Advanced Materials Research Online: 2013-08-30
ISSN: 1662-8985, Vol. 746, pp 262-265
doi:10.4028/www.scientific.net/AMR.746.262

Development of the Waterproof Coating Material in China

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Keywords: Waterproof coating; waterproof mechanism; research progress

Abstract. Waterproof coating is an important construction material, which has been drawn widely attention and concern around the world. This paper introduces the classification, waterproof mechanism and research progress of waterproof coatings. The development and application of various waterproof coatings in China was given. The development trend and research focus in this field was proposed.

Introduction

Waterproof coating for construction and building is a sticky liquid polymer material with no fixed shape at room temperature. After coating, with solvent and/or water evaporated or reaction cured, it forms tough waterproof membrane material at the base surface. The main purpose of waterproof coating is to prevent moisture, seepage and leakage. Now waterproof coating occupies an extremely important position in the building materials, and it is widely used in residential kitchen, bathrooms, basements and other places with heavy water vapor. In recent years, with the development of science and technology and the improvement of people's living standard, the requirements for coatings are also increased. Firstly, waterproof coating should have a good waterproof performance; secondly, waterproof coating has little side effect on the appearance of buildings; finally, waterproof coating is not harmful to the human health. In China, the waterproof coatings is in the evolution from solvent-based to water-based, from thin to thick, from dark to light in color, from low to high elasticity, high durability and functionality.

Classification of waterproof coatings

There are many kinds of waterproof paints, which can be divided into two categories according to the waterproof mechanism, coating type and hydrophobic type.

In accordance with the state and forms, they also can be divided into three categories: solvent type, reaction type and emulsion type.

According to the different waterproof paint compositions, they are usually divided into two types, single component and double component. The former have solvent type and water emulsion type, and the latter are mainly reaction type.

By the uses on different parts, they can be divided into roofing waterproof coating, stereo waterproof coating, underground engineering waterproof coating, and so on.

According to the main component of coatings, they are divided into five categories: asphalt, polymer modified asphalt (also known as the rubber asphalt), synthetic polymer (also can be divided into synthetic resin and synthetic rubber), cement and polymer-modified cement.

Waterproof mechanism of the waterproof coating

The coating type. By forming a complete coating to prevent the penetration of the water molecule, waterproof function was realized. There are always some gaps between molecules of polymer coatings. The width is about several nm, a single water molecule is able to pass, but water in nature are usually in the associated state due to hydrogen bonding effect, dozens of water molecules forming a large molecular mass, so it is actually very difficult to pass through the polymer gap, which is the main reason of waterproof function [1].

The hydrophobic type. Some polymer molecules have hydrophilic groups, so the complete continuous coatings formed by polymers can not guarantee good waterproof performance. If the polymer itself has hydrophobic characteristics, which makes water molecules and coatings don't compatible, it can fundamentally solve the problem about transport of water molecules, polysiloxane waterproof coating is designed according to the principle [1].

Main types of waterproof coating in China

Asphaltic base waterproof coating. Asphaltic base waterproof paint is mainly water emulsion. Emulsified asphalt is a kind of cold construction waterproof coating, which is formed with the petroleum asphalt and emulsifier by strong agitation. Asphalt is dispersed into small particles of 1-6um, and is wrapped up by the emulsifier forming water emulsion. Coatings' flexibility, crack resistance, strength and high temperature performance can not meet the increasing requirements, so asphaltic based waterproof paint belongs to restricted products these years.

Polymer modified asphalt waterproofing coating. In order to improve waterproof performance of waterproof coatings, appropriate amount of polymer is added, which is called high polymer modified asphalt waterproof coating. Many of the coating's performances are improved, such as flexibility, mechanical strength, crack resistance and performances under high and low temperature. Modified polymers include chloroprene rubber, butadiene rubber, styrene butadiene rubber, SBS and APP, etc.. Solvent type high polymer modified asphalt waterproof coatings use organic solvents that do not meet environmental requirements, so it is gradually replaced by water emulsion. Because of the modified asphalt coating's good waterproof performance, it still has large market in China.

Polyurethane waterproofing coating. Polyurethane waterproof coating is a kind of polymer waterproof material with polyurethane resin as the main film-forming material. In the building waterproof coatings, the most used one is polyurethane waterproof coating, which has high strength, good bonding, tear resistance, puncture resistance, wear resistance, water resistance, chemical resistance and many other excellent properties [2-4]. Tar polyurethane paints, whose performance are not stable, aging resistance is poor, and usually have volatiles toxic substances which pollute the environment and do harm to our health, the uses is decreasing. In recent years, waterborne polyurethane, with non-toxic, non-flammable, no pollution, easy storage, convenient use and other advantages, has become an important development direction in the field of polyurethane paints [5].

Acrylic ester waterproof coating. Acrylate, methyl acrylate, as main monomers, copolymerize with other monomer containing vinyl groups, adding to appropriate fillers, additives, etc., the acrylic ester waterproof coating is obtained. Acrylic ester waterproof coating is a new paint developed rapidly in recent years, its advantages are good color retention and weather resistance, high hardness, light color and excellent gloss retention.

Cement-based capillary crystalline waterproof coating. Cementitious capillary crystalline waterproofing coating is a new type of rigid waterproof material consisting of Portland cement or ordinary portland cement and quartz sand or silica sand and active ingredients such as chemical compounds, fillers, additives. After reacting with water, active chemical substances in materials penetrate into the concrete internal structure by carrier, which formed water-insoluble crystals tamped capillary channel, thus the concrete become dense and waterproof [6]. Now, the cement-based capillary crystalline waterproof materials have widely used in the underground structure of industrial and civil buildings, bridge, roads, drinking water plants, sewage treatment plants, hydropower stations, nuclear power plants, water conservancy engineering, etc., because of its good anti-permeability, self-healing performance, strong cohesive force, anti-corrosion, human harmless, easy use and other characteristics.

Polymer modified cement waterproof coating. Polymer cement waterproof coating, JS waterproof coating for short, is a kind of two-component waterborne waterproof coating which is composed of liquid (polymer emulsion and additives) and powder (cement, inorganic fillers and additives) [7]. It is one of the recommended waterproof materials of the China Ministry of Construction, and it belongs to environment-friendly product. JS waterproof coating has got rapidly development because of a variety of advantages such as high flexibility, strong adhesion, freeze-thaw resistance, high temperature resistance, corrosion resistance, harmless and non poisonous characteristics, etc..

Recent research progress of waterproof coatings

At late 1950s, waterproof coatings were used to prevent water seepage and leakage for buildings. In the 1960s, a new type of polymer waterproof coating called polyurethane waterproof coating was prepared in Germany, France, America, Japan and other countries. In recent years, polymer modified asphalt waterproof coating and synthetic polymer waterproof coating and inorganic infiltration crystalline powder waterproof coating were developed, with the focus on environmental friendly materials. Jasperson developed emulsion type waterproof coating of acrylic polymer and vinyl polymer, mainly used in roof and outer wall waterproofing, with high elasticity and good durability, and can be used for at least 10 years [8]. Meddaugh developed emulsion type silicone waterproofing coatings, producing flexible film after the film was dried. The flexible film affixes to the surface of masonry wall, and can provide high force to resist the water pressure from surface [9]. Polymer modified cement waterproof coating developed by Rodgers has good flame retardancy, thermal insulation and resistance to chemical corrosion [10]. Kyminas prepared durable roofing waterproof coating, with good adhesion with the base layer, excellent flame retardancy, and can reflect much sunshine and heat, so it will delay the thermal aging of the roof and lower the indoor temperature [11].

In China, the development and application of building waterproof coating began in the 1960s. Emulsified asphalt waterproof coating and styrene tar waterproof coating found widely used in engineering projects at that time. Polyether type polyurethane waterproof coating and tar polyurethane waterproof coating were developed in late 1970s and 1980s respectively. From the 1980s to the 1990s, a variety of polymer modified asphalt waterproof coatings were developed, including solvent type and emulsion type neoprene rubber modified asphalt waterproof coating, solvent type and SBS modified asphalt waterproof coating, styrene butadiene rubber modified asphalt waterproof coating and others. In the early 90s, polymer modified cement waterproof coating has been developed. In recent decades, many inorganic waterproof coatings have also been developed and applied. Inorganic infiltration crystalline type waterproof coating has been widely used in industrial and civil buildings [12]. Much progress has achieved these years, there's still some work to do in the future.

(1) Develop waterproof coatings with better waterproof performance and higher aging resistance, with waterproof shelf life of over 30 years.

(2) Develop no solvent, pollution-free, high efficiency, high weather resistance and low cost products.

(3) Develop multifunction waterproof coatings, such as thermal insulation or fire retarding.

Conclusion

Waterproof coatings play more and more important role in the construction industry and show good prospects for the future. With the strengthing of environmental protection concern, the requirement for quality of coatings becomes much stricter. Waterproof paint is developing from solvent type to emulsion and reaction type, from low-end products to products of high elasticity, high durability and functionality. The focus is to develop polyurethane, rubber modified asphalt, polymer cement waterproof coatings and the cement-based capillary crystalline waterproof coating, etc., with environment friendly feature and high performance.

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