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Preparation of the Plywood Using Starch-based Adhesives Modified with blocked isocyanates

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Abstract

The purpose of the research was to prepare environment friendly plywood using starch adhesives modified by blocked isocyanate. Blocked isocyanate and auxiliary agent were used to modify starch. The influence factors of the bonding strength and water resistance of starch adhesive were studied by different solid content, adding additives and adding blocked isocyanate. The results show that starch and blocked isocyanate adhesive to join the ratio of 100/20, the dry bonding strength the most, while the starch adhesives and the ratio of blocked isocyanate to join 100/25, the wet strength the most. Bonding strength and water resistance was improved significantly by adding additives and isocyanates to starch adhesive. Plywood bonding strength from the performance of integrated cost considerations, the optimum ratio of additives added 4% and 6%.

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Key words: Blocked isocyanates; Starch-based Adhesives; Modified;

1. Introduction

Starch adhesive wide range of sources of raw materials, simple process, easy to operate, low cost, good adhesion and film forming, non-formaldehyde emission and other characteristics, and to highlight environmentally friendly and renewable, sustainable development today, Become the most potential for development of wood with a natural adhesive with one [1]. But the starch adhesive performance due to poor water, poor storage stability and the bonding strength is small and limited areas in the application of the timber industry [2].

Isocyanate adhesive with excellent bonding properties, water resistance, aging resistance, no formaldehyde and other pollution problems is to adapt to a wide range of bonding materials, but the cost is high, easy storage and water vapor reaction is difficult, especially in the stability of aqueous solution Of the poor, soon after contact with water, foam and failure to respond and for short duration [3]. By lively isocyanate (-NCO) closed, to ensure a stable closed system. When using the method to re-lift by heating temperature, the isocyanate is released again, to play its superior performance [4]. Characteristics and for lack of starch adhesive, combined with the advantages of isocyanate adhesive, this study blocked isocyanate modified starch adhesive, to add a small amount of modified starch

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adhesive in order to achieve improved plywood Bonding strength and water resistance effect, expand the range of starch adhesive used.

2. Materials and methods

2.1. Materials.

Starch, adipic acid, PVA, isocyanate, sodium bisulfite, anhydrous ethanol, dioxane, Blocked isocyanate: blocked isocyanate closure rate of 95%, and the storage period of 30d, pH: 4.8-5.5, solid content: 28% ~ 35%.

2.2. Test equipment and test equipment.

Pre-Press: The pilot presses; pressing machines; universal mechanical testing machine; oven; Moisture Tester; electronic scales, vernier caliper, constant temperature water bath and so on.

2.3. Process parameters and the intensity of the system board test standards.

Pressing temperature 120°C; pressing time 1min/mm; hot pressure 3MPa; pre-pressure 2Mpa; veneer coating amount of 320g/m². Strength testing standards by national standard, the water boiled at 63 degrees for 3h, and then put out 10min, using universal mechanical testing machine strength.

2.4. Preparation of blocked isocyanate.

Blocked isocyanate with sodium bisulfite solution in a certain solvent conditions, the PAPI be blocked, at a temperature of 0~25°C conditions, the sodium bisulfite solution and the solvent feed into the reactor, control bisulfite The initial concentration of sodium 15 ~ 40wt.%, of which solvent to PAPI's 20~80wt%, sodium bisulphate-based isocyanate molar ratio of 1.05~1.5:1, control, dropping to 150 ~ 500g /h, and then in a closed temperature -5 ~ 25°C closed under the conditions of 1.5 to 3 hours, get blocked isocyanate.

2.5. The improved method of synthesis of starch adhesive.

Taking esterified starch, water, a number, added directly to the 1000ml flask, stirring 10min, taking with pipet mixing the appropriate amount of starch solution to a small beaker, measured pH, with a good use of hydroxide 5% Adjusting the pH value of sodium to the alkaline, pour in three flask, stirring until evenly, repeat the above steps, the final pH value in the flask to 11 below basic state can be, then weigh a certain amount of polyethylene Alcohol (PVA, the amount of starch content 15%) added to the flask, the reaction for 2-3 minutes, check the small amount of sodium dodecyl sulfate (the amount of starch, 1% -2%volume) added to the flask, At this time began to heat up, slowly stirring in water bath shock, 60 minutes out of material.

3. Results and discussion

3.1. To determine the proportion of mixed glue (observation for period)

To determine the adhesive mixture of starch glue and the ratio of blocked isocyanate, a total of 4 groups did comparison test. Starch adhesives and blocked isocyanate in the proportion of mixed glue were 100/10, 100/15, 100/20, 100/25, 100/30. Starch adhesive solid content of 55%, blocked isocyanate (BPI) with the best ratio of synthesis.

Table 1 lists the blocked isocyanate adhesive blends of starch and stability, and applies. As can be seen from the table, St0, St1, St2, St3, St4 is the inclusion of the ratio of blocked isocyanate are 100/10, 100/15, 100/20, 100/25, 100/30, St0 joined the ratio of blocked isocyanate 10%, start mixing, the dispersion viscosity did not increase evenly, no more uniform bubble system, with the blocked isocyanate ratio gradually increases, the viscosity of the system has gradually decreased, there was no stratification, and in the ratio of 30% to join when stratified, less effective.

Therefore, the performance point of view from the mixed isocyanate to urea-formaldehyde resin in the ratio is not better, according to process needs to be determined by adding the proportion of experimental conditions and appropriate.

Table 1 The stability of storage for composites adhesive with different ratio

| (St/BPI) | Stability of Composite Adhesive mixture |
|--------------|---|
| St0 (100/10) | System is not hierarchical, there is no air bubbles and sediment, viscosity does not reduce |
| St1 (100/15) | System more uniform, no air bubbles and sediment, viscosity does not reduce |
| St2 (100/20) | System more uniform, no air bubbles and sediment, viscosity does not reduce |
| St3 (100/25) | System more uniform, no air bubbles and sediment, a slight decrease in viscosity |
| St4 (100/30) | System more uniform, no bubbles, but a little sediment, the viscosity decreased significantly |

3.2. The ratio of blocked isocyanate bonding strength

The proportions of different isocyanate adhesive preparation of modified starch plywood, plywood bonding strength were measured, the results shown in the table2. Group 5 tests in preparation of the bonding strength glue mixed with the blocked isocyanate is not the added amount of the increase, but the ratio of 100/20 in the dry bonding strength was 1.56MPa when the peak.

It follows that, if you want to get the best bonding strength, mixing glue in the UF resin and blocked isocyanate ratio should be 100/20. 100/30 or greater, the intensity decreased. 100/25 wet strength is not in the best, but appear in the starch adhesive and blocked isocyanate ratio of 100/25, but still did not meet national standards for two types of plywood, so need to add thickener and additives to enhance the bonding strength of plywood water resistance.

Table 2 Blocked isocyanate ratio on Bonding Strength

| Number | Average Dry Strength (MPa) | Average Wet Strength (MPa) |
|--------------|----------------------------|----------------------------------|
| St0 (100/10) | 0.97 | 0.53 |
| St1 (100/15) | 1.10 | 0.60 |
| St2 (100/20) | 1.54 | 0.58 |
| St3 (100/25) | 1.34 | 0.675 |
| St4 (100/30) | 1.23 | After the open plastic boiled 2h |

3.3. Additive ratio on Bonding Strength

Joined the blocked isocyanate will reduce the starch adhesive in the viscosity of the blend, and in order to improve the water resistance of plywood, use additives bentonite as a thickening agent to improve the viscosity of blends. Using starch adhesive with the ratio of blocked isocyanate 100/25, adding bentonite ratio of total starch adhesive was 2%, 4%, 6%, 8%. Bonding strength of plywood prepared for testing, the results shown in Table 3.

Table3 the proportion of additive effect of starch adhesive bonding strength

| Ratio of auxiliary agent (%) | Average Dry Strength (MPa) | Average Wet Strength (MPa) |
|------------------------------|----------------------------|----------------------------|
| G1 (2%) | 1.31 | 0.68 |
| G2 (4%) | 1.45 | 0.73 |
| G3 (6%) | 1.40 | 0.80 |
| G4 (8%) | 1.56 | 0.72 |

Table 3 shows that, with additives added to increase the proportion of dry strength first increased and then decreased slightly, while the ratio of 8% in the additives, the optimum value of 1.56MPa, but the wet strength varies somewhat different in Additive ratio of 6%, adding wet strength to the highest, in order to 0.80MPa, two types of plywood to the national standard, and additives added ratio of 8%, the wet strength but some decline, but also to meet national standards.

This may be because the proportion of added chemicals may affect the closure of excess isocyanate deblocking reaction and the condensation reaction of starch itself, while adding greater proportion, the higher the cost. Integrated wet and dry strength and therefore the cost, choose the ratio of additive to 4% and 6% is more suitable

4. Conclusions

Through the use of blocked isocyanate and the preparation of plywood adhesive additive of modified starch, the results show that wet and dry bonding strength from the point of view, starch and blocked isocyanate adhesive to join the ratio of 100/20, the dry bonding strength the most, while the starch Adhesives and closure of the ratio of isocyanate to join 100/25, the wet strength the most. By adding the proportion of additives prepared and mixed the glue bonding strength of plywood, plywood bonding strength from the performance of integrated cost considerations, the optimum ratio of additives added 4% and 6%, its been wet and dry bonding Strength of 1.4MPa, 0.8MPa, 1.56MPa, 0.72MPa.

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