry Only				
9.	Loss on ignition (other than loss on drying), % by mass, maximum	6.00	-	-
10.	Matter soluble in water, % by mass, maximum	4.00	-	-
11.	Copper (as CuO), % by mass, maximum	0.01	-	-
12.	Manganese (as MnO), % by mass, maximum	0.01	-	-

** This material shall also have a yield of 90 barrels, which shall be determined by the number of barrels (181- litre capacity) of mud of 15-centipoise viscosity obtained from 1,000 kg bentonite dispersed in water and aged for 24 hours.*

Table - 4 : BIS Specifications of Bentonite in Foundry Industry {IS:12446-1988 (Reaffirmed 2003) }

Sl. No.	Characteristic	Grade 1 (Sodium base)	Grade 2 (Calcium base)
1.	Loss on drying, % by weight		
	a) Minimum	5.00	5.00
	b) Maximum	12.00	12.00
2.	pH, at 2% suspension	9.00 to 10.50	8.00 to 9.00
3.	Gel formation index (as obtained with mechanical shaking)	60 (min)	10 (min)
4.	Fineness		
	a) Dry - To pass through 150 - micron IS sieve, % by weight, minimum	97.00	97.00
	To pass through 75 - micron IS sieve, % by weight, minimum	90.00	90.00
	b) Wet - To pass through 45 - micron IS sieve, % by weight, minimum	95.00	95.00
5.	Calcium oxide (Replaceable Ca^{++}), % by weight	0.70	3.00
6.	Liquid limit	450-550	200-300

Table - 5 : BIS Specifications of Bentonite in Ceramic Industry {IS:12621-1988 (Reaffirmed 2001)}

Sl. No.	Characteristic	Requirement
1.	Free moisture content at 105 ± 2°C, % by mass, max	6.0
2.	Residue on 106 - micron IS sieve, % by mass, max	Nil
3.	Grit content on 45 - micron IS sieve, % by mass max	1.0
4.	Loss on ignition, % by mass	8 to 12
5.	Silica (as SiO_2), % by mass	48 to 55
6.	Alumina (as Al_2O_3), % by mass	18 to 28
7.	Iron oxides (as Fe_2O_3), % by mass, max	4
8.	Titanium oxide (as TiO_2), % by mass, max	3
9.	Oxides of iron (as Fe_2O_3) and titanium (as TiO_2) together, % by mass, min	6
10.	Water of plasticity, % by mass	45 to 60
11.	Swelling power after 24 hours	15 to 20
12.	Calcium oxide (as CaO), % by mass, max	3
13.	Magnesium oxide (as MgO), % by mass, max	3
14.	Oxides of calcium (as CaO) and magnesium (as MgO), together, % by mass, max	5
15.	Viscosity at 30°C, centipoise, min	4.5

Note: *All tests except for Sl. No. 1 shall be carried out on dry basis.*

CONSUMPTION

The consumption of bentonite in 2007-08 decreased to 124,700 tonnes from 125,600 in the previous year. Foundry industry accounted for 41% consumption, followed by pelletisation 26%, oil well drilling 14% and iron and steel industry 6% (Table-6).

Table - 6 : Reported Consumption of Bentonite, 2005-06 to 2007-08 (By Industries)

(In tonnes)

Industry	2005-06(R)	2006-07	2007-08(p)
All Industries	**126000**	**125600**	**124700**
Alloy steel	900 (2)	900 (2)	900 (2)
Ceramic	700 (6)	700 (7)	700 (7)
Chemical	1500 (3)	1500 (3)	1500 (3)
Ferro-alloys	500 (1)	500 (1)	500 (1)
Fertilizer	3300 (3)	3300 (3)	3300 (3)
Foundry[e]	51100 (20)	51500 (21)	51300 (21)
Iron & Steel	7700 (2)	7000 (2)	7000 (2)
Oil - well drilling	18100 (2)	18500 (2)	17400 (2)
Pelletisation (iron & steel)	33000 (2)	32500 (2)	32800 (2)
Pesticide	4600 (1)	4600 (1)	4600 (1)
Refractory	4600 (14)	4600 (14)	4600 (14)
Others (electrode, paint, sugar, petroleum refining and textile)	100 (12)	100 (12)	100 (12)

Figures rounded off. Data collected on non-statutory basis.
Figures in parentheses denote the number of units in organised sector reporting consumption.
Substantial quantity has also been consumed in civil construction of which data are not available.

INDUSTRY

There were about 30 pulverising units in Gujarat and 27 in Rajasthan. The pulverisation plant of RSMML (formerly RSMDC) set up in Barmer in collaboration with ONGC was closed down. The processing plants of bentonite owned by Neelkanth Chemical Work at Akli, Barmer and Jodhpur in Rajasthan produce about 25,000 tpy sodium bentonite.

The Ashapura Minechem Pvt. Ltd., Kachchh has a bentonite pulverising plant having a capacity of 60,000 tpy near Bhuj, Kachchh district. The plant can produce 90% 200-mesh powder. The company also has a new Pellet Strength Test (PST) grade bentonite plant having a capacity of 100,000 tpy near Bhuj. It produces 90% minus 63-micron powder which is supplied to the iron ore pelletisation industry.

Ashapura Volclay is a joint venture between Ashapura Group, India's leading bentonite exporter, and Illinois-based Amcol International Corp., one of the USA's top bentonite producers. The company began producing bleaching clays from a new plant in Bhuj in Kachchh district at the end of 2001. This plant has 30,000 tpy capacity to produce attapulgite-bentonite product. The blended clay is particularly in demand in the domestic market for bleaching of light-coloured vegetable oils, such as sunflower, groundnut and cotton seed oils.

Gimpex Ltd has processing plant with capacity of 45,000 tpy in Kachchh region of Gujarat producing sodium and calcium bentonite.

WORLD REVIEW

The global production of bentonite in 2007 was around 16 million tonnes. The USA was the largest producer with an estimated output of around 5.1 million tonnes followed by China and Greece with 3.2 million and 1.1 million tonnes estimated output, rspectively. Other major producers were India, Mexico, Italy, Japan, Russia, Turkey, Brazil and Germany (Table - 7).

Table - 7 : World Production of Bentonite (By Principal Countries)

(In '000 tonnes)

Country	2005	2006	2007
World : Total	**14400**	**14800**	**15700**
Brazil	460	419	330
China	2300	3200	3200[e]
Germany	352	364	385
Greece	1125	1100[e]	1100[e]
India[e]	590	610	630
Italy	446	470	560
Japan	422[e]	425	425[e]
Mexico	426	435	614
Russia	500[e]	456[e]	460[e]
Turkey	583	400[e]	400[e]
USA	4710	4940	5070[e]
Other countries	2486	1981	2526

Source: *World Mineral Production, 2003-2007.*

FOREIGN TRADE

Exports of bentonite decreased marginally to 462,502 tonnes in 2007-08 from 480,189 tonnes in the previous year. Major buyers were Poland (15%), Brazil (14%), Indonesia (13%), Netherlands and UAE (10% each) and Italy, Malaysia and Australia (5% each) (Table-8).

Imports of bentonite increased to 8,025 tonnes in 2007-08 from 4,987 tonnes in the previous year. Imports were mainly from Indonesia (43%), USA (27%) and China (8%) (Table-9).

Table - 8 : Exports of Bentonite (By Countries)

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	**480189**	**906621**	**462502**	**1061530**
Brazil	99293	166489	63827	121887
Poland	16312	24647	68124	111979
Indonesia	64793	115694	60152	94767
Australia	30943	59858	21769	94030
Netherlands	44465	83686	45811	89925
UAE	41818	88351	48513	84240
Malaysia	52701	66030	23491	70749
Italy	24063	30200	24826	54647
Spain	5608	16272	13546	39541
Russia	3545	28890	4698	28783
Other countries	96648	226504	87745	270982

Table - 9 : Imports of Bentonite (By Countries)

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	**4987**	**105946**	**8025**	**135241**
Indonesia	1393	19482	3449	45374
USA	206	16758	2131	28011
China	1162	27879	669	23835
Germany	322	7848	461	9815
Malaysia	693	8972	419	5007
UK	19	1931	26	4721
Thailand	681	7449	301	4266
Italy	122	1675	326	3984
South Africa	21	1669	61	3880
Honduras	32	4798	-	-
Other countries	336	7485	182	6348

FUTURE OUTLOOK

The biggest markets for bentonite in both North America and European countries are foundry, cat litter, iron ore pelletising and drilling. Civil engineering and environmental applications, such as land fills, require bentonite for use as a sealant and lubricant. The global bleaching clay market is estimated at 860,000 tpy of which 700,000 tpy is used for bleaching edible oils, 150,000 tpy for petroleum, and the remaining 10,000 tpy for clarifying beverages, such as wines and fruit juices. Ashapura Volclay produces and sells more than 20,000 tpy bleaching clays which can be used for refining all kinds of vegetable oils, industrial oils, fats and waxes. The Indian bentonite industry is expected to get on well in the coming years because of emerging demand for oil clarification and cat litter. The strong growth in India has led to an exponential demand for foundry and casting products for the automotive industry. Also due to huge demand of iron ore pelletiation, demand for bentonite in India would augment for years to come.