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COMPOSITION & PROPERTIES OF OIL WELL DRILLING FLUIDS 1980

Pages Mentioning Asbestos as pe Index

Table 11–5
Attapulgite Requirements for API Specification*

Moisture, as shipped from point of manufacture:	16% maximum
Wet screen analysis, residue on U.S. Sieve (ASTM) no. 200:	8% maximum
Properties of a suspension of 20 g attapulgite clay (as received) in 350 cm^3 of a saturated sodium chloride solution; stirred 20 minutes; 2 drops of octyl alcohol added to break the foam.	
Viscometer dial reading at 600 rpm:	30, minimum

* Courtesy *API Specification for Oil-Well Drilling-Fluid Materials*, API Spec. 13-A, seventh edition, May, 1979.

sodium chloride solution than in pure water. Usual application is in muds of higher salinity than sea water.

Attapulgite does not afford filtration control. This feature is used to advantage in the preparation of high-filtration slurries to stop loss of circulation.[74] The amount of attapulgite needed to remove cuttings from the hole, or to suspend barite in weighted muds, ranges from 5 to 25 lb/bbl (14 to 70 kg/m^3).

According to the U.S. Bureau of Mines,[14] the quantity of fuller's earth (attapulgite) used in drilling muds in 1977 was almost 100,000 short tons. In 1978, the quantity was slightly more, estimated on the basis of increased footage drilled.

Beneficiation of Attapulgite. Magnesium oxide and magnesium hydroxide increase the mud-thickening ability of attapulgite,[75] and the effect is heightened by inclusion of the mannogalactan from guar.[76] By dispersing attapulgite clay in saturated salt water and allowing the suspension to age, the addition of an interpolymer of ethylene and maleic anhydride (0.1% by weight) increases the yield about 40%, as compared with the yield of the treating agent and clay added simultaneously to the brine.[77]

Sepiolite

Sepiolite is a hydrated magnesium silicate that contains less substituted aluminum than does attapulgite, which it closely resembles. Sepiolite occurs in fibrous and elongated lathlike particles. The crystal structure of sepiolite is

similar to that of attapulgite;[78,79,80] the unit cell is somewhat larger. Molecular-sized channels and grooves are responsible for its adsorptive properties.

Sepiolite is the salt-water gel of foreign drilling operations, but only in recent years has it been available in the United States. The domestic source is in Nevada.[81] Sepiolite is found in a near-surface dry lake bed four feet thick in the Amargosa Desert, Nye County, Nevada. Associated with the sepiolite are dolomite (up to 40% of the bed), saponite, illite, quartz, feldspar, and volcanic glass. The development of sepiolite and dolomite is attributed to an initial high concentration of magnesium in the lake water.

The reported stability of sepiolite at elevated temperatures,[82,83] led Carney and Meyer[84] to investigate its application in muds for geothermal drilling. Only a moderate increase in consistency was observed on heating a slurry of sepiolite in fresh water (24 lb/bbl, 70 kg/m^3) to 750°F (400°C). In order to reduce filtration rate, small amounts of Wyoming bentonite and certain unidentified polymers were added. Muds composed of water, sepiolite, modified lignite, sodium polyacrylate, and caustic soda were used in geothermal drilling California.[85] A high-shear device was useful in promoting dispersion of the sepiolite. Among the cited applications of sepiolite in oil-well drilling were: (1) as a replacement for attapulgite in brine muds; (2) as a replacement for asbestos in "sweep" or "pill" slugs for hole cleaning; (3) in a composition containing bentonite and blown asphalt, and (4) as a packer mud.[85]

Further study of the stability of sepiolite at elevated temperatures shows that sepiolite is converted to stevensite (a smectite) by heating the aqueous slurries to 300°F (150°C) and above.[86] Temperature is the major factor in the conversion: More than 10% change was noted after 24 hours at 400°F (205°C). The presence of the chlorides or hydroxides of sodium, calcium, or magnesium did not significantly affect the conversion.

The API Committee on Standardization of Drilling Fluid Materials in 1978 set tentative specifications for sepiolite to be the same as those for attapulgite.[13]

Organophilic Clays

The contribution made by the introduction of organophilic clays to the technology of oil muds was pointed out in Chapter 2. By a process of cation exchange, the normally hydrophilic clay reacts with aliphatic amine salts and with quaternary ammonium salts or bases to form a clay-organic product that can be dispersed in oil to provide suspending properties.[87,88,89,90]

The organophilic clay is prepared from bentonite or attapulgite. The organic cation is added to a suspension of the clay in water. The amino

groups replace the sodium and calcium cations originally present on the clay surfaces. At the same time, the hydrocarbon chains displace the previously adsorbed water molecules. The clay precipitates because it is no longer wetted by water. The organophilic clay is separated, washed and dried.

Organophilic clays are used in oil muds in concentrations of 2 to 15 lb/bbl (6 to 40 kg/m^3), depending on the density of the mud and the extent of filtration control. The higher concentrations are used in the higher-filtration oil muds that afford faster drilling rates than normal compositions.[91,92] As much as 50 lb/bbl (140 kg/m^3) may be used in arctic casing packs.[93,94]

Consumption of organophilic clays in oil muds in 1978 is estimated to have been 10,000 tons (9,100 tonnes).

Asbestos

Although clays are by far the major thickening agent (or viscosifier) for drilling fluids, another mineral substance, asbestos, has found some limited applications. When drilling conditions are such that removal of cuttings is the only requirement of the drilling fluid, asbestos can be added to water to improve the carrying capacity.[95]

Asbestos is the generic name for a group of naturally occuring fibrous silicate minerals. The principal component of commercial asbestos is *chrysotile*, hydrated magnesium silicate. The other minerals comprising asbestos have other cations in addition to magnesium associated with the hydrated silica. Chrysotile consists of tubular, parallel fibers that are closely packed. Chrysotile is unusual in that when dispersed in water, the particles have a positive charge.

The occurrence, mining, and processing of asbestos have been reviewed by Winson.[96] Asbestos used in drilling in the United States is produced in the province of Quebec, Canada, and near Coalinga, California, and consists of the short fiber chrysotile variety.

The fibrous nature of chrysotile leads to the development of a brush-heap structure when it is dispersed in water, whether fresh or salty.[97,98] Preshearing expedites dispersion at the well site and pelletizing reduces the bulk volume of the product.[99] From 2 to 5 lb/bb; (6 to 14 kg/m^3) gives adequate carrying capacity but no filtration control. If fresh water is available, a mixture of equal parts of bentonite and chrysotile asbestos has been used to provide good hole-cleaning with some filtration control.[100]

Asbestos has been classed as a "hazardous material" under the Occupational Safety and Health Act, with the threshold limit value set at 2 fibers longer than 5μm per cm^3 of air for those handling the material.[101]

Special processing methods have been introduced to minimize the possibility of inhaling the fibers while handling the product.

Consumption in 1978 is estimated to have been about 10,000 tons (9100 tonnes).

Organic Polymers

As related to drilling fluids, the term *organic polymer* is applied to the several varied and versatile substances which are composed of a number of repeating or similar units, or groups of atoms (called *monomers*) consisting primarily of compounds of carbon. Organic colloidal materials are used in drilling fluids to reduce filtration, stabilize clays, flocculate drilled solids, increase carrying capacity, and (incidentally) to serve as emulsifiers and lubricants. Several improvements in mud performance often result from the addition of a single product.

The colloidal properties of organic polymers greatly affect the role of organic polymers in drilling fluids. The organic polymers useful in muds have a strong affinity for water. They develop highly swollen gels in low concentrations. Some are strongly adsorbed by clay particles and offer protection from flocculation by salts. Although these polymers do not swell as much in salt water as they do in fresh water, they nevertheless provide slimy particles of such size as to resist the flow of water through a filter cake. These versatile polymers make practical the use of low-solids, nondispersive drilling fluids. Although properly classed as organic polymers, substances such as the lignosulfonates, lignite derivatives, and compounds that are used primarily because of their surface active properties are not discussed in this section. The colloidal properties of organic polymers are discussed in greater depth in Chapter 4.

Organic polymers used in drilling fluids may be broadly classified according to their origin and composition. Some, such as the starches and guar gum, occur naturally, and are ready for use after slight processing. Others, such as xanthan gum, employ natural processes in their production. Still other polymers, such as derivatives of the starches and gums, and sodium carboxymethylcellulose, might be called semi-synthetic. Another class of petrochemical derivatives, such as the polyacrylates and ethylene oxide polymers is purely synthetic.

The repeating units (*monomers*) that make up the polymer may be the same, or two or more monomers may be combined forming *copolymers.* Structurally, the polymer may be linear or branched (see Fig. 11–4),[102] and these structures, either linear, branched, or both, may be cross-linked, i.e., tied together by covalent bonds. Further variations in the structure of