Research on Mildew and Anticorrosion Technology of Mortar Admixture

XueRui Mu
KZJ New Materials Group Henan Co., Ltd., Xinxiang, Henan 453731, China
owen@xmabr-kzj.com
*Corresponding author, E-mail: 499285887@qq.com

Abstract: The mortar admixture has a shorter storage period without preservatives. In order to prolong the storage period of the mortar admixture and the performance of the product is not affected, the anticorrosion research experiment of the mortar admixture product is carried out. Through this test, it can be seen that the higher the temperature of microorganisms under the condition of incomplete sealing outdoors, the faster the mildew cycle. Then by adding isothiazole preservatives to improve the mildew cycle and appearance changes of admixtures, by testing the number of colonies in the samples after adding preservatives and testing the performance of mortars, when the preservative content is 2.0‰, the inhibition bacteria effect is obvious. The experimental results show that the addition of preservatives can effectively inhibit the growth and reproduction of bacteria, significantly prolong the mildew cycle of mortar admixtures, and have no effect on the performance of mortar admixtures.

1. Introduction

Because the wet-mix mortar admixture has the advantages of convenient construction, good workability, and low environmental pollution during the construction process, it occupies a large proportion in the use process. However, in the actual production and storage process, it was found to be prone to mildew (smelling, blackening) and cannot be used normally; and the admixtures at the customer have a long service life, and the storage environment is different, which is more prone to mildew. Considering the adverse effects of the mildew of the admixture on the performance of the wet-mixed mortar, the project carried out a mildew analysis and anti-corrosion technology research on it.

This project is mainly for the mold analysis of our company's mortar admixture product KZJ-100. The main components of mortar admixtures are water-retaining thickeners, air-entraining agents, defoamers and other small-molecule organics. The organics provide nutrients and energy for the reproduction and survival of bacteria. After long-term storage, a large number of microorganisms and their metabolites will be produced, which will cause discoloration, mold, precipitation, and peculiar smell, which will cause obvious deterioration of the product appearance and affect the performance of the product. The air-entraining agent used by our company is a solution prepared by a third-party solid powder, which is very easy to breed bacteria due to the pollution of the storage environment during production or transportation.

Therefore, it is very necessary to add preservatives to the mortar admixture to inhibit the growth of microorganisms, improve the storage period of the product, and keep the performance of the product unchanged. This experiment studied the appropriate dosage of three isothiazole preservatives to inhibit
the growth of microorganisms and their influence on the appearance and performance of mortar admixtures, aiming to provide technical guidance for extending the storage period of mortar admixtures.

2. Test

2.1. Test materials
(1) Cement: The cement is Mengdian PO42.5, and its indicators meet the requirements of GB 175-2007 "General Portland Cement".
(2) Standard sand: ISO standard sand.
(3) Mortar admixture: The water retention and thickening series, used to improve the water retention, workability and bonding properties of mortar. Its basic parameters are: density 1.002, g/cm³, pH 7.13, and apparent density 1919 kg/m³.
(4) Tap water: groundwater.
(5) Preservatives: isothiazole preservatives.

2.2. Testing Method

2.2.1. Homogeneity
Test according to the method specified in GB/T8077-2012 "Test Method for Homogeneity of Concrete Admixtures", the concentration of the mortar admixture solution is 3%, and the indoor temperature is 21.5℃.

2.2.2. Apparent density of mortar
Mortar apparent density test: add a certain amount of cement, sand, admixtures, and water to the cement mortar mixer, mix it for the specified time, put it into a container with a fixed volume, weigh the mass of the mortar poured into the container, and determine the unit volume the weight of the inner mortar.

2.2.3. Microbiological determination
Carry out the test in accordance with the method specified in GB/T5750.12-2006 "Standard Test Method for Drinking Water and Microbiological Index". The bacterial culture temperature was 32±1℃, and the culture period was 48~72 hours; the mold yeast culture temperature was 28±1℃, and the culture period was 72 hours.

3. Analysis of results

3.1. The mildew process and influence factors of mortar admixture

3.1.1. Influence of storage conditions
In order to observe the growth of microorganisms under different storage conditions for mortar admixtures, two storage environments and four storage methods were designed in this experiment. The details are shown in Tab. 1.

| Number | Storage Condition | Storage Method                  |
|--------|-------------------|---------------------------------|
| 1      | Interior          | Incompletely sealed and half bottle |
| 2      |                   | Fully sealed and half bottle   |
| 3      |                   | Incompletely sealed and bottle  |
| 4      |                   | Fully sealed and bottle         |
| 5      | Outdoor           | Incompletely sealed and half bottle |
| 6      |                   | Fully sealed and half bottle    |
The appearance changes of the mortar admixture were observed, and the results are shown in Tab. 2. The appearance of the mortar admixture began to change on the fourth day. The appearance of samples No. 1 to 4 was clear and transparent, but white flocculent suspension appeared inside. The color of No. 5 to No. 6 liquid was yellow, and the solution was slightly turbid. When stored for 10 days, obvious mildew spots appeared on No. 6 and No. 8, with more sediment at the bottom and a pungent odor. Samples No. 1 and No. 7 showed more sediment at the bottom, the solution was turbid, and the appearance of samples No. 2 to 5, the condition is slightly better, with less sediment at the bottom; When stored for 15 days, all No. 1 to No. 8 have mildew, the color of No. 1 to No. 4 samples and the bottom sediment are all black, the solution is turbid and smelly, and the colors and sediments of No. 6-8 sample are all white, and the solution is turbid and smelly.

Table 2. Periodic table of appearance of mortar admixture

| Number | Appearance changes of mortar admixtures at different storage times |
|--------|-------------------------------------------------------------------|
|        | 0 Day | 4 Days | 10 Days | 15 Days |
| 1      | ----- | +----- | +++-    | *       |
| 2      | ----- | +----- | ++--    | *       |
| 3      | ----- | +----- | ++--    | *       |
| 4      | ----- | +----- | ++--    | *       |
| 5      | ----- | +----- | +--     | *       |
| 6      | ----- | +----- | *       | *       |
| 7      | ----- | +----- | +++-    | *       |
| 8      | ----- | +----- | *       | *       |

Note: “-----” the mortar admixture is completely clarified; “+” the mortar admixture appears floating, precipitate or turbid, as the number of “+” increases, it means that the mortar admixture is more or more turbid; “*” the surface of the admixture has begun to grow mildew and smell.

According to the analysis of Tab. 1 and Tab. 2, it can be seen that the appearance of the mortar admixture sample stored indoor is obviously better than that of the outdoor sample; under the same storage environment, the mortar admixture sample in a completely sealed state is more prone to deterioration.

3.1.2. Temperature effect

During the test recorded indoor and outdoor temperature variations, the results shown in Fig.1. The average indoor temperature is 17°C, and the average outdoor temperature is 27°C. Due to the influence of weather during the test, the maximum temperature difference outside is 10°C, while the maximum temperature difference indoors is 5°C. The temperature fluctuation outside is larger than that in the room.

![Fig. 1 Outdoor and indoor temperature comparison chart](image)
Combining the analysis of Fig.1 and Tab.2, it can be seen that the mildew period of outdoor admixtures is significantly earlier than that of indoor admixtures. This is because at high temperatures, bacterial secretions cause substances to decompose and transform into alcohols, organic acids and other substances, and these substances provide a favorable environment for the growth of molds, so that molds can breed and multiply, and the biodegradation of low-molecular-weight organic matter in the admixture is intensified. It can be seen that high temperature storage environment will accelerate the mildew cycle of mortar water reducer.

3.1.3. Microbial Detection
In order to understand and analyze the number and types of microorganisms in samples of spoiled mortar admixtures more clearly and accurately, combined with the mildew status of the samples in Tab. 1, samples were selected for sampling and inspection. The sampling principle is: indoors select one with the most severe appearance deterioration and relatively slight appearance deterioration for inspection, and select the outdoor samples as No. 1 and No. 3 samples; combined with the actual storage conditions of the concrete mixing plant, the samples tested outdoors were selected as No. 5 and No. 7 samples. At the same time, send a new configuration sample to observe the growth of microorganisms. The results are shown in Tab. 3.

| Number | Bacteria Content, cfu/ml | Mold Content, cfu/ml | Yeast Content, cfu/ml |
|--------|-------------------------|---------------------|----------------------|
| Blank sample | $1.3 \times 10^4$ | $<10$ | $<10$ |
| 1 | $>10^6$, Overgrown | $<10$ | $<10$ |
| 3 | $>10^6$, Overgrown | $<10$ | $<10$ |
| 5 | $>10^6$, Overgrown | $<10$ | $<10$ |
| 7 | $>10^6$, Overgrown | $<10$ | $<10$ |

Analysis of Tab. 3, when the appearance of mortar admixture significant change occurs, even under various storage conditions and storage conditions, a similar sample of bacteria, mold and yeast growth. The newly prepared sample had a small amount of bacteria after culture, indicating that the bacteria have been brought in during the preparation of the sample. There were many reasons for this, such as raw materials, water, and unclean containers. This article will not elaborate.

3.2. The influence of preservatives on mortar additives

3.2.1. The effect of preservatives on appearance
Through the above experiments, it can be known that under the erosion of microorganisms, the appearance of the mortar admixture begins to change on the fourth day. Due to the random production of the concrete mixing plant, the mortar admixture cannot be used for production in a short time after being delivered to the concrete mixing plant. In order to extend the storage period and make the performance of the product not be affected during storage, it is necessary to conduct anticorrosion research on mortar admixtures. The field inspection of the concrete mixing plant in Henan shows that the storage tank of the concrete mixing plant is generally in the simple tent of the factory area, which can block the direct sunlight, and the product in the tank will not be in a full tank state. In order to fit the actual storage environment of the mixing plant, the storage environment and storage method selected for this anti-corrosion test are: outdoor, incompletely sealed. As preservatives, three samples of isothiazole preservatives A, B and C were selected to investigate the inhibitory effect of the amount of preservatives on bacteria, molds and yeasts. Through 30 days of observation, the changes were recorded. The experimental results are shown in Tab. 4.
Table 4. Effect of preservatives on the appearance of mortar admixtures

| Preservative | Dosage, ‰ | Appearance Change |
|--------------|-----------|-------------------|
|              | 3 Days    | 15 Days           | 30 Days           |
| Preservative A | 0        | +++              | *                | *                |
|              | 1         | +++              | +++              | +++              |
|              | 1.5       | +++              | +++              | +++              |
|              | 2         | +++              | +++              | +++              |
|              | 2.5       | +++              | +++              | +++              |
|              | 3.5       | +++              | +++              | +++              |
| Preservative B | 0        | +++              | *                | *                |
|              | 1         | +++              | +++              | +++              |
|              | 1.5       | +++              | +++              | +++              |
|              | 2         | +++              | +++              | +++              |
|              | 2.5       | +++              | +++              | +++              |
|              | 3.5       | +++              | +++              | +++              |
| Preservative C | 0        | +++              | *                | *                |
|              | 1         | +++              | +++              | +++              |
|              | 1.5       | +++              | +++              | +++              |
|              | 2         | +++              | +++              | +++              |
|              | 2.5       | +++              | +++              | +++              |
|              | 3.5       | +++              | +++              | +++              |

Note: “+++” — The mortar admixture is completely clarified; “+” — The admixture appears floating, precipitated or turbid, as the amount of + increases, it means that the mortar admixture has more or more turbidity; “*” — The surface of the admixture has begun to grow mildew and smell.

It can be seen from the above table that the appearance of the blank sample began to change on the third day, and sediments appeared; when the sample was placed for 15 days, mold began to appear and the smell was obvious. The samples with preservatives are stable in appearance during storage. A white film-like substance appears on the upper layer of the solution after 15 days of storage. After 30 days of storage, there is no change in appearance. Some samples have a small amount of precipitation, no mold or peculiar smell. When the preservative content is between 1‰ and 1.5‰, the floating matter in the upper layer of the solution is obviously too much. When the content is more than 2‰, the appearance change is not obvious. This is mainly because preservatives inhibit the growth and reproduction of microorganisms to a large extent, and reduce the decomposition of mortar admixture components by microorganisms and the emission of microbial metabolites.

3.2.2. Effect of preservatives on the growth of microorganism

After adding the preservative, the appearance of the sample has been significantly improved, but in order to have a clearer understanding of the growth of microorganisms in the sample, the samples of this test were submitted for inspection to detect the content of bacteria, molds, and yeasts. The experimental results are shown in Tab. 5 shown. It can be seen from the following analysis that when the preservative content is 1‰ to 1.5‰, a small amount of bacteria will grow in the mortar admixture. When the dosage is increased to 2‰, there are only a few bacteria, molds and yeasts in the mortar admixture, and as the dosage of preservatives increases, the antibacterial effect is not obvious.

Table 5. Effect of preservatives on the growth of microorganism

| Preservative | Dosage, ‰ | Microbial Content |
|--------------|-----------|-------------------|
|              | Bacteria Content, cfu/ml | Mold Content, cfu/ml | Yeast Content, cfu/ml |
| Preservative | 0         | 6.3*10⁶           | <10              | <10              |
3.2.3. The influence of preservative on the performance of mortar admixture

Compare the performance of mortar admixtures after adding different preservatives, and the results are shown in Tab. 6. The analysis in the table shows that after adding preservatives, the pH value and density of the mortar admixture have basically not changed significantly. The apparent density of the mortar admixture is slightly higher after 30 days of storage, but it is within the qualified range. After adding preservatives, the apparent density of the mortar becomes smaller, but the dosage has little effect on it. Preservatives change the pH of the mortar water-reducing agent, change the mortar water-reducing agent from neutral to weakly alkaline, change the living environment of microorganisms, extend the mildew cycle of the mortar water-reducing agent, and maintain the mortar admixture performance is not affected.

Table 6. Effect of preservative on the performance of mortar admixture

| Preservative | Dosage, ‰ | pH   | Density, g/cm³ | Apparent density of mortar, kg/m³ |
|-------------|-----------|------|----------------|-----------------------------------|
| Preservative A | 0   | 6.98 | 1.003          | 1963                              |
|             | 1   | 8.28 | 1.002          | 1946                              |
|             | 1.5 | 8.28 | 1.002          | 1940                              |
|             | 2   | 8.28 | 1.002          | 1932                              |
|             | 2.5 | 8.28 | 1.002          | 1934                              |
|             | 3.5 | 8.28 | 1.002          | 1930                              |
| Preservative B | 0   | 6.98 | 1.003          | 1963                              |
|             | 1   | 8.24 | 1.002          | 1922                              |
|             | 1.5 | 8.24 | 1.002          | 1924                              |
|             | 2   | 8.24 | 1.002          | 1918                              |
|             | 2.5 | 8.24 | 1.002          | 1915                              |
|             | 3.5 | 8.24 | 1.002          | 1917                              |
| Preservative C | 0   | 6.98 | 1.003          | 1963                              |
|             | 1   | 8.34 | 1.002          | 1922                              |
|             | 1.5 | 8.34 | 1.002          | 1915                              |
|             | 2   | 8.34 | 1.002          | 1916                              |
|             | 2.5 | 8.34 | 1.002          | 1920                              |
|             | 3.5 | 8.34 | 1.002          | 1917                              |
4. Conclusion
(1) Under different storage environments and storage conditions, mortar admixtures are easily decomposed due to the organic matter in the material components. After a certain period of storage, mildew will occur.

(2) Preservatives can effectively inhibit the growth and reproduction of bacteria, molds and yeasts in mortar admixtures, and the inhibitory effect on bacteria is particularly significant. Therefore, it can effectively prolong the mildew cycle of mortar admixtures.

(3) After adding the preservative, the performance of the mortar admixture is not affected. But the longest storage period remains to be studied.

(4) Through the comprehensive evaluation of microbial test and appearance, the antibacterial effect of preservative B is slightly better than that of preservative A and C. The former is clearer in appearance, and the suitable dosage is 2.0‰.

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