

BENTONITE COMMODITY MARKETS FROM 1990 AND FUTURE TRENDS

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Introduction

From a historical perspective, bentonite is the common rock term for various uses and applications. Its name originates from water-based muds near Fort *Benton* used for lubrication of wagon wheels during the 19th century migration to western territories (which are presently part of the United States) when the pioneers ran out of axle grease.

From a clay mineralogy perspective, bentonite is composed primarily of montmorillonite, an expandable magnesium aluminum silicate clay mineral. When magnesium occupies an octahedral structural site that usually contains an aluminum atom, a negative charge is created. In order to neutralize negative charges, cations are drawn to the interlayer surfaces between clay mineral sheet structures. Modern applications for bentonite depend on the sodium or calcium cation populations and other characteristics of the clay mineral. When sodium is the dominant cation, the material is also called sodium bentonite, also known as swelling bentonite, western bentonite or Wyoming bentonite. When calcium or magnesium is the dominant cation, the material is called calcium bentonite, also known as nonswelling bentonite or southern bentonite.

Swelling bentonite is recognized for its rapid hydration of interlayer sodium and subsequent dramatic expansion up to more than 20 times its original volume. Low shear can then disperse the hydrated sodium bentonite to form suspensions that increase viscosity and suspend solids. However, when shear is subsequently eliminated a sodium bentonite slurry gels.

Characteristically, nonswelling calcium bentonite has relatively poor hydration properties and thus low expansion of the clay mineral. When subjected to low shear, calcium bentonite exhibits very little viscosity and poor suspension. Additionally, when shear is subsequently eliminated no more than minimal gelling takes place.

The domestic and export markets related to both swelling and nonswelling bentonite are discussed below.

Major Commodity Markets

The US Geological Survey uses the two categories of swelling bentonite and nonswelling bentonite in publications about the markets for and uses of bentonite. In the most recent USGS Minerals Yearbook, the annual commodity markets for swelling bentonite are typically 10 to 12 times greater than for nonswelling bentonite. For example, clumping pet litter brands (which use swelling bentonite) garner the greatest market share and depend on the rapid hydration and expansion of sodium bentonite. In contrast, traditional merely absorbent pet litters (which use nonswelling bentonite) have experienced a decline in market share. They do not require hydration and expansion characteristics; such pet litters are heated or calcined using calcium bentonite, fuller's earth or diatomite. However, both pet litter markets also rely on the absorption capacity of bentonite or other minerals.

Table 1 lists the annual major domestic and export commodity markets for bentonite. These data are from the USGS Minerals Yearbooks from 1990 through 2005.

The largest domestic market for swelling bentonites is as a component of clumping pet litters. The first clumping pet litter utilizing swelling sodium bentonite was patented in the 1980s, and its market developed around 1986. By 1990, the market for clumping pet litters reached 157,000 metric tons. By 2005, it reached the astounding figure of 1,244,000 metric tons. During the rapid rise of the clumping pet litter market, producers struggled to expand production capacity for granular sodium bentonite. Unless a competitive new pet litter product is accepted by cats and cat owners, sodium bentonite for clumping pet litter, will exceed 1,244,000 metric tons per year in North America. This market is related to the economy and demographics of the USA and Canada.

The second domestic largest market for swelling bentonite is as a component of drilling mud for oil, gas and various minerals. For the drilling mud market, certain grades of sodium bentonite (typically Wyoming bentonite) aqueous suspensions provide a viscous but shear thinning fluid that suspends weighting agents such as barite, iron oxides, and drill cuttings. During the boring process, the drilling mud not only lubricates the drill stem but also applies hydrostatic pressure on the drill bit. When the pump (which introduces the drilling mud to the bored down-hole circulation processes) ceases, the drilling mud in the hole forms a gel to suspend the drill cuttings and weighting agent. Additionally, resumed pumping requires only minimum shear strength to break the gelled condition and restart circulation.

The domestic production of drilling grades of sodium bentonite progressed from a low of 463,000 metric tons in 1992 to 945,000 metric tons in 2005. In the near future, the growing use of both oil and gas in the Chinese and Indian economies is projected to increase the demand for drilling mud sodium bentonites to over 1,000,000 metric tons per year.

A significant portion of the sodium bentonite listed for domestic drilling is actually ultimately exported in refined drilling products. In addition, the export market for sodium bentonite ore grades ranged from 57,000 to 76,000 metric tons per year during the last five years.

The third largest domestic commodity market for swelling bentonite is as a binder in foundry sand blends. A grade of sodium bentonite, (with a greater number of cations per unit weight than the sodium bentonite used for drilling mud) is combined with foundry sand, other components, and water, then mullied. Such mix is then compacted into a mold of the final desired product, and subsequently molten metal is poured into the mold and cooled before the mold is broken away, releasing the final three-dimensional product.

Domestically, the foundry sand market is subject to the vagaries of the USA industrial economy and has ranged from a low of 660,000 metric tons in 1991 to a high of 901,000 metric tons in 1997. Since 2004, this commodity market has stabilized just below 900,000 metric tons. The USA foundry business aggressively defends its present production volumes. Nevertheless, if the foreign foundry business undercuts USA foundry pricing, or foundry businesses are relocated off shore, domestic production will fall below the annual 900,000 metric ton level.

Past foreign exports of up to 321,000 metric tons of sodium bentonite (of which over half goes to Canada for their eastern foundry operations near the Great Lakes iron ore mines) have slowly decreased to 205,000 metric tons in 2005. Future trends for the export commodity market should stabilize between 175,000 and 225,000 metric tons per year unless the

Canadian industrial economy falls under pressures from other competing foreign foundry producers.

The fourth largest domestic commodity market of swelling bentonite is for iron ore pelletizing. In order to increase yields of iron ore from current mines, the ore is finely ground to gravity separate the iron oxides from gang minerals. Pelletizing depends on the rapid hydration of sodium bentonite to form a paste that adheres to individual iron oxide grains and binds them together in pellet form, such pellets are then hardened by heat and transported to iron smelters around the world. The pelletizing commodity market within the USA ranged from 717,000 metric tons in 1991 to 466,000 metric tons in 1993, and has stabilized at approximately 550,000 metric tons in the last five years. The USA market trend should remain near this value per year for the near future unless iron and steel production decreases even more in favor of foreign producers.

Note, the USGS currently lists the foreign exports of sodium bentonite to Canada and other countries for iron ore pelletizing under the category of "Other". In addition to the fact that exported pelletizing sodium bentonite is listed under "Other", such category includes the foreign exports of bentonite used in absorbents, fillers and extenders, miscellaneous refractories, and other undescribed uses. Since 1997, these foreign exports ranged from 101,000 to 159,000 metric tons per year.

The fifth largest domestic market of swelling bentonite is for waterproofing and sealing. Formerly, the domestic market related to waterproofing and sealing had ranged from 176,000 to 287,000 metric tons per year; however, this market used less than 200,000 metric tons per year since 2004. The future trend for this market will remain under 200,000 for the next several years unless regulations require additional sealing of ponds and waste-water in the USA.

The sixth largest domestic market for swelling bentonite (which market is also substantially shared by nonswelling bentonite) is its use as fillers and extenders (which include asphalt tiles, cosmetics, ink, medical, paint, paper coatings and fillings, pesticides, pharmaceuticals, and plastics). In the last five years, it ranged from 40,000 to 60,000 metric tons. Again foreign competition may gain the edge in this market.

The seventh largest domestic market for swelling bentonite (which market is also substantially shared by nonswelling bentonite) is its use as an animal feed additive. The bentonite can carry trace elements, drugs and additives. It can also slow the animal digestive process to enhance digestion and food conversion. In the last six years this market stabilized at about 50,000 metric tons. Bentonite for animal feed use should remain at this level for the near future.

The eighth largest domestic market for swelling bentonite (which market is also substantially shared by nonswelling bentonite) is listed as “Miscellaneous” by the USGS. This category contains several minor uses of bentonite (which market is also substantially shared by nonswelling bentonite) by two or less domestic producers. Such producers provide products such as absorbents, ceramics, tiles, pottery, filtering and clarifying oils, waterproofing seals, chemical manufacturing, oil well sealing, heavy clay products, lightweight aggregates, desiccants, miscellaneous refractories and kiln furniture, and other uses undefined by the USGS. Future miscellaneous trends from USGS data are not persuasively predictable because, at the point when three or more producers compete in producing any of these products, the USGS removes the listing to an inclusion in a more descriptive category.

The use of bentonite in a minor domestic market in adhesives had declined from 12,900 metric tons in 1998 to just 2,000 metric tons in 2005. Foreign pressures many diminish this market more.

The August 2006 *Mineral Price Watch* reports that demand is currently at its highest level for US producers since the early 1980s. Most Wyoming bentonite plants are running 24 hours a day, seven days a week. Prices for Wyoming bentonite ex-works are now \$55 to \$80 per short ton for API drilling grade bentonite. Foundry grades of Wyoming bentonite ex-works are \$55 to \$80 per short ton. Other Wyoming bentonite grades ex-works currently range from \$36 to \$82 per short ton

In summary, USA producers of swelling bentonite say that demand is now at its highest level since the early 1980s. With the current trend for exports of drilling mud, foundry sand binder and other uses remaining above 400,000 metric tons per year, the grand total domestic production reached 4,554,000 and 4,713,000 metric tons in 2004 and 2005, respectively. With increased oil and gas drilling on a world basis and increased domestic pet litter demand, steady domestic and world economies will require that domestic production of swelling bentonite remain greater than 4,500,000 metric tons per year for the foreseeable future.

References

1. Virta, Robert L., Clay and Shale Chapter, *U.S. Geological Survey Minerals Yearbook*: 2004, 2003, 2002, 2001, 2000, 1999, 1998, 1997, 1996, 1995, 1994, 1993, 1992, 1991, 1990.
2. Virta, Robert L., Draft copies of bentonite tables, Clay and Shale Chapter, *U.S. Geological Survey Minerals Yearbook*: 2005.
3. *Mineral Price Watch*, Metal Bulletin plc., August 2006.

Table 1 Major Domestic and Export Commodity Markets for Bentonite, metric tons produced

Domestic Markets	Year:	1990	1991	1992	1993	1994	1995	1996	1997
Absorbents:									
Pet Waste		157,000	217,000	264,000	302,000	455,000	574,000	607,000	604,000
Other		39,800	87,700	30,300	66,400	91,000	88,400	90,500	W
Adhesives		4,410	11,100	8,800	W	W	W	11,200	15,100
Animal Feed		106,000	100,000	112,000	78,300	96,900	97,800	65,200	110,000
Ceramics, Tile, Pottery		47,600	31,700	31,300	24,100	W	W	W	W
Drilling Mud		713,000	680,000	463,000	476,000	586,000	627,000	572,000	789,000
Fillers and Extenders		49,200	30,000	30,300	30,600	30,000	69,900	33,500	41,300
Filtering, clarifying, deodorant		62,800	74,400	111,000	13,000	W	W	W	82,400
Foundry Sand Binder		865,000	660,000	684,000	733,000	712,000	745,000	772,000	901,000
Iron Ore Pelletizing		683,000	717,000	506,000	466,000	509,000	646,000	674,000	536,000
Misc. Refractories		49,400	56,800	47,000	58,000	32,200	21,800	16,700	7,800
Miscellaneous		53,500	25,800	13,800	2,340	55,400	288,000	242,000	126,000
Waterproofing and Sealing		181,000	171,000	213,000	213,000	287,000	228,000	227,000	267,000
Subtotal:		3,010,000	2,870,000	2,530,000	2,460,000	2,850,000	3,390,000	3,310,000	3,480,000
Exports									
Drilling Mud		113,000	107,000	72,000	90,400	34,200	86,500	102,000	150,000
Foundry Sand Binder		254,000	274,000	277,000	243,000	321,000	256,000	278,000	293,000
Other		95,100	57,300	70,900	72,000	80,500	89,100	46,400	101,000
Subtotal:		462,100	438,300	419,900	405,000	436,000	431,000	426,000	544,000
Grand Total:		3,470,000	3,308,000	2,950,000	2,870,000	3,329,000	3,820,000	3,740,000	4,020,000
Domestic Market	Year:	1998	1999	2000	2001	2002	2003	2004	2005
Absorbents:									
Pet Waste		773,000	788,000	862,000	902,000	899,000	987,000	1,036,000	1,244,000
Other		W	W	W	W	W	W	W	W
Adhesives		12,900	14,200	5,680	2,170	2,100	5,610	2,000	2,000
Animal Feed		77,400	74,200	46,800	52,200	42,400	52,400	51,000	53,000
Ceramics, Tile, Pottery		W	W	W	W	W	W	W	W
Drilling Mud		665,000	667,000	654,000	787,000	762,000	790,000	847,000	945,000
Fillers and Extenders		48,700	24,700	35,400	49,300	45,700	41,300	39,000	61,000
Filtering, clarifying, deodor.		104,000	81,400	93,800	91,600	127,000	W	W	W
Foundry Sand Binder		869,000	888,000	835,000	746,000	762,000	763,000	891,000	893,000
Iron Ore Pelletizing		529,000	540,000	500,000	522,000	536,000	530,000	614,000	579,000
Misc. Refractories		2,530	201,000	4,050	W	W	W	--	--
Miscellaneous		79,800	83,300	66,800	90,700	117,000	378,000	412,000	356,000
Waterproofing & Sealing		236,000	268,000	254,000	283,000	269,000	W	193,000	176,000
Subtotal:		3,400,000	3,630,000	3,360,000	3,520,000	3,560,000	3,550,000	4,086,000	4,309,000
Exports									
Drilling Mud		64,800	68,800	56,400	73,300	59,200	57,200	59,000	76,000
Foundry Sand Binder		239,000	239,000	233,000	244,000	244,000	226,000	258,000	205,000
Other		123,000	121,000	115,000	159,000	106,000	108,000	151,200	123,000
Subtotal:		427,000	440,000	404,000	446,000	408,000	392,000	468,000	544,000
Grand Total:		3,820,000	4,070,000	3,760,000	3,970,000	3,970,000	3,940,000	4,550,000	4,713,000

W = withheld to avoid disclosing proprietary data included with "Miscellaneous".

Adhesives includes catalysts (oil-refining), mineral wools, insulation, floor and wall tile, and pottery.

Fillers & Extenders includes asphalt tiles (2004), cosmetics, ink, medical, paint, paper coatings & filling, pesticides, pharmaceuticals, and plastics.

Pelletizing excludes shipments to Canada, Total north american sales were 503,000 metric tons in 2002 and 600,000 metric tons in 2003.

Miscellaneous includes waterproofing seals, chemical manufacturing, oil well sealings, filtering and clarifying oils, heavy clay products, lightweight aggregates, desiccants and other undefined uses.

"Other" exports includes absorbents, fillers & extenders, miscellaneous refractories, pelletizing iron ore, and other undefined uses.