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Technical Bulletin

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FROM: ROMAN KOROBIJ

SUBJECT: PHYSICAL PROPERTIES OF A/C PIPE

Attached is a short report on the physical properties of Asbestos-Cement pipe.

Though this information is very technical in nature, you may find it surprisingly useful.

By having this information handy in your A/C Technical Bulletin Binder, you will be able to present this information to a customer upon his request.

NOTE: This report should be placed after the red colored "General" tab of your A/C Technical Bulletin Binder.

PHYSICAL CHARACTERISTICS OF ASBESTOS CEMENT PIPE

Asbestos cement pipe is composed of an intimate mixture of either: (1) portland cement or portland blast furnace slag cement and asbestos fiber with or without silica; or (2) portland pozzolana cement and asbestos fiber. Either can be with or without the addition of curing agents. The pipe is formed under pressure and cured. The finished pipe is free from organic materials.

Indestructible Asbestos is as permanent as rock itself. It will not burn, will not rot, cannot corrode. In ready-to-use form, these fibers are finer than silk, stronger than iron, flexible enough to be spun into threads and woven into cloth.

The ancient Chinese, the early Greeks and the Egyptians used Asbestos centuries ago. The Greeks named it "Amianthus, " meaning "Incorruptible." We call it "Asbestos."

The ancient people prized Asbestos for its resistance to fire, heat, most acids and the weather -- and its durability. They used it for centuries without finding the adequate substitute for these unusual properties. They learned how to card the flexible fiber, and to weave cloth from it. In the nineteenth century a third outstanding quality of Asbestos was discovered. That is as a reinforcing material for portland cement.

Asbestos used in the asbestos cement pipe production is brought in from Canada and Africa. Continuous research and product development has produced a formulation wherein the proper amount of several types of fiber are used to assure maximum product strength. Most of the fiber used is Chrysotile which comes from the free world.

Asbestos is a broad term applied to numerous fibrous mineral silicates composed of silicon, oxygen, hydrogen, and metal cations such as sodium, magnesium, calcium, or iron. There are two major groups of asbestos, serpentine (chrysotile) and amphibole.

The chemical composition of different asbestos fibers varies widely and typical formulas are presented in Table I (U.S. EPA, 1976). It should be noted that the values obtained from actual chemical analysis of the various fibers also may differ slightly from the typical formulas. Although chrysotile is considered to be a distinct mineral, the five amphibole minerals are each varieties of other minerals. These minerals differ from each other both chemically and physically with the exception that they all contain silicon and all form fibers when crushed. Good quality asbestos will form fibers with higher ratios of length to width than poorer grades.

TABLE I

Typical Formulas for Asbestos Fibers

1.	Serpentines	chrysotile	$Mg_3Si_2O_5(OH)_4$
2.	Amphiboles	amosite	$(Mg,Fe)_7Si_8O_{22}(OH)_2$
		crocidolite	$Na/_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
		anthophyllite	$(Mg,Fe)_7Si_8O_{22}(OH)_2$
		tremolite	$Ca_2Mg_5Si_8O_{22}(OH)_2$
		actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

The basic crystal form of the amphibole minerals is less complicated than for chrysotile. The basic structure consists of a double silica chain (Si_4O_{11}) that is paired back-to-back with a layer of hydrated cations between the chains.

Some typical physical properties of three different mineral forms are presented in Table 2.

TABLE 2

Typical physical properties of chrysotile (white asbestos), crocidolite (blue asbestos) and amosite

	Units	Chrysotile (white asbestos)	Crocidolite	Amosite (blue asbestos)
Approximate diameter of smallest fiber	micron	0.01	0.08	0.1
Specific gravity	--	2.55	3.37	3.45
Average Tensile Strength	$lb./inch^2$	3.5×10^5	5×10^5	1.75×10^5
Modulus of elasticity	$lb./inch^2$	23.5×10^6	27.0×10^6	23.5×10^6

Asbestos minerals, despite a relatively high fusion temperature, are completely decomposed at temperatures of 1,000°C. Both the dehydroxlation temperature and decomposition temperature increase with increased MgO content among the various amphibole species.

The solubility product constants for various chrysotile fibers range from 1.0×10^{-11} to 3×10^{-12}. Most materials have a negative surface charge in aqueous systems. However, since chrysotile has a positive (+) charge, it will attract, or be attracted to, most dispersed materials. The highly reactive surface of asbestos causes many surface reactions which are intermediate between simple absorption and a true chemical reaction. The absorption of various materials on the surface of chrysotile has a greater affinity for polar molecules (e.g. H_2O, NH_3) than for non-polar molecules.

Of all the asbestos minerals, chrysotile is the most susceptible to acid attack. It is almost completely destroyed within one hour in 1 N HCL at 95°D. Amphibole fibers are much more resistant to mineral acids.

The resistance of the asbestos fibers to attack by reagents other than acid is excellent up to temperatures of approximately 100°C with rapid deterioration observed at higher temperatures. Chrysotile is completely decomposed in concentrated KOH at 200°C. In general, organic acids have a tendency to react slowly with chrysotile.

Type 1 Portland Cement is used in manufacturing Asbestos Cement Pipe. This cement meets the appropriate ASTM specification. A complete analysis of each shipment of cement is made by the cement company. The pipe manufacturing company's laboratory also checks the cement for strength. All cement is subject to maximum controls to assure its uniformity and ability to meet the high strength requirements.

Silica is subjected to strict specifications as to percentage of pure silica (95% SiO_2) and also as to fineness. The silica receives further processing after it is received at the pipe manufacturing plant. First it is dried completely and then fed automatically into a ball mill where it is ground into flour-like fineness. The extremely minute particles that result provide the utmost surface area for maximum chemical and physical combination with the cement-thereby imparting highest strength and corrosion resistance.

Some of the physical properties of asbestos cement pipe are as follows:

Modulus of eleasticity	2.5 - 3.5 X 10^6 psi
Density	100 - 115 lb/ft^3
Thermal conductivity	K = 5.5 BTU/Hr/^{o}F/sq.ft/in.
Thermal coef. of expansion	4 - 5 X 10^{-6} in./in./^{o}F
Specific heat	0.27 BTU/lb/^{o}F at 212^{o}F
Moisture coef. of expansion	1.5 - 2.0 X 10^{-5}in./in./% moist. cont.
Hazen Williams'coef.	C = 140
Manning's coef.	n = 0.010
Axial tensile stress	500 - 3000 psi (depending on blend)
Axial compressive stress	8000 psi (full pipe cross section)
Shear stress	Laminar 1000 psi Across pipe axis 4000 psi
Permeability	0.3 - 0.5 grains/Hr/ft^2/in.Hg/in.thick
Poissons ratio	0.2
Dielectric constant	20 (dry) 100 (wet)
Water absorption	24 hr. immersion 15 - 20% (depending on blend)
Hardness	Rockwell M ID = 87 OD = 60
Temperatures	A/C material can withstand temperatures on the order of 570^{o}F without notable degredation unless mechanical fissurations are brought about by thermal tensions or by retreats due to irregular desiccations of the mass. Dry A/C pipes do not undergo any degredation until temperatures around -122^{o}F.

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