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Study on The Influence of The Application of Nano-Starch About the Paper Properties as Spray-Starch

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Abstract. In this thesis, we study the application of nano-starch in ordinary sizing starch was replaced by nano-starch as surface sizing in paper surface sizing, and its impact on paper properties was examined. It includes the study of Nano-starch, its influence on the performance of the sizing and on paper properties as sizing agents. The experimental data showed that the viscosity of the nano-starch solution was moderate. And the viscosity grown slow with the increase of concentration. JN and sodium dihydrogen phosphate both improved nano-starch solution viscosity. The effect of JN is more than sodium dihydrogen phosphate. When conventional surface sizing starch was replaced by Nano-starch, the physical properties of the paper, such as the tightness, burst index, breaking length, tear index, folding degree, sizing degree, have been greatly improved. And in comprehensive consideration, the best ratio between conventional surface sizing starch and Nano-starch was 6:2. The deposition properties of Nano- starch was good.
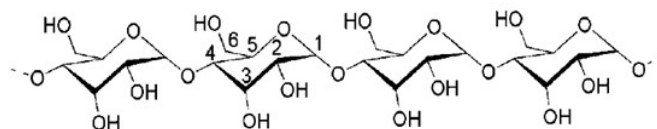
1. Introduction

With the increasing demand for energy and environmental protection, starch has gained wider attention as a renewable and environmentally friendly material. Starch is a kind of high molecular polysaccharide compound, which has a wide distribution on the earth, so we can use a lot of starch resources. The fiber molecules in the raw materials of starch molecules and papermaking fibers are very similar in structure. In addition, starch has a wide range of sources, low prices, and low environmental pollution, and is widely used in the paper industry.
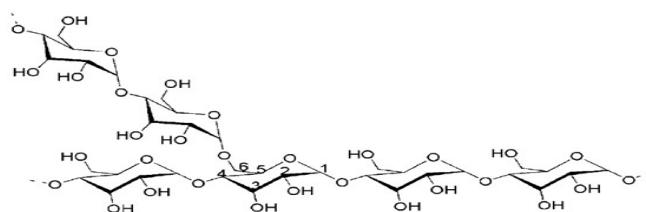
At present, research on modified starch has achieved a large number of industrial achievements and scientific research results. For example, the use of green, non-polluting, biodegradable, renewable starch materials to replace petroleum-based latex styrene-butadiene latex can alleviate the pressure of resource shortages and contribute to environmental protection.

Starch can be classified into amylose and amylopectin depending on the difference in glycosidic linkage positions in the glucose unit.

Figure 1. Chemical structure of amylose

Figure 2. Chemical structure of amylopectin

Nano starch: Starch is granular in application, small in specific surface area and small in contact area. As a small-sized and high-crystallinity crystal grain prepared on the basis of natural starch, nano-starch not only has the property of natural starch, but also has nano-particles. characteristic. Nano-grade starch, exposed to the outside of the hydroxyl group, can be combined with the surface fibers of the paper to improve the surface strength of the paper. Each structural unit in the starch contains three hydroxyl groups, forming strong intramolecular hydrogen bonds and intermolecular hydrogen bonds.

Surface sizing: Surface sizing enhances the printing and liquid resistance of paper and enhances the physical properties of paper. The main functions are: (1) improve the physical strength of the paper; (2) enhance the printing performance and liquid resistance of the paper; (3) reduce the two sides of the paper; (4) increase the durability of the paper; (5) save the rubber (6) Stabilize the performance of paper.

This topic mainly studies the surface sizing of ordinary paper with nano-starch instead of ordinary surface sizing starch, and investigates its effect on the performance of the sizing solution and paper properties. It is roughly divided into the following three parts:

(1) Performance testing of nano starch;
(2) the effect of nano starch on the properties of the sizing solution;
(3) The effect of nano-starch as a surface sizing agent on paper properties;

2. Experimental

2.1. Materials
Bleached hardwood pulp board, bleached softwood pulp board; nano starch, water 7.89%; US coated starch; coated starch, moisture 12.89%; sizing agent AKD (alkyl ketene dimer), solid content 15%; JN additive; sodium dihydrogen phosphate (NaH_2PO_4)

2.2. Main experimental instruments and equipment
Drum dryer; Wali type beater; digital viscometer; automatic sheet applicator; high speed disperser; multi-function sand grinder analyzer; intelligent dispersing sand mill controller; high speed universal grinder; MIT paper Folding resistance tester; horizontal computer tensile tester; tear tester; paper breakage tester; paper thickness tester.

2.3. Experimental method:
1.Determination of water content of starch: Weigh a certain amount of starch in a weighing bottle that is washed and dried in advance, placed in a digital blast drying oven at 105 ° C, and transferred to a desiccator for 5 hours, then cooled for half an hour, then Weighing. Record data and calculate moisture.

2.Paper sheetBeating: After decontamination, the beating is performed with a tile-type beater. After the end, the residual slurry is washed into the container with water.

3.Papermaking: (1) Turn on the drum dryer, adjust the temperature to 80 °C; open the paper plane dryer and adjust the temperature to 105 °C.(2) Weigh 2 g of dry pulp and add 0.3% AKD (solid content: 15%), stir with a glass rod, and mix well.(3) Open the sheet former, lock the lid, then unscrew the tap to start adding water, wait until about 5L to stop adding water, pour the mixed slurry, continue adding water to about 7L, stop adding water.(4) Stir in the vertical direction with a stirrer for 5 times so that the slurry was uniformly dispersed and there was no pulp, and then drainage was started.

(5) After the water is completely drained, stop draining, open the lid, and then start uncovering the paper. First, lay a white cloth on the wet paper sheet, add 5 pieces of water-absorbing filter paper on top, and slowly press the roller back and forth to make the water-absorbing filter paper absorb water, and then use the roller to expose the paper. After the wet paper sheet is peeled off, a white cloth is placed on the top to make the paper sandwich between the two layers of cloth, and a layer of felt is placed on the outside. Slowly press back and forth with a heavy roller, then press the felt and the white cloth and paper inside it in the press, and take it out after 30 seconds. (6) Put the paper sheets taken out after pressing and white cloth together in a flat dryer on the paper sheet for drying. After about 10 minutes, remove the paper sheets, balance the water in a constant temperature and humidity environment for 24 hours, and flatten with the pressed iron blocks.

4.Finally, the surface sizing of the paper is performed.The paper performance testing stage includes quantification and tightness, tensile strength and crack length, determination of tear and burst strength, and determination of folding resistance and sizing.

3. Results

This thesis mainly studies the surface sizing of paper with nano-starch instead of ordinary sizing starch, and investigates its effect on the performance of the sizing solution and paper properties.

(1) Comparison of viscosity properties of nano starch and other starches

The viscosity of the nanostarch is lower than that of the coated starch, the ordinary size starch, and higher than the viscosity of the US coated starch. Therefore, the viscosity of the nano starch is moderate.

(2) Effect of different concentrations on starch viscosity

As the concentration increases, the viscosity of the nanostarch and coated starch gradually increases, and the rate of increase is getting faster and faster. The rate of increase in the viscosity of the coated starch is greater than the rate of growth of the nanostarch.

(3) Effect of nano-starch replacing ordinary surface sizing starch on viscosity.

(4) Effect of additives on the viscosity of nano-starch solution (5) Comparison of film forming properties of nano starch and other starches

Among the four kinds of starch, the filming property of the coated starch is the worst, and the solution has cracks and falls off after drying; the coated starch of the United States has good film forming property, and the surface is flat, but the color is yellowish. The ordinary surface sizing starch solution is relatively viscous and easily split into two lobes after drying; while the nano starch is white in color, has a starchy aroma, moderate viscosity, and good film forming property. Nano starch is most desirable in terms of film formation, appearance and odor.

(6) By analyzing the infrared spectrum, it can be seen that the internal structure of the nano starch has undergone a certain change, so that more hydroxyl groups are exposed, which is more suitable for application to surface sizing.

(7) Effect of nano-starch replacing ordinary surface sizing starch on physical properties of paper

4. Conclusion

The wide application of nanotechnology in the paper industry has brought us not only economic improvement, but also the reduction of environmental pollution and resource conservation. Therefore, continuing to study nano-starch will bring unprecedented opportunities and achievements to the future environment, chemical and materials fields.

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