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BENTONITE

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

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5 Bentonite

Bentonite is essentially a highly plastic clay containing not less than 85% clay mineral, montmorillonite. It gets its name from the place where its presence and usages were first discovered - Fort Benton, America. Bentonite's commercial importance is due to its inherent bleaching properties similar to that of fuller's earth, hence, it is also 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 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 & lubricity, high dry-bonding strength, high shear & compressive strength, low permeability and low compressibility make bentonite commercially viable. Bentonite is valued in applications, such as, foundry sand binding, drilling mud, iron ore pelletisation and as a waterproofing & 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 producing areas 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 both as unprocessed (crude) and processed (including activated) forms.

RESOURCES

The total resources of bentonite in the country as per UNFC system as on 1.4.2010 are about 568 million tonnes out of which 25 million tonnes are categorised as reserves. The bulk of the resources, i.e. 424 million tonnes (75%) are in Rajasthan, 134 million tonnes (24%) 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 485 million tonnes (85%) of total resources is placed under 'Unclassified' and 'Not-known' categories collectively. The reserves/resources of bentonite as per the UNFC system as on 1.4.2010 are furnished in Table - 1.

EXPLORATION & DEVELOPMENT

GSI carried out exploration for potash in glauconite bearing shale and sandstone around village Guneri of Kachchh district of Gujarat. During the investigation, occurrences of other minerals like bentonite as small vein/patches/pockets were observed. Earlier DMG, Rajasthan carried out exploration for bentonite near village Devka, Pusad and Rajral in Barmer district.

In the FS 2014-15 DMG, Rajasthan further carried out exploration for minerals bentonite, siliceous earth, sandstone etc. near village Jasse ka Gaon, Rawar ka Gaon and Lalso ki Dhani in Sheo tahsil, district Barmer by carrying out Detailed Geological Mapping on 1:2000 scale in 3 sq. Km. area. Reserves/Resources were not estimated yet. Also in addition to this DMG carried out Detailed Geological Mapping on 1:2000 scale in 2.70 sq. Km area near village Jharniya, tah. Pirawa, district Jhalawar. For Chemical analysis about 40 samples were collected. About 37,500 tonnes of bentonite reserves were estimated.

PRODUCTION

The value of bentonite produced in India in 2013-14 at ₹ 82 crore decreased by about 10% as compared to the previous year.

During the year under review Gujarat contributed 97% to the total value of production of bentonite while remaining 3% was accounted by Rajasthan (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 amount 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 has extensive reserves of both types of Sodium & Calcium based bentonite in Kachchh, Gujarat, India. However, predominantly, most of its reserves are high quality, high montmorillonite based Sodium grades which gives Ashapura the opportunity to produce various quality bentonite products for diverse industry sectors.

Table – 1 : Reserves/Resources of Bentonite as on 1.4.2010 (By Grades/States)

(In tonnes)

Grade/State	Reserves			Remaining Resources						Total Resources (A+B)
	Probable		Total (A)	Pre-feasibility STD221	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
	STD121	STD122								
All India : Total	**11415982**	**13644526**	**25060508**	**3067**	**26519818**	**225744237**	**265309715**	**25730000**	**543306837**	**568367345**
By Grades										
Drilling fluid	-	-	-	-	-	-	9303460	-	9303460	9303460
Foundry	592570	3565120	4157690	-	420000	-	50468524	-	50888524	55046214
Poor/blendable	-	-	-	-	-	-	18530969	-	18530969	18530969
Unclassified	2126060	609406	2735466	3067	13583818	5302333	52583197	-	71472415	74207881
Not-known	8697352	9470000	18167352	-	12516000	220441904	134423565	25730000	393111469	411278821
By States										
Gujarat	-	12460170	12460170	-	2163813	1904	119553173	-	121718890	134179060
Jammu & Kashmir	-	-	-	-	-	-	147400	-	147400	147400
Jharkhand	-	609406	609406	3067	-	-	367527	-	370594	980000
Rajasthan	11415982	574950	11990932	-	24356005	222017000	139423096	25730000	411526101	423517033
Tamil Nadu	-	-	-	-	-	3725333	5818519	-	9543852	9543852

Figures rounded off.

Table – 2 : Value of Production of Bentonite 2011-12 to 2013-14 (By States)

(Value in ₹'000)

State	2011-12	2012-13	2013-14(P)
India	**71307**	**907770**	**817825**
Gujarat	33697	728770	790800
Rajasthan	37610	179000	27025

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 and is abundantly used in horizontal drilling for shale production. 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 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 Reaffirmed 2010) are given in Table-3. Specifications for Ceramic Industry vide IS:12621-1988 (Reaffirmed 2011) are given in Table-4. BIS has revised the specifications of bentonite for use in Foundries, the new specifications are prescribed vide IS : 12446 - 2007 (First Revision, Reaffirmed 2012).

Table – 3 : BIS Specifications of Bentonite in Chemical, Rubber and Oil - Well Drilling Industries {IS:6186-1986 (Second Revision, Reaffirmed 2010)}

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	–

(Contd.)

Table - 3 (Concld.)

Sl. No.	Characteristic	Industry		
		Type 1 Chemical & Rubber	Type 2* Oil-well drilling	
			High grade	Offshore grade
6.	Viscosity at 30 °C, centipoise, min.			
	a) Apparent	–	15.00	–
	b) Plastic	–	6.00	–
7.	Filtration loss, ml, maximum	–	15.00	15.00
For Rubber Industry Only				
8.	Sand content, % by mass, maximum	–	2.00	2.00
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 for Ceramic Industry {IS:12621-1988 (Second amendment, Reaffirmed 2011)}

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 2014-15 decreased slightly to 70,700 tonnes from 79,700 tonnes in the previous year. Oil-well Drilling Industry accounted for 31% consumption, followed by Iron & Steel 28%, Chemical Industry 11%, Foundry 9%, Pelletisation (iron & steel) 8% and Refractory (6%) (Table-5).

Table - 5 : Consumption* of Bentonite 2012-13 to 2014-15 (By Industries)

(In tonnes)

Industry	2012-13	2013-14(R)	2014-15(P)
All Industries	**73400**	**79700**	**70700**
Alloy steel	900(2)	900(2)	900(2)
Ceramic	700(7)	700(7)	700(7)
Chemical	7500(3)	7500(3)	7500(3)
Electrode	14(3)	17(3)	19(3)
Fertilizer	3300(1)	3300(1)	3300(1)
Foundry[(e)]	6100(21)	6100(21)	6100(21)
Iron & Steel	17400(6)	19800(3)	19800(2)
Oil-well drilling	23400(2)	22000(2)	22000(2)
Pelletisation (iron & steel)	9600(2)	15100 (2)	6000(2)
Refractory	4500(11)	4300(11)	4400(11)

Figures rounded off.
Figures in parentheses denote the number of units in Organised Sector.
**Paucity of data, hence coverage may not be complete.*

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 with a capacity of 3,50,000 tpy near Bhuj in Kachchh district. The plant can produce 90% 200-mesh powder. The Company also has a new Pellet Strength Test (PST) grade bentonite plant with a capacity of 1,00,000 tpy near Bhuj. It produces 90% minus 63-micron powder which is supplied to the Iron Ore Pelletisation Industry. Its main processing facility is close to Mundra port which is a deep water, all weather port, and can berth even up to cape sized vessels. It also has mining and mineral processing facilities in the states of Karnataka, Kerala, Andhra Pradesh and Odisha. Quantities of various products of bentonite produced by the Ashapura Minechem Pvt. Ltd during 2013-14 are given below:

Table- 6 : Bentonite Products Produced During 2013-14

(In tonnes)

Product	2013-14
Bentonite Granules	16,174
Bentonite Powder	1,50,535
Bentonite Processed Lumps	2,87,442
Bentonite Unactivated Lumps	3,47,982
Bauxite Lumps	7,01,065
Bauxite Powder	4,926
Attapulgite Lumps	1,649
Bleaching Clay	33,306
Kaolin	7,875
China Clay	-

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 produces bleaching clays from its plant in Bhuj in Kachchh district, Gujarat since 2001 with the installed capacity of 50,000 tpy. 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. The Company is in the process of expanding its production capacity of acid activated bleaching clay. Ashapura is India's largest and one of the top five players in Bentonite globally having extensive reserves of high quality Na and Ca Bentonite which are mined & processed carefully into several grades.

Following the success of the plant at Bhuj, Ashapura Group has set up another plant for manufacturing bleaching earth at Dharur, Andhra Pradesh, with installed capacity of 30,000 tpy. This plant not only has access to the primary raw mineral attapulgite but also has a logical edge for exports to the palm oil producing and refining countries in South-East Asia. The brand 'Clearflow' has within a short span established itself as a cost-effective brand in major oil refiners in India and overseas. Given the importance of Europe as a market, the Ashapura Minechem has set up a mineral processing complex at Antwerp, Belgium as a joint venture with AMCOL International Corp. with installed capacity of 20,000 tpy. The facility has the capability of processing bleaching earth which would be exported from India in a semi-processed form. The Antwerp facility today serves all the major oil refineries of Europe by making available cost-effective and quality product at their doorstep. All the Bleaching Earth grades from Ashapura are available at Antwerp facility. Malaysia being a strategic manufacturing hub in South-East Asia for edible oils, has prompted Ashapura to invest in Hudson MPA Snd. Bhd., a reputed Bleaching Earth manufacturer of Malaysia. The Selangor facility imports attapulgite and bleaching earth from Ashapura in India and processes it for marketing in Malaysia and neighbouring countries. The Selangor plant has an installed capacity of 20,000 tpy.

Gimpex Pvt. 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 Pvt. Ltd, Jumbo Mining, Star Bentonite Group , Fonadwell Minechem and Gexmin Co. also produce processed bentonite.

WORLD REVIEW

The global production of bentonite in 2014 was around 16.2 million tonnes. The USA was the largest producer with an estimated output of around 4.66 million tonnes followed by China with 3.5 million tonnes. Other major producers were India, Greece, Mexico, Turkey, Iran, Russia, Brazil, Japan and Germany (Table - 7).

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

(In '000 tonnes)

Country	2012	2013	2014
World: Total (rounded)	**17100**	**16200**	**16200**
Argentina	194	200	200
Brazil	513	434	400
China	3500	3500	3500
Cyprus	160	158	140
Czech Republic	221	226	301
Germany	366	359	395
Greece	1235	1200	1000
India[(e)]	1240	1567	1372
Iran	430	502	500
Italy	96	20	21
Japan[(e)]	420	400	400
Mexico	956	618	620
Morocco	91	105	99
Russia[(e)]	460	460	460
Slovakia	177	184	205
South Africa	121	177	170
Spain	97	103	100[(e)]
Turkey	1034	623	620[(e)]
Ukraine	219	219[(e)]	219[(e)]
USA	4980	4350	4660[(e)]
Other countries	590	795	818

FOREIGN TRADE

Exports of bentonite increased slightly to 1.30 million tonnes in 2014-15 from 1.23 million tonnes in the previous year. Major buyers were Indonesia & Malaysia (20% each), Ukraine (17%), Oman (6%) and Saudi Arabia (5%) (Table-8).

Table – 8 : Exports of Bentonite (By Countries)

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**1225568**	**3860451**	**1300083**	**3999735**
Malaysia	294079	690200	259139	657564
Indonesia	233792	524873	259785	548507
Ukraine	115500	233587	216503	495331
Oman	77450	241995	80316	235003
Saudi Arabia	54085	264567	62559	228029
UAE	33844	142387	43240	156683
Korea, Rep. of	31767	112482	39010	136036
Australia	24631	124305	26854	116176
Thailand	26207	120213	23153	112838
Belgium	42472	88863	36198	88270
Other countries	291741	1316980	253326	1225298

Similarly imports of bentonite also increased considerably to 11,002 tonnes in 2014-15 from 6,071 tonnes in the previous year. Imports were mainly from Turkey (52%), China & USA (17% each), Italy (6%), and Egypt (4%) (Table-9).

Table – 9 : Imports of Bentonite (By Countries)

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**6071**	**201663**	**11002**	**316055**
USA	2336	105122	1845	120448
Turkey	1533	28609	5711	102803
China	1278	31243	1866	35016
UK	181	11041	186	15794
Italy	348	7966	620	13190
Egypt	120	3316	425	10562
Thailand	71	3822	25	3929
France	24	4965	15	2768
Spain	-	-	70	2347
Indonesia	94	2796	75	2307
Other countries	86	2783	164	6891

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 biggest market 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 8,60,000 tpy of which 7,00,000 tpy is used for bleaching edible oils, 1,50,000 tpy for petroleum and the remaining 10,000 tpy for clarifying beverages, such as, wines and fruit juices.

Bentonite is among the exportable mineral commodities in India. Bentonite is exported both in unprocessed (crude) and processed (including activated) forms. Though, export of crude bentonite account for a higher quantity, the exports of processed bentonite fetch higher value than the crude bentonite. There is a pressing need to develop different processing techniques that suit our available resources, in order to make our products match the international standards. There is scope to establish bentonite processing granulation and paint-grade processed bentonite units in the country to meet the indigenous demand as well as demand in the international market.