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CHRYSOTILE ASBESTOS

Chemical and Mineralogical Properties as Related to Behavior in Aqueous Media

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Behavior of Chrysotile Asbestos in Aqueous Media

Suspensions of Chrysotile asbestos in water are generally believed to carry a positive charge, whereas the Amphibole grades result in negative potentials in water. Upon opening of Chrysotile fibers in water, polyvalent metal ions are released which cause coagulation of anionic additives in papermaking. The surface area of asbestos which is believed to have a strong bearing on zeta potential is approximately 130,000 to 220,000 sq./cm/gm. (As noted in another section of this report, the general formula for Chrysotile asbestos is $Mg_3Si_2O_5(OH)_4$. The $Mg(OH)_2$ portion of the molecule is closest to the fiber surface, whereas the silicon-oxygen part is "inside." Note: The former has been cited as the reason for the poor acid resistance of Chrysotile. The Amphibole varieties of asbestos have the silicon-oxygen layer on the outside.

The magnesium ions and hydroxyl ions of Chrysotile asbestos dissociate in water. More hydroxyl ions probably dissociate, since the Chrysotile grade has been reported to carry a negative charge in carbon-dioxide-freewater; the charge, however, becomes positive as pH increases--i.e., Chrysotile possesses a positive charge in ordinary distilled or tap water.

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Physical Properties of Chrysotile Asbestos

Chrysotile asbestos is found in fibrous form grades ranging from powder form to over 3/4 inch staple and classified by Canadian Standards from 7 grade to Number One grade with various subclassifications; most papermaking applications, however, utilize grades 5 through 7. Asbestos fiber is generally found in a green to gray color with a soft to harsh texture--depending upon where mined.d General physical properties of asbestos are noted below:

Crystal Structure	Monoclinic
Hardness	2.5-4.0
Specific Gravity	2.4-2.6
Refractive Index	1.50-1.55
Tensile Strength (psi)	824,000 max
Fusion Point (^{o}F)	2770
Resistance to Heat	Good but brittle above $900^{o}F$
Filtration Properties	Slow
Fiber Diameter (inches)	.000000706 to .00000118
	7.06×10^{-7} 1.18×10^{-6}

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Mineralogical Properties of Chrysotile Asbestos

Chrysotile asbestos is a hydrous silicate of magnesia found in three forms--i.e., cross fiber, slip fiber and mass fiber. The former is generally a shorter fiber, since fiber is arranged normal to vein wall and limited to vein width, whereas slip fiber lies in the same plane as the vein; mass fiber is interlaced and unoriented.

As noted previously, Chrysotile has the general formula $Mg_3Si_2O_5(OH)_4$ and consists essentially of $Mg(OH)_2$ layers condensed into silicon-oxygen tetrahedra. Mineralogical properties are noted below:

Essential Composition	Hydrous silicate of magnesia
Crystal Structure	Fibrous and asbestiform
Crystal System	Monoclinic and orthorhombic[1]
Mineralogical Structure	In veins of serpentine, etc.
Mineral Association	In altered peridotite adjacent to serpentine and limestone near contact with basis igneous rocks
Veining	Cross and slip fibers
Luster	Silky
Hardness	2.5-4.0
pH	9.2-9.8
Specific Gravity	2.4-2.6
Cleavage	0.0 perfect
Optical Properties	Biaxial positive, extinction parallel
Refractive Index	1.50-1.55

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General

Asbestos fiber, unlike standard papermaking (cellulosic) grades, is of mineral origin. Although found in six major forms, only Chrysotile asbestos is of major importance in papermaking. The Chrysotile fiber, as it is known today, is the highly fibrous portion of Serpentine rock; picrolite and common Serpentine make up the remaining portion of the rock, but represent little commercial value. Other grades of asbestos, referred to as amphiboles, include Crocidolite, Amosite, Anthophyllite, Tremolite and Actinolite. The three former grades have some use in papermaking and general building products, whereas the latter two are in short supply and have little significant commercial value.

Most of the Chrysotile fiber referred to in the literature is mined in Quebec, Canada, although the Soviet Union also produces large quantities of this variety; smaller deposits also exist in Vermont, Arizona and California in the U.S.A. Africa produces Amosite and Crocidolite, whereas Anthophyllite is obtained primarily from Finland.

Prior to its use in papermaking, the fiber must be removed from the rock by several techniques--i.e., crushing, defiberizing, screening, grading and packing. After separation, the fiber is shipped to the mills for processing into product forms. Due to its mineral origin, however, the fiber is a chemical complex and presents a particular problem when used in aqueous media. In view of the above, asbestos suspensions in water present an interesting study. The discussions on the attached pages represent a summary of the salient properties of asbestos and a brief synopsis of the behavior of this mineral fiber in papermaking systems.

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Chemical Properties of Chrysotile Asbestos

A typical chemical analysis of Chrysotile asbestos is noted below. Primary differences between the Chrysotile (Serpentine) grade and the Amphiboles is higher magnesium oxide content and higher water of crystallization in the former. All of the Amphiboles contain relatively high iron content in their chemical structure except Tremolite; paradoxically, Chrysotile, with no iron in the chemical structure, contains the highest percentage of magnetic (tramp) iron.

Generally defined, Chrysotile asbestos is a hydrous silicate of magnesia with a theoretical formula of $3MgO$, $2SiO_2$ $2H_2O$ or $Mg_3Si_2O_5(OH)_4$. The fibers consist of layers of silicon-oxygen tetrahedras condensed into magnesium hydroxide layers. No chemical binding exists between the layers. Chrysotile can be considered as a magnesium hydroxide layer on a silicate substrate. It is as strong a base as magnesium hydroxide, and its hydroxyl ions dissociate the same as magnesium hydroxide. Acid resistance of Chrysotile is poor (as opposed to all Amphiboles where acid resistance is fair to good), but alkali resistance of the Chrysotile is excellent.

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Typical Analysis of Chrysotile Asbestos

	Chrysotile[1]
Silica (SiO_2)	39.05
Alumina (Al_2O_2)	3.67
Ferric oxide (Fe_2O_3)	2.41
Ferrous oxide (FeO)	-
Magnesia (MgO)	40.07
Lime (CaO)	-
Sodium oxide (Na_2O)	-
Combined water (H_2O)	14.48
Alumina, Calcium, Water, etc.	-
Sulpher	-
Phosphorus	-
	99.68

[1] Canadian (Thetford)

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