

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 works. Processing is a prerequisite for bentonite marketing. Bhavnagar and Kachchh districts of Gujarat and Barmer district of Rajasthan are the major producers of bentonite. The sodium bentonite mined in Rajasthan tends to be of lower quality and is used as foundry sand. Both activated and granular bentonite are produced in the country. Bentonite is exported in unprocessed (crude) and processed (including activated) forms as well.

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 resources are placed under drilling fluid grade, 55 million tonnes under foundry grade and 19 million tonnes resources are placed under 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 & DEVELOPMENT

During 2009-10 Directorate of Mining & Geology, Rajasthan carried out exploration for the project (IM -01) continuation of prospecting for silicious earth, silica sand, clay, bentonite, in Sheo

Tehsil, Barmer district. Bentonite has been noticed n/v Kumraho - ki Dhani, Pusad, Bisu Kalan, North of Gunga below 0.35 m to 1.25 m in nalaha section pits and trenches. Thickness was observed up to 2.25 m or more. Regional Mineral Survey over 305 sq km area, Regional Geoloical Mapping over 22 sq km area and Detailed Geoloical Mapping over 4 sq km was carried out and 11 samples were collected from the area.

PRODUCTION

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

The value of bentonite produced in India in 2008-09 at Rs. 14.7 crore increased by 14.3% as compared to the previous year. During 2008-09, Gujarat alone accounted for 78% share and Rajasthan for the remaining 22% in the total value of production of bentonite (Table - 2).

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. Ashapura Minchem Ltd is one of the major processors which processed about 159,789 tonnes of bentonite lumps and produced 50,993 tonnes of granules during 2009-10.

BENTONITE

**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.

BENTONITE

**Table – 2 : Production Value of Bentonite
2006-07 to 2008-09
(By States)**

State	(In Rs. '000)		
	2006-07	2007-08	2008-09(P)
India	115592	128414	146768
Gujarat	107509	115153	115153
Rajasthan	8083	13261	31615

Source: State Governments.

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 as 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 process 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 micron size finds suitability in iron ore pelletisation for bonding by user industries. Bentonite clay is also used in pyrotechnics, to make end plugs and rocket engine nozzles.

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. Bentonite which is the active mineral in clays with medicinal properties is also prescribed as a bulk laxative and it is also used as a base for many dermatological formulations

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° C, centipoise, min.			
	a) Apparent	–	15.00	–
	b) Plastic	–	6.00	–

(Contd.)

BENTONITE

Table - 3 (Concl.)

Sl. No.	Characteristic	Industry		
		Type 1 Chemical & Rubber	Type 2* Oil-well drilling	
			High grade	Offshore grade
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 ₂ O ₃), % by mass	18 to 28

(Contd.)

BENTONITE

Table - 5 (Concl.d.)

Sl. No.	Characteristic	Requirement
7.	Iron oxides (as Fe ₂ O ₃), % by mass, max	4
8.	Titanium oxide (as TiO ₂), % by mass, max	3
9.	Oxides of iron (as Fe ₂ O 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 2009-10 increased to 103,700 tonnes from 100,800 tonnes in the previous year. Foundry industry accounted for 51% consumption, followed by, oil well drilling 24%, pelletisation 7% and pesticide and refractory industry 4% each (Table-6).

Table – 6 : Reported Consumption of Bentonite, 2007-08 to 2009-10 (By Industries)

Industry	(In tonnes)		
	2007-08	2008-09(R)	2009-10(P)
All Industries	109000	100800	103700
Alloy steel	900 (2)	900 (2)	900 (2)
Ceramic	700 (8)	700 (8)	700 (8)
Chemical	1500 (3)	1500 (3)	1500 (3)
Ferro-alloys	500 (1)	500 (1)	500 (1)
Fertilizer	3300 (3)	3300 (3)	3300 (3)
Foundry ^(e)	52000 (22)	52500(23)	52500 (23)
Iron & Steel	7000 (2)	3900 (2)	3600 (2)
Oil - well drilling	17400 (2)	17400 (2)	24400 (2)
Pelletisation (iron & steel)	16500 (2)	10900 (2)	7100 (2)
Pesticide	4600 (1)	4600 (1)	4600 (1)
Refractory	4600 (14)	4600 (14)	4600 (14)
Others (electrode, paint, sugar, petroleum refining and textile)	++ (13)	++(13)	++ (13)

Figures rounded off. Data collected on non-statutory basis. Figures in parentheses denote the number of units in organised sector reporting consumption.*

(Includes actual consumption and/or estimates made wherever required).*

In addition, substantial quantity has also been consumed in civil construction of which data is not available.

INDUSTRY

There were about 30 pulverising units in Gujarat and 27 in Rajasthan. 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, Gujarat 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. It also has mining and mineral processing facilities in the states of Karnataka, Kerala, Andhra Pradesh and Odisha. The new exciting areas with immense growth potential are value added products like bleaching clay, clay catalysts, Geosynthetic Clay Liners (GCL), etc.

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 is producing bleaching clays from its plant in Bhuj in Kachchh district, Gujarat since 2001. This plant has 30,000 tpy capacity to produce attapulgit-bentonite product. The blended clay is in demand particularly in the domestic market for bleaching of light-coloured vegetable oils, such as sunflower, groundnut and cotton seed oils.

Gimpex Ltd has a processing plant with capacity of 45,000 tpy in Kachchh region of Gujarat producing sodium and calcium bentonite. It is reported that in addition to Gimpex Ltd, Jumbo

BENTONITE

Mining, Star Bentonite Group and Gexmin Co. also produce processed bentonite.

WORLD REVIEW

The global production of bentonite in 2009 was around 14.1 million tonnes. The USA was the largest producer with an estimated output of around 4.1 million tonnes followed by China with 3.4 million tonnes. Other major producers were Turkey, India, Mexico, Russia, Japan, Brazil, Germany and Italy (Table - 7).

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

Country	(In '000 tonnes)		
	2007	2008	2009
World: Total	16200	15800	14200
Brazil	330	340 ^(e)	340 ^(e)
China ^(e)	3300 ^(e)	3300 ^(e)	3400 ^(e)
Germany	385	414	326
Greece	1390	1529	926
India ^(e)	579	700	560
Italy	600	281	146
Japan ^(e)	430	435	435
Mexico	614	375	511
Russia ^(e)	460 ^(e)	460 ^(e)	460 ^(e)
Turkey	748	683	753
USA ^(e)	4820 ^(e)	4900 ^(e)	4100 ^(e)
Other countries	2544	2383	2243

Source: World Mineral Production, 2005-2009.

FOREIGN TRADE

Exports of bentonite decreased to 457,079 tonnes in 2009-10 from 566,890 tonnes in the previous year. Major buyers were Indonesia (21%), Malaysia (12%), Ukraine (7%) and Kuwait (6%) (Table-8).

Imports of bentonite decreased to 2,378 tonnes in 2009-10 from 4,500 tonnes in the previous year. Imports were mainly from USA (48%), China (17%) (Table-9).

Table – 8 : Exports of Bentonite (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	566890	1414440	457079	1252043
Indonesia	108115	178169	97297	168325
Ukraine	–	–	30550	103647
Malaysia	78151	106456	56936	101375
Brazil	59472	164506	23393	75688
Saudi Arabia	5531	26202	24266	70177
Spain	13848	51860	15595	68069
Kuwait	14912	27304	27769	64140
UAE	60584	117463	22760	55972
Russia	4413	49812	2975	43473
Netherlands	34343	94374	10500	28688
Other countries	187521	598294	145038	472489

Table – 9 : Imports of Bentonite (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	4500	95996	2378	74132
USA	523	24015	1161	44723
China	557	9929	410	9803
Italy	295	4245	317	5218
Spain	37	935	80	3341
UK	37	3429	48	3289
Indonesia	2684	42706	139	2286
France	31	1576	13	1966
Turkey	42	422	124	1640
Germany	282	7729	11	596
Thailand	6	669	2	343
Other countries	6	341	73	927

FUTURE OUTLOOK

The Indian bentonite industry is expected to perform better 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. Demand for bentonite in India would augment for years to come due to iron ore pelletisation.