International Core Journal of Engineering Volume 7 Issue 8, 2021
ISSN: 2414-1895 DOI: 10.6919/ICJE.202108_7(8).0011

Technical Application of Low-molecular-weight Siloxane/Silane Hybrid Solvent-free Emulsion Based on High-molecular-weight Polysiloxane in Fossil Wood Waterproofing Project

Shihui Bai[1,a], Yusheng Wang[1], Shuna Xi[1], Yanbin Zhu[2,3] and Yaoyao Chen[1], Liangbo Cao[1]

[1]137 Exploration Team, Sichuan Bureau of Coal Geological Exploration, Dazhou 635000, China;

[2]State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology and Center for Excellence in Life and Palaeoenvironment, Chinese Academy of Sciences, Nanjing 210008, China;

[3]University of Chinese Academy of Science, Beijing 100049, China.

[a]297519275@qq.com

Abstract

With the acceleration of transformation of the geological prospecting industry in recent years, the pilot project for protection and conservation of silicified wood fossils in Chinese Jurassic Park in Wangjiagou, Shehong, Sichuan has been undertaken in 2020. Waterproofing of fossil wood is an important content of fossil protection and conservation. The selection and application of waterproof materials is the top priority in the protection and conservation project. Conservation staff must strengthen their understanding of the characteristics of fossil waterproof materials. Meanwhile, they have to master the application technology of waterproof materials well. This paper analyzes the characteristics and the technical application of the currently used fossil waterproof materials in fossil conservation waterproof engineering.

Keywords

Waterproof; Waterproof Material; Fossil Wood; Protection and Conservation.

1. Introduction

Fossil wood refers to the trees being buried deeply in the geological period. They are eroded by chemicals around the trunk under action of groundwater, which original woody components were replaced mostly and the original tree morphology preserved [1]. Generally, fossil wood is the stems, branches and roots of trees, which are formed by long-term geological petrification [2].

Currently, there are 512 fossil woods discovered in the Chinese Jurassic Park in Wangjiagou, Shehong, Sichuan, which were produced in the Penglai town layer about 150 million years ago, i.e., Late Jurassic. The largest tree diameter is 1.5 meters and the longest trunk is 9 meters long. This park is the largest and best-preserved group of fossil woods in southern China.

In the protection and conservation project of fossil wood, waterproofing is an important basis measure for ensuring the quality of these two tasks. Waterproofing can effectively prevent rain, production and domestic water, groundwater and other types of water from penetrating into the fossils wood [3]. Low-molecular-weight siloxane/silane hybrid solvent-free emulsion based on high-molecular-weight polysiloxane (LMW-S/S-HSE-HMWP) is the key to waterproofing of fossil wood. It is an important

ISSN: 2414-1895 DOI: 10.6919/ICJE.202108_7(8).0011

prerequisite for ensuring the quality of fossil waterproofing by learning LMW-S/S-HSE-HMW. As far as it goes, the commonly used waterproof coatings of fossil wood waterproofing in China include oil-based waterproof sealing materials, silicone rubber waterproof sealing materials, and water-soluble polymer waterproof coatings.

Figure 1. Fossil woods

This paper is aim to analyzes the characteristics of LMW-S/S-HSE-HMWP and its technical application in the waterproofing of fossil wood.

2. The Characteristic of LMW-S/S-HSE-HMWP

LMW-S/S-HSE-HMWP combines the advantages of high-molecular waterproofing and low-molecular waterproofing agents. As a mixed water-soluble agent, LMW-S/S-HSE-HMWP can not only penetrate into the pores of the fossil wood to form a “water-repellent” network structure (Shown in Figure 2), but also form a water-repellent membrane on the surface. The membrane prevents rain from penetrating into the pores of fossil woods, and at the same time releases the moisture. Due to this characteristic, LMW-S/S-HSE-HMWP is used to formulate external spraying agent for surface, which can obtain the effect of long-lasting protection and outstanding color of original material of fossil woods.

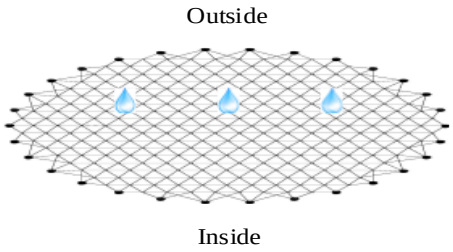

Figure 2. “water-repellent” network structure

2.1 Water repellency

The high water repellency gives the coating a low water absorption rate, so the water resistance is relatively unaffected by temperature. At the same time, LMW-S/S-HSE-HMWP avoids wrinkling, blistering and cracking caused by commonly used waterproofing agents such as wood varnishes, acrylic emulsions and so on.

2.2 Pollution resistance

The fossil woods in Chinese Jurassic Park in Wangjiagou, Shehong, Sichuan are in Penglai town layer from Late Jurassic. This layer has a lot of sand and dust formed by the weathering of sandstone. In the natural environment, dirt, dust or other pollutants will accumulate on the surface of fossil woods. Their appearance are damaged. LMW-S/S-HSE-HMWP formed a protective layer on woods’ surface and makes it difficult for dust particles and other dirt to adhere. Simple mechanical cleaning can make the texture and color appear.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202108_7(8).0011

2.3 Water vapor permeability

LMW-S/S-HSE-HMWP can maintain outstanding water vapor permeability, and can exchange the moisture inside the fossil woods with natural dry environment, changing the moisture absorption state. Meanwhile, the porous surface formed by natural weathering of fossil wood avoids its progressive destruction due to environmental humidity.

2.4 Scrub resistance

We hope that the waterproofing project can maintain the main protection and original appearance of fossil woods themselves for a long time, and can withstand the ability to scrub with a little deionized water. These can make fossil woods be cleaned-free and restored its own color and texture a period of time when protection, conservation, and waterproofing are completed.

3. Application of LMW-S/S-HSE-HMWP in fossil woods

LMW-S/S-HSE-HMW is an organic non-toxic milky white liquid (Shown in Figure 3). It is almost odorless, and there are ≥40% effective substance contents in LMW-S/S-HSE-HMWP. Its PH value is neutral. In order to increase its adhesion ability, we add a certain proportion of acrylic emulsion to optimize its adhesion. The following are mixing considerations:

(1) The membrane cannot be formed and the adhesion is low When the concentration of acrylic emulsion diluted with deionized water is <10%.

(2) The membrane cannot be formed and cannot achieve the purpose of waterproofing When the concentration is about <40%.

(3) It will be dry and solidify after forming a membrane when the concentration is >50%. Although it can achieve the purpose of waterproofing, but the internal and external environment of the fossil woods cannot be exchanged and the air permeability is extremely poor.

Figure 3. LMW-S/S-HSE-HMWP

Therefore, two organic materials are mixed to achieve the purpose of waterproofing.

At present, there are three types of coatings commonly used in fossil woods waterproofing, such as synthetic high-molecular coatings, inorganic coatings, and polymer cement coatings. Different waterproof coatings have great differences in the application and effect of fossil woods waterproofing. The following are technical application, advantages and disadvantages of LMW-S/S-HSE-HMWP.

3.1 Proportioning

After mixing LMW-S/S-HSE-HMWP with acrylic emulsion at a ratio of 1:1, it is diluted with deionized water to become a mixed emulsion with a certain ratio. The configuration of the mixed solution in different proportions is as follows:

ISSN: 2414-1895 DOI: 10.6919/ICJE.202108_7(8).0011

Table 1. Proportioning of LMW-S/S-HSE-HMWP with acrylic emulsion and deionized water

Formula / Proportion / Reagent name	A	B	C	D
LMW-S/S-HSE-HMWP	1	1	1	1
Acrylic emulsion	1	1	1	1
Deionized water	2	5	7	9

Type A –sprayed on the surface of fossil woods, hardly spread, converging in the cavities of the surface, and the natural air-drying time is longer, which is about 24~48h in winter. Its converging cavities form obvious glue, which is only suitable for extremely humid areas.

Type B - sprayed on the surface of fossils woods, easily spread, a little converging in the cavities of the surface. It can be absorbed by absorbent paper, and natural air drying time is about 24h in winter. The surface has obvious lotus leaf water drop effect, and it is generally suitable for the surface of fossil woods.

Type C - sprayed on the surface of fossil woods, easily spread, and gradually invade the fossil along the pores of fossil woods. The natural air-drying time is <16h in winter. The surface is not prone to lotus leaf water drop effect. This type is suitable for dry areas.

Type D - sprayed on the surface of fossil woods, easily spread, and quickly penetrate into the interior of fossil woods. The natural air-drying time is <16h in winter. The surface does not appear the lotus leaf water drop effect. The water drop can invade after spreading on the surface for a period of time, and waterproof effect is not obvious.

3.2 Feeding method

The brush coating method has uneven smearing on the surface of the fossil woods, and the mixed waterproofing agent gathers in the pits on the surface and cannot be dispersed. The spray feeding method is more uniform, time-saved, and efficient.

3.3 Cleaning

For cavities and cracks on the surface, more spraying can be used to effectively prevent precipitation or other liquids from intruding. On the broken surface or root of the fossil woods, it needs to be consolidated without loosening, and then spray the reagent in an appropriate amount.

4. Outlook

At present, fossil woods waterproof materials still have problems such as single function and fewer selections. Waterproof material manufacturers, relevant scientific research units, and fossil protection and conservation units should actively carry out scientific research on fossil woods waterproof materials, and further improve the current dependence on imports of waterproofing agents and the performance of domestic waterproof materials. The key is to focus on “environmental protection”, “no secondary damage” and “long service life”, so that we can promote the sustainable development of the protection and conservation of fossil woods.

References

[1] Zhou ZH, Zhou M. Status Quo and Development Trends of Chinese Architectural Waterproof Coatings [J]. China Coatings, 2018.

[2] Hu QQ, Zhao FQ. Development of the Waterproof Coating Material in China [J]. Advanced Materials Research, 2013.

[3] Jia F. Development and Prospect of Polyurethane Waterproof Coatings [J]. Advances in Fine Petrochemicals, 2011.