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Chemical Hydrophobization Of Materials

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Abstract: In modern construction, one of the distinctive features of construction products and materials is their porosity, which leads to high moisture absorption. Rainwater can penetrate into the pores of materials, expanding several times at low temperatures and potentially causing their structural breakdown. Chemical treatments involve processes that create a dense, water-resistant layer on the surface of the material. One method to increase the density of a material's surface is by flotation. Impregnating porous stones with solutions based on monomers significantly enhances their durability.

Key words: moisture, capillary, film, rainwater, sulfur, ammonia, phosphorus, chlorine, carbon monoxide, hydrogen chloride, marble, ceramic bricks, concrete, waterproofing, hydrophobization, asbestos, concrete, limestone blocks, slag blocks, tiles, cement-sand, cement-lime plasters, roofing material, artificial stone, drywall, wood, flotation, monomer, polymerization, strength.

In modern construction, one of the distinctive features of materials used in buildings is their porosity, which results in the absorption of high moisture levels. Moisture, when it enters the capillaries from the external surface, forms films that reduce the uniform structure of materials and products.

Rainwater enters the pores of materials, expanding several times at low temperatures, which can lead to structural failure. Furthermore, rainwater can also contain various substances, such as sulfur, ammonia, phosphorus, chlorine, carbon monoxide, and hydrogen chloride, which can affect the degradation of materials like marble, ceramic bricks, concrete, and others. These substances increase the number of capillaries, pores, and micro-cracks in the construction materials, which leads to more areas being prone to degradation, intensifying the damage.

Generally, the simplest way to wash materials is through the formation of new pores and cracks, which leads to the clouding of marble, the cracking of facades, and the aging of concrete. However, the primary danger in construction is the freezing and thawing cycles within the pores of the material, which causes its degradation.

Currently, there are two common methods for protecting buildings from moisture-related degradation: waterproofing and hydrophobization. Waterproofing involves applying a binding agent or impregnating the material's surface to form a water-resistant layer. Waterproofing is used for corrosion protection and safeguarding buildings.

The disadvantage of this method is that the water-resistant layer closes the pores, stopping the material from "breathing." Additionally, over time, cracks may form on the surface, leading to the destruction of the waterproofing layer. Meanwhile, hydrophobization is an alternative method that allows materials to maintain their breathability, i.e., enabling the passage of gases and vapors.

Hydrophobization is a process of treating materials with special solutions that block moisture entry. These solutions form a thin film or monomolecular layer on the walls of the capillaries, preventing water molecules from entering the capillaries. Hydrophobic substances are reliably retained in the upper layers of the material and are not washed away over time. The impregnation depth ranges from 1 to 6 mm. Typically, these substances are transparent, so they do not change the appearance or color of the material. During the treatment of buildings and structures, both the external and internal surfaces of the walls are treated with a water-repellent agent. This processing method allows you to increase the service life of the products.

Water-repellent agents are applied to porous materials that absorb water. These include bricks, ceramics, asbestos, concrete, limestone blocks, slag blocks, various types of tiles, cement-sand and cement-lime plasters, roofing materials, artificial stone, drywall, wood, and other construction materials.

Chemical treatments involve processes that create a dense, water-resistant layer on the surface of the treated material. One method to increase the density of the material's surface is flotation. In this process, carbonate rocks are impregnated with magnesium fluoride salts (fluorides), such as magnesium fluosilicate. This results in a chemical reaction:

$$\mathbf{2CaCO_3 + MgSiF_6 \rightarrow 2CaF_2 + MgF_2 + SiO_2 + 2CO_2}$$

The nearly insoluble calcium and magnesium fluorides, along with silicon dioxide, are released in the material’s surface pores and capillaries, reducing the overall porosity and water absorption while also preventing the surface from being contaminated by dirt and dust.

Non-carbonate porous materials are primarily impregnated with aqueous solutions of calcium salts, such as calcium chloride. After the drying process, the material is treated with soda and then with fluoride.

The impregnation of high-porosity stone materials with hydrophobic compounds prevents moisture from entering the material and increases its resistance to weathering. Excellent performance is achieved by using organic silicon hydrophobizers and other polymer-based materials, as well as through treatment with solutions of paraffin, metal soaps, or stearin in flammable organic solvents such as gasoline, kerosene, etc.

Thus, impregnating porous stone with monomer-based solutions significantly increases its durability. Heat treatment of the material with monomers leads to subsequent polymerization in the surface layers and pores, giving the material enhanced strength properties.

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