Synthesis and Computer Simulation Analysis of MF Modified Starch Adhesive

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Abstract. At present, corn starch can be used as raw material to complete the preparation. The preparation process of waterproof high-viscosity starch adhesive is as follows: firstly, the corn starch is oxidized and polymerized, and then the MF is used to modify, thus the waterproof high-viscosity starch adhesive is prepared. In this paper, the effects of starch gelatinization temperature, mass ratio of NaClO to starch, mass fraction of PVA solution and mass ratio of MF to starch on adhesive properties were established and verified by computer simulation software. The following is an introduction to the experimental process and results for readers' reference.

Keywords: Starch Adhesive, Mf Modification, Computer Simulation Analysis, Oxidation Treatment

1. Introduction
The original starch adhesive is widely used in chemical industry because of its wide sources, green environment protection and low price [1-3]. But the original starch adhesive viscosity and water resistance of the flaws, in order to the original viscosity and water resistance of modified starch adhesive, need through oxidation, etherification, grafting, crosslinking and composite modification, not only the viscosity of modified starch adhesive and water resistance has improved, at the same time in the process of preparation of modified starch adhesive is fast drying and environmental protection [4-6]. At present, there are many researches on starch modified adhesive at home and abroad, and further researches are being carried out on its viscosity, waterproofing improvement, or application of adhesive properties.

2. Preparation significance and process of MF-modified starch adhesive

2.1. Significance of preparation of MF modified starch adhesive
Used in adhesives, sintering plant protein adhesives, rubber chemical pollution already can't satisfy people's needs, starch and modified starch glue adhesive of the raw material price is low, and as a renewable resource is more and more get the favor of people, especially in the industrial production of adhesives in recent years towards the direction of low cost, pollution-free, starch adhesive is used as a natural renewable adhesive is better than the other adhesives in many aspects. Due to the need of comprehensive performance, the original starch adhesive usually needs to add human formaldehyde,
so there will be formaldehyde residue in the product, which will cause certain harm to the environment and human experience. By oxidizing the original starch and cross-linking it with polyvinyl alcohol (PVA), a new type of starch adhesive with good adhesive strength and stable properties was prepared, which was formaldehyde-free, green, and environmentally friendly.

2.2. Preparation process of MF modified starch adhesive
The preparation process of the original starch adhesive was as follows: using hydrogen peroxide as oxidant to prepare corn starch adhesive. Under the action of catalyst by changing all kinds of reagent dosage, namely content of quantity of water, hydrogen peroxide, the amount of NaOH, borax and investigation on the initial adhesion, standing, gel time and the influence of the drying rate and so on performance, in the final analysis to determine the best ratio for: on 20 g starch as a benchmark for 100 ml to 140 ml water, FeSO4 0 8 g H2O2 was 0.4 g, 10%, 1% Na OH for 16 to 18 g - S2O3 is 20 g. 1.5% borax is 26, 66 under the action of sulfuric acid, maize starch glue was prepared with KMnO4 as oxidant. The effects of water amount, Know amount, NaOH amount and borax amount on initial viscosity, viscosity, drying rate and fluidity were investigated. The optimal ratio was determined as follows: taking 20g starch as the benchmark, 160mL water, 40%KMnO4 4-6ml, 10%H2SO4 42 mL, 10%NaOH 40 mL, and 1% borax 40 mien order to determine Fanhood transition temperature, Na, ClO relative to the mass fraction and mass ratio of starch and PVA solution of MF relative to starch quality ratio on the properties of starch adhesives, using computer simulation software to establish raw material is PVA mass fraction 20%, starch gelatinization temperature of 55 ℃, MF feeding ratio 1.25, Na to the dosing radio Cl O 1% of the model, this paper introduced the test, and the modified adhesive test process as follows: Firstly, starch was gelatinized and oxidized, and then polymerized with PVA. Finally, the starch adhesive modified by MF was prepared by adding melamine formaldehyde resin (MF).MF modified starch adhesive is a kind of high viscosity starch adhesive with good water resistance. Its properties of water resistance and viscosity were tested through experiments.

3. Experimental part

3.1. Experimental materials and instruments
Corn starch (industrial grade); Melamine formaldehyde resin (MF) (AR); Polyvinyl alcohol PVA (AR); Sodium hypochlorite (AR); Potassium persulfate (AR); Sodium hydroxide (AR); Dodecyl benzene sulfonic acid (AR); OP - 10 (AR).

Three-mouth flask; Magnetic stirrer with constant temperature heating (DF-101S); Electronic analysis tainting (SL.602K); Digital viscosimeter (NDJ-5S/8S); Electric heat constant temperature drying box (DHG9023); Refrigerator (utm6 BCD - 253).

3.2. Experimental methods
Weigh and corn starch 8 g plus a small amount of sodium hydroxide dissolved completely to quantitative water (p H = 9), starch gelatinization processing slow heat gelatinization temperature 20 min, join Na Cl oxidation reaction at 95 ℃, O add preparation beforehand good 20 mL a certain concentration of PVA and 0.14 g potassium persulfate solution polymerization, at the end of the reaction temperature to 60 ℃, adding suitable amount of MF and emulsifier (OP - 10,1 g of sodium dodecylbenzene sulfonate) was reacted at 60 ℃ for 1 h and cooled to room temperature, then discharged.

3.3. Performance measurement methods

3.3.1. Viscosity measurement
Refer to GB/ T2794-1995 standard for viscosity measurement by digital display viscometer.
3.3.2. Determination of stability
After the preparation of the adhesive, the colloidal viscosity was measured regularly and the appearance of the gel was observed.

3.3.3. Determination of water resistance time
Water resistance was tested in accordance with QB/ T1094-1991: the samples were bonded and cured for 3 days and soaked in warm water at room temperature and 80 °C, respectively. The former was soaked for 30 days and the latter for 15 days, and the glue opening time was observed and recorded.

4. Experimental results
In the literature analysis, it was found that the four factors that significantly affected the properties of modified starch adhesive were: starch gelatinization degree T. The mass ratio of NaClO to starch was 1, the mass fraction of PVA solution was 2, and the mass ratio of MF to starch was 3, so the orthogonal experiment is designed, see the table below.

| Sample | number | T/°C | omega | 1,  | omega |
|--------|--------|------|-------|-----|-------|
| 1.55   | 1%     | 20%  | 1.25  |     |       |
| 2,     | 65     | 2%   | 40%   | 1.5%|       |
| 3      | 75     | 3%   | 60%   | 1.75|       |

Table 2. Experimental scheme.

| Sample | number | T/°C | omega | 1  | 2   |
|--------|--------|------|-------|----|-----|
| 1.55   | 1%     | 20%  | 1.25  |    |     |
| 2,     | 55     | 2%   | 40%   | 1.5|     |
| 3      | 55     | 3%   | 60%   | 1.75|     |
| 4      | 65     | 1%   | 40%   | 1.75|     |
| 5      | 65     | 2%   | 60%   | 1.25|     |
| 665,   | 3%     | 20%  | 1.5%  |    |     |
| 775    | 1%     | 60%  | 1.5   |    |     |
| 8      | 75     | 2%   | 20%   | 1.75|     |
| 9      | 75     | 3%   | 40%   | 1.25|     |

4.1. Viscosity measurement results of computer simulation analysis
According to the test data, computer technology was used to process the data and the test results in Table 2 were obtained. The initial viscosity of each sample was as follows:

| Sample | number | T/°C | 1  | 2   |
|--------|--------|------|----|-----|
| 1.55   | 1%     | 20%  | 1.25| 13220|
| 355    | 3%     | 60%  | 1.75| 35100|
| 665    | 3%     | 20%  | 1.5 | 5400 |
| 975    | 3%     | 40%  | 1.25| 11280|

According to the analysis in table 3, the influence of the four factors on the viscosity of starch adhesive ranged from 2> 1> 3> T. In practical application, excessive viscosity will increase the difficulty of sizing, while low viscosity may lead to stratification and poor bonding effect. According to GB/ T2794-1995, the viscosity is between 5000~12000(m Pa·s), so the PVA concentration should not exceed 60%.

4.2. Determination of stability
The computer was used to process the data, and the test results in Table 3 were obtained. The viscosity and appearance changes of the adhesive samples during the standing period were as follows:
Table 3 shows that when the concentration of PVA increases, the risk of adhesive gel also increases. In order to facilitate the sizing and storage of adhesive, the concentration of PVA solution should be selected at about 20%. In addition, when the concentration of PVA was 20%, it was observed that with the increase of MF usage, the adhesive was prone to gel or lamination, so the added amount should not be higher than 1.5.

5. Conclusion

In this test, a model of PVA mass fraction (20%), starch gelatinization temperature (55 °C), MF feeding ratio (1.25) and NaClO feeding ratio (1%) was established by using the computer simulation software. Then relevant tests were carried out and the experimental data were processed by computer technology, and the following conclusions could be drawn:

1. The viscosity and water resistance of the starch adhesive modified by MF were improved to a certain extent, but the stability of the adhesive decreased when MF was added in large amount.

2. The effects on the viscosity of modified starch adhesive ranged from large too small for PVA solution mass fraction (2 > NaClO) to starch mass ratio (1 > MF) to starch mass ratio (3 > starch gelatinization temperature (T)).

3. A waterproof high-viscosity starch adhesive was prepared under the following production conditions: PVA solution mass fraction 20% starch gelatinization temperature 55 °C, MF feeding ratio 1.25, NaClO feeding ratio 1%. Under these conditions, the viscosity of the adhesive reached the standard of GB/T 2794-1995, and the water resistance performance met the standard of QB/T L094-1991.

Therefore, in order to prepare starch adhesive with excellent water resistance and viscosity properties, the ratio, and conditions of raw materials in the production process should be PVA solution mass fraction 20% starch gelatinization temperature 55 °C, MF feeding ratio 1.25, NaClO feeding ratio 1%.

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