SILOXANE POLYMERIZATION IN WALLBOARD

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a divisional of U.S. Ser. No. 12/888,162, filed Sep. 22, 2010, now U.S. Pat. No. 8,133,600, issued Mar. 13, 2012 and entitled "Siloxane Polymerization in Wallboard", which is a divisional of U.S. Ser. No. 12/478,114, filed Jun. 4, 2009, now U.S. Pat. No. 7,815,730, issued Oct. 19, 2010, and entitled "Siloxane Polymerization in Wallboard" which is a continuation application of U.S. Ser. No. 11/192,652, filed Jul. 29, 2005 and entitled, "Siloxane Polymerization in Wallboard," now U.S. Pat. No. 7,803,226.

BACKGROUND OF THE INVENTION

This invention relates to a method for making water resistant gypsum products that include siloxane. More specifically, the present invention relates to the addition of a novel catalyst for curing of the siloxane in a gypsum product.

Gypsum-based building products are commonly used in construction. Wallboard made of gypsum is fire retardant and can be used in the construction of walls of almost any shape. It is used primarily as an interior wall and ceiling product. Gypsum has sound-deadening properties. It is relatively easily patched or replaced if it becomes damaged. There are a variety of decorative finishes that can be applied to the wallboard, including paint and wallpaper. Even with all of these advantages, it is still a relatively inexpensive building material.

Gypsum is also known as calcium sulfate dihydrate, terra alba or landplaster. Plaster of Paris is also known as calcined gypsum, stucco, calcium sulfate semihydrate, calcium sulfate half-hydrate or calcium sulfate hemihydrate. Synthetic gypsum, which is a byproduct of flue gas desulfurization processes from power plants, may also be used. When it is mined, raw gypsum is generally found in the dihydrate form. In this form, there are approximately two water molecules of water associated with each molecule of calcium sulfate. In order to produce the hemihydrate form, the gypsum can be calcined to drive off some of the water of hydration by the following equation:

$$CaSO_4.2H_2O \rightarrow CaSO_4.1/2H_2O + 3/2H_2O$$

A number of useful gypsum products can be made by mixing the stucco with water and permitting it to set by allowing the calcium sulfate hemihydrate to react with water to convert the hemihydrate into a matrix of interlocking calcium sulfate dihydrate crystals. As the matrix forms, the product slurry becomes firm and holds a desired shape. Excess water must then be removed from the product by drying.

In the absence of additives to prevent it, set gypsum absorbs up to 50% of its weight when immersed in water. Boards or panels that absorb water swell, become deformed and lose strength. This property is undesirable in products that are likely to be exposed to water. In areas such as bathrooms or kitchens, high temperature and humidity are common, and walls are likely to be splashed. In such areas, it is preferable to use a gypsum board that exhibits water resistancy, thus maintaining strength and dimensional stability.

Many attempts have been made to improve the water resistance of gypsum products. Various hydrocarbons, including wax, resins and asphalt have been added to the slurry in order to impart water resistance to the set product. The use of siloxanes, which form silicone resins in gypsum products, to impart water resistance is well known.

Although the use of siloxanes in gypsum slurries is a useful means of imparting water resistance to the finished product, there are drawbacks associated with it. When added to a gypsum slurry to form silicone resins in situ, siloxane can be slow to cure. The siloxane forms a reactive silanol intermediate to yield polymethylsilicic acid, which cross links to form the silicone resin. The reaction proceeds slowly, often continuing after the gypsum is set and requiring one to two weeks to fully develop water-resistance. Wallboard made using this method must be stored for a time sufficient for the water-resistance to develop before the board can be shipped. In some cases, the siloxane may not cure within a reasonable time or it may not cure fully. In such cases, the water resistance does not develop in the gypsum board to a satisfactory level. Additionally, failure to cure fully leads to using a larger dose of the siloxane, increasing the cost of the raw materials.

Catalysts, such as alkaline earth oxides and hydroxides, are known to accelerate the curing reaction of siloxane in a stucco slurry. These catalysts are relatively water soluble and elevate the pH of the slurry. High pH can interfere with the rehydration of the stucco, and can negatively react with some preferred wallboard additives. Thus, while the siloxane polymerization is promoted, other considerations make the use of these catalysts undesirable.

Magnesium oxide ("MgO") is known to catalyze siloxane reactions, but where the catalyst reactivity is high enough to fully cure the siloxane, undesirable cracking results. Light-burned MgO has the activity needed to cure siloxane quickly, but the activity leads to unwanted side reactions. These side reactions generate hydrogen, which cause expansion of the product and cracking of set gypsum. Hard-burned or dead-burned MgO has lower reactivity, but results in a less water-resistant product. Thus, when MgO is used alone, it is very difficult to balance catalyst activity with the desired extent of siloxane polymerization.

There are also certain stucco sources for which it is very difficult to drive the polymerization of siloxane. Gypsum is a complex mixture of calcium sulfate in various forms, salts and a variety of aluminates, silicates and aluminosilicates. Apparently some gypsum sources include one or more components that suppress the formation of the silicone resin. When used with these stuccos, known catalysts fall short of the desired level of water-resistance of less than 5% water absorbance.

Thus there is a need in the art for a catalyst and a method of producing water-resistant gypsum articles with improved water-resistance at reasonable cost. The catalyst should be relatively inexpensive, having good activity for siloxane polymerization with a minimum of unwanted side reactions. There should be little interference between the catalyst and other common gypsum additives.

SUMMARY OF THE INVENTION

These and other needs are met or exceeded by the present invention which accelerates the polymerization of siloxane and in some cases reduces the amount of siloxane needed to meet the specifications of ASTM 1398.

More specifically, polymerization of siloxane is improved using a slurry that includes stucco, Class C fly ash, magnesium oxide and an emulsion of siloxane and water. This slurry is used in a method of making water-resistant gypsum articles that includes making an emulsion of siloxane and water, then combining the slurry with a dry mixture of stucco, magne-