

Additional Reading: General Wollastonite Information

About This Document

NYCO has the benefit of many years of experience in the production, handling and marketing of wollastonite products. The purpose of this document is to share some of this accumulated knowledge and experience with NYCO's customers, associates, agents and distributors with a view towards the successful usage and application of NYCO's wollastonite products.

The document provides a basis for understanding and for obtaining more definitive information or advice. This guide in no way represents a definitive reference for wollastonite. In consideration of the peculiarities of wollastonite, NYCO strongly recommends that the appropriate professionals carry out any design of products, processes, installations or modifications. NYCO also recommends that any test work deemed necessary by those involved in these endeavors be carried out on the appropriate NYCO products. NYCO can provide contacts that have had past experience working with wollastonite.

Where specific information is given, this is based on NYCO's experience and as such is offered as an example only. Situations and conditions in other's facilities will be different enough to warrant that a qualified professional makes specific recommendations. NYCO can provide assistance in contacting individuals with past experience.

Feel free to contact NYCO for additional information.

*** NYCO believes the information and recommendations herein to be accurate and reliable. However, since any assistance furnished by NYCO with reference to proper use and disposal of its products is provided without charge, and since use conditions and disposal are not within its control, NYCO assumes no obligation or liability for such assistance and does not guarantee results from use of such products or other information herein, no warranty, express or implied is given. Information herein concerning laws and regulations is based on U.S. federal laws and regulations except where specific reference is made to those of other jurisdictions. Since use conditions and governmental regulations may differ from one location to another and may change within time, it is the buyer's responsibility to determine whether NYCO's products are appropriate for buyer's use, and to assure buyer's workplace and disposal practices are in compliance with laws, regulations, ordinances, and other governmental enactment applicable in the jurisdiction(s) having authority over the buyer's operations. ***

General Information About Wollastonite

Wollastonite is a naturally occurring mineral, which provides strength and improved performance for plastics, coating, friction, refractory, construction, elastomer, and sealant applications. Due to the high quality and acicular structure of NYCO's ores, a broad range of high aspect-ratio and powder wollastonite grades are produced. Typical properties are listed below however, for specific information the customer should consult the individual product data sheet or contact NYCO directly.

Typical Properties

PROPERTY	VALUE
Morphology	Acicular
Aspect Ratio	20:1 to 3:1
Particle Size	products vary from –10 Mesh to –1250 Mesh
Loose Bulk Density, kg/m ³ (lbs./cu.ft.)	products vary from 220 to 1360 (14 to 85)
Tapped Bulk Density, kg/m ³ (lbs./cu.ft.)	products vary from 420 to 1440 (26 to 90)
Specific Gravity of Solids	2.87-3.09
pH (10% slurry)	8-10
Molecular Formula	CaSiO ₃ or alternatively CaO.SiO ₂
Color	Brilliant white to cream
Melting Point (°C)	1540
Water Solubility (g/100cc)	0.0095

The benign health aspects of wollastonite provide a compelling reason for its use in place of other industrial minerals and fibers. Since wollastonite products are considered non-toxic and non-carcinogenic, health and safety concerns during handling are limited to those associated with nuisance dusts. Standard industry practice with regard to dust containment and collection should be observed.

Wollastonite products are composed of very stable oxides and dusts generated during handling can be considered non-conductive, non-flammable and non-explosive. Wollastonite is not hygroscopic and is normally provided with less than 0.1% moisture.

Historical Notes

Mineral History Highlights

Although it is a useful mineral, wollastonite has a short history of industrial use because commercially viable deposits are unusual.

- Late 1700's: unique characteristics of the mineral 'table spar' became known in the scientific community
- 1822: table spar mineral renamed "Wollastonite" in honour of William Hyde Wollaston for his contributions to the fields of mineralogy and crystallography.
- 1933: wollastonite first mined for industrial use in California. Records indicate that it was briefly trialed in the manufacturing of mineral wool.

- 1953: construction of the original processing facilities and commercial production began at NYCO's Willsboro, NY deposit following the pioneering work of entrepreneur Koert D. Burnham.
- 1967: commercial wollastonite production began in Finland and Mexico
- 1970: commercial wollastonite production began in India
- 1975: commercial wollastonite production began in Africa
- Early 1980's: commercial wollastonite production began in China

Early common names for wollastonite were "Table Spar" or "Tabular Spar." In the late 1700's, Sir William Hyde Wollaston (1766-1828), an English chemist and mineralogist brought to the attention of the scientific community, the mineralogical peculiarities and uniqueness of table spar. In 1822, one of Wollaston's fellow scientists, Dr. A. Hauy, proposed the name "Wollastonite" in honour of Wollaston's work. Since that time, the mineral has been commonly known referred to as "Wollastonite".

Although it is a unique mineral, wollastonite has a short history of industrial use. Deposits of sufficient size and purity to be of commercial interest are unusual, even though it is also a relatively common mineral. Wollastonite was probably first mined for industrial purposes in California in 1933. It appears that this wollastonite was first used in production trials in the manufacture of mineral wool. Apparently this production was not sustainable and it appears that only a few rail cars of impure material were actually used for these purposes.

Significant commercial production did not start, however, until 1953, at what is now NYCO's Willsboro, NY deposit. The pioneering work by Koert D. Burnham, a local resident entrepreneur, led to the purchase of the deposit by Godfrey L. Cabot Inc. in 1951. Cabot commissioned the construction of processing facilities, which were completed late in 1953.

Early research beginning in 1947 by the New York State College of Ceramics, Alfred University, Alfred, New York led to many of the early commercial uses of wollastonite. These early studies also identified many potential uses of which wollastonite is in common usage today. Early uses were in the ceramic industry where it is still used today as an additive in many types of glazes and ceramic body formulations. Other early uses were in the production of paints, concrete, asphalt, welding fluxes, metallurgical fluxes, glass, ceramic wool, filters, insulation, plastics, elastomers, and abrasives. Wollastonite is still used in most if not all of these applications today.

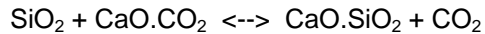
Until the early 1960's, commercial production of wollastonite was carried out, for the most part, by NYCO (Willsboro, NY). During the 1960's, wollastonite became widely known as an industrial mineral with a variety of potential uses. Production in Finland and in Mexico began commercially in the late 1960's, in India and Africa in the 1970's, and in China in the 1980's. Worldwide production has more than doubled in the last ten years with an average annual growth rate of over 10% per year. Throughout the years, NYCO has been the market leader and with the recent addition of production from Minera NYCO in Mexico, it is likely that NYCO will dominate the market for years to come.

Geological Formation

Wollastonite can be formed in nature in a variety of ways, however for commercial deposits it is generally accepted that there are two methods of formation. Both involve metamorphism (heat and pressure) of limestones (calcite). In silica (quartz) bearing limestones, silica and calcite react to form wollastonite. This commonly occurs through contact metamorphism as a result of intrusive igneous activity. Wollastonite can also form by the passage of highly siliceous hydrothermal solutions through limestone beds or zones. These siliceous solutions generally result from local intrusive igneous activity. Groundwater heated by the local intrusion dissolves large amounts of

silicate during contact with the intrusion. Hot silicate laden water migrates into surrounding limestone beds where the silica precipitates and CO₂ is carried out of the deposit. CaO.SiO₂ precipitates and slowly forms characteristic wollastonite crystal structures in what was formerly limestone. This process is called metasomatism. The recrystallization into wollastonite occurs over a long period of time (in the order of thousands of years). Subsequent geological events, which involve additional heat, can result in recrystallization and can lead to even more massive crystal structures. The simple metamorphic reaction between silica and calcium carbonate to form wollastonite occurs at about 600°C at shallow depths. The temperature required increases with depth (pressure).

quartz + calcite <--> wollastonite + carbon dioxide



If they are present, ions such as aluminium, iron, magnesium, manganese, potassium and sodium can be absorbed to a certain extent into the wollastonite structure during its formation. Excess amounts of these ions however, will lead to the formation of other minerals such as diopside, feldspars, etc. Alternatively other minerals may be formed during secondary alterations by subsequent passage of ground waters or intrusions from subsequent geologic events. These would include garnets, epidote, etc. Subsequent weathering of the deposit may also result in the formation of secondary minerals.

Suggested References

Deer, Howie, and Zussman, Rock Forming Minerals, v. 2A, p. 547-563, New York, Longman-Wiley, 1978.

Bolger, R., "Wollastonite, Quality Remains the Key Aspect," Industrial Minerals, Nov '98, p. 41-51.

Fattah, H., "Wollastonite, New Aspects Promise Growth," Industrial Minerals, Nov '94, p. 21.

The Economics of Wollastonite, Sixth Edition 1996, London, Roskill Information Services, 1996.

Harben, Peter W., The Industrial Minerals Handybook, 2nd Edition, p. 197-199, London, Industrial Minerals Information, 1995.

Bauer, Copeland, and Santini, "Wollastonite" in Industrial Minerals and Rocks, 6th Edition, p. 1119-1128, Society for Mining Metallurgy, and Exploration, 1994.

Robbins, M., Fluorescence, Gems and Minerals Under Ultraviolet Light, p. 266-267, Phoenix, Geoscience Press, 1994.

"Wollastonite" in IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Silica and Some Silicates, Volume 42, 1986, 15 pp.

Andrews, R.W., Wollastonite, Monograph, Institute of Geological Sciences, Her Majesty's Stationary Office, London, 1970, 114 pp.

Amberg and McMahon, Wollastonite, An Industrial Mineral, Bulletin No.4, New York State College of Ceramics, 1949, 60 pp.

Touloukian, T.S., Judd, W.R., Roy, R.F., Physical Properties of Rocks and Minerals, McGraw-Hill, 1981.