Development of technology for obtaining starch gluing modified with uzkhitan and hydrolyzed emulsion

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Abstract. In this article, in order to reduce the consumption of starch for gluing warp threads and reduce the cost of sizing materials used in sizing and improve the quality of threads, an effective gluing composition was created based on a hydrolyzed acrylic emulsion (GAE) and uzkhitan (chitosan and carboxymethyl cellulose), that is, corn starch polymer and studied their rheological properties. In the article, the main threads passing through the gluing process and moving at a certain speed, which are then impregnated with liquid gluing. Then they pass through a nip roller and a drying drum, are subjected to friction and form a layer of a certain thickness. A theoretical analysis of the surface of the warp threads is carried out to determine the change in the diameter of the threads when a layer of a certain thickness is formed on their surface.

1. Introduction
Gluing is one of the most critical processes in the preparation of yarn for weaving. During gluing, the physical and mechanical properties of the base yarn can significantly change, which affects the breakage of the threads on the weaving machine. To reduce breakage in weaving, it is necessary to carry out a high-quality gluing process.

The essence of the traditional gluing process is to impregnate the warp yarns from the warp rolls at a given tension with a gluing solution, remove excess gluing from the yarns when squeezing them in squeezing rollers, dry the sized threads in a drying apparatus to a certain moisture content, separate the glued threads and send them to weaving beam [1].

The main components of the gluing are adhesives, which are used as starch products (potato, corn and rice starch, wheat and rye flour). In the case of using these products, various types of starch breakers (acids, alkalies, oxidizing agents) are necessarily introduced into the size. The gluing also includes auxiliary components - hygroscopic substances (glycerin) and softeners (stearin).

If there is a need for long-term storage of gluing bases, then to prevent the appearance of microorganisms, anti-putrefactive compounds (copper sulfate, phenol, boric acid, etc.) are introduced into the gluing [2].

Gluing materials applied to the yarn or thread from solutions or melts, upon drying, form film bonds between the fibers inside the yarn and a coating on its surface.

Despite the very valuable qualities of synthetic gluing, starch is still widely used in the textile industry and occupies a dominant position in terms of the volume of use on a global scale. In this regard, numerous studies are carried out all over the world, not only aimed at replacing food raw materials with synthetic materials, but also at finding ways to improve the quality of starch gluing, in particular, by modifying starch [3].
Modification of polymers, as a rule, is carried out to improve their properties in the desired direction, which practically makes it possible to obtain polymers with desired properties. The use of modified polymers in gluing technology can improve the quality of gluing and, as a result, reduce the breakage of warp in weaving, increase the speed of yarn processing, and reduce dust. In the domestic and foreign literature there are a large number of works that consider the issues of obtaining gluing preparations based on modified natural and synthetic polymers [4].

The aim of the study is to develop the optimal structure of the gluing material based on local raw materials and the development of resource-saving gluing technology, improving the quality of fabrics.

2. Materials and methods

For the first time a modification of starch based on hydrolyzednoisy acrylic emulsion and chitosan, as well as the optimal structure of the gluing composition, which gives a high effect:

- analysis of the effect on the technological parameters of starch gluing and on the base threads of the hydrolyzed acrylic emulsion sized by them and the effect of chitosan;
- development of textile materials from warp threads sanitized on the basis of local components, theoretical and practical substantiation of optimal parameters and operating modes;
- development of high-quality textile materials from warp threads sized based on local components;
- determination of the quality and assessment of technical and economic indicators of textile materials made from warp threads sanded on the basis of local components.

The object of the research is cotton warp threads, gluing reagents: corn starch, chitosan, uzkhitan, acrylic emulsion developed at Navoiazot JSC, gluing machine, weaving machine.

The subject of the research is the devices for determining the indicators of sized warp threads, gluing materials, warping rolls and weaving beams, operating modes and indicators, as well as the laws of their change.

In the course of the study, the methods of small squares of the structure of regression models, optical microscopy, viscosometry, rheology were used, a comprehensive assessment of the qualitative parameters of tissues, a full-factor experiment and processing of the experimental results were carried out.

The scientific novelty of the research is as follows:

- for the first time, the structure of a gluing material based on natural starch and uzkhitan polymer was developed for gluing cotton warp threads;
- a technology for the production of a gluing of a new structure based on corn starch, uzkhitan and a hydrolyzed acrylic emulsion has been developed using targeted control of methods for obtaining gluing materials, the formation of its structure and properties, as well as parameters acting on it;
- the coefficient of coverage of the main thread with the gluing was determined, taking into account the action of the parameters of time and the environment that drains it;
- substantiated the optimal technological parameters for the production of textile materials from the main threads sanitized on the basis of local raw materials.

The practical results of the study are as follows:

- the actions of the ratio of uzkhitan on the structure of starch gluing, on its relative viscosity and on the main indicators of cotton threads are determined;
- the possibilities of production of the main threads with a new gluing structure have been determined, which provides the possibility of producing yarns with high complex indicators in comparison with the traditional method of gluing structure;
• an inexpensive gluing material is recommended that forms a durable coating, easily absorbed by threads and allows the production of fabric with resistance to abrasion;
• the production of high-quality fabrics has been achieved, which ensures consumer demands of the population, reduces energy consumption and the supply of raw materials, which makes it possible to increase production efficiency when introducing a gluing composition made from corn starch and uzkhan preparation.

The reliability of the research results is confirmed by the compatibility of theoretical and experimental studies considered according to certain evaluation criteria, the use of mathematical models of technique and technology for gluing cotton warp threads.

The scientific significance of the research results is justified by the fact that mixing the structure of the starch gluing composition with chitosan during gluing of the warp threads will lead to an increase in the efficiency of gluing the strength of the threads and to an increase in the quality of fabrics made from them.

3. Results and discussion
The practical significance of the research results is justified by the fact that a new gluing composition has been developed based on starch mixed with uzkhan, which makes it possible to produce fabric with a smooth surface and improved physical and mechanical properties, as well as allowing to reduce thread breakage in the weaving process and improve the quality of fabrics produced.

As a result of comprehensive studies, which serve as an important scientific and technological prerequisite for the creation of production methods for obtaining gluing based on starch, uzkhan and GAE for yarn gluing, we have developed a yarn gluing technology, which is the subject of the next part of this study.

In recent years, in the educational and scientific laboratory of the Department of Textile Technology and Design of the Bukhara Engineering and Technological Institute, new resource and energy-saving technologies for obtaining gluing materials from starch have been developed, which make it possible to combine the process of preparing gluing with chemical modification of starch. In the course of preliminary scientific research by special kinetic and analytical methods, it was proved that chemical transformations of starch in the presence of water-soluble polymers in starch fractions can occur. Moreover, even at low degrees of polymer conversion, a significant effect is observed in changing the rheological properties of the processed materials.

The main element of the modified starch gluing technologies is the use of waste from the production of silk-winding factories and the original design. The small size of the modified units makes it easy to modernize the lines operating at the enterprises and to carry out the modification of starch at the place of consumption. When processing the suspension coming from the "milk" tank, the following processes take place in the reactor:

• amorphization on the surface of starch particles;
• adsorption and chemisorption of chemical reagents on the surface of starch particles;
• splitting of starch grains;
• forming a new structure;
• homogenization.

The proposed technology for obtaining starch gluing based on uzkha and GAA has been successfully tested at the company "Delyuks Fabric" LLC. Below are the gluing recipes for the traditional (Delyuks Fabric LLC) and modified methods of gluing preparation: Traditional method (kg / t)
• Corn starch - 80
• Glycerin - 0.4
• PVA - 4.0
- Sodium metasilicate - 0.3
- Modified way
- Corn starch - 50
- Uzhitan - 0.6% of dry weight of starch
- GAE - 0.6%
- Sodium metasilicate - 0.1

Table 1 shows the technological parameters of the traditional (base) and polymer composition starch gluing: starch, uzkhitan and GAE.

Table 1 shows that the developed new resource and energy-saving technologies for the preparation of modified gel-like starch gluing with water-soluble polymers can save starch consumption per 1 ton of gluing from 80 kg to 50 kg, reduce the gluing preparation time from 45 to 20 minutes and improve the technological parameters of gluing.

To prepare the gluing, the following equipment was used: an apparatus for preparing a gluing with high-speed stirrers, an automated device for feeding and loading gluing materials, pumps and instruments for controlling the parameters of gluing preparation, containers for storing initial components and finished products.

**Table 1. Technological parameters of the yarn gluing process.**

| Index                                             | Gluing type                  | Polymer composition |
|---------------------------------------------------|------------------------------|---------------------|
| Starch consumption per 1 ton of product, kg / ton | 80                           | 50                  |
| Heating duration, min                             | 45                           | 20                  |
| Dynamic viscosity of the size (Pa * s) at various starch concentrations, g / l | - | 11-12 |
| 40                                                | -                            | 25-27               |
| 50                                                | 18-22                        | -                   |
| 80                                                | 50-80                        | 70-85               |
| Degree, splitting of starch grains, %             | 5%                           | 6%                  |
| Glue, %                                           | 17%                          | 23%                 |

The sludge was supplied with compressed air. Apparatuses for the preparation of gluing were installed 2-3 m higher than the gluing machines. From the outside, the reactors were insulated with 60 mm thick asbestos cement. The bottom of the reactor has a 20 mm slope towards the pipe outlet.

At the bottom of the reactor were installed burbers for heating and a pipeline with a diameter of 50 mm, for feeding machines with gluing, with a three-way valve, switching to an outlet for draining the remaining gluing from the reactor.

Each reactor is connected to pipelines with a diameter of 50 mm for the supply of polymer suspension from the reactor and water; the reactor has an individual steam extraction.

The polymer gluing composition is prepared in a 1750-1754 liter reactor with one frame-type mixer.

A solution of gluing compositions from this reactor is pumped into the main reactors equipped with a pump with a capacity of 6 m³ / h.

The gluing of cotton yarn with polymer compositions was carried out as follows: Corn starch and GAE are loaded into special containers [5]. Through dispensers [6] the components are fed into the reactor, where the gluing is cooked. Cold water is poured into the reactor [7] in the amount of 2/3 of the reactor, then starch is introduced. The resulting solution is stirred for 10 minutes. Next, the required PAA is added through the dispenser. From the reactor [8] through a flow meter, the corresponding calculated amounts of a 0.5% uzkhitan solution are added and the volume of the reaction mixture is brought to 1000 liters. The splitting of starch mainly begins at a temperature of 60-65 °C, therefore...
sodium metasilicate is also added here.

After that, turn on the heating to a boil. At a temperature of 88 °C for 15-20 minutes, the composition is cooked until the starch is completely decomposed. Cottonseed oil is added to the gluing machine before gluing.

Currently, starch, sodium metasilicate and chloramine are used for gluing warp threads. The proposed synthetic polymeric materials for gluing warp threads in weaving have a number of technological disadvantages: its high price and not having universal properties like starch. Therefore, the creation of a new gluing composition based on uzkhitan and starch with high efficiency and low polysaccharide content during gluing is of great importance.

In order to reduce the consumption of starch for gluing warp threads and reduce the cost of gluing materials used in gluing and improve the quality of threads, an effective gluing composition was created based on a hydrolyzed acrylic emulsion (GAE) and uzkhitan (chitosan and carboxymethylcellulose), that is, corn starch with a studied polymer their rheological properties. Table 2 shows the viscosity and fluidity of the composition based on starch, uzkhitan and GAE.

| Starch, % | GAE%, % | Uzhitan, % | Viscosity, Pa.s | Yield strength, (Pa) |
|----------|---------|------------|----------------|---------------------|
| 5        | -       | -          | 0.92           | 2.74                |
| 6        | -       | -          | 1.17           | 3.77                |
| 7        | -       | -          | 1.22           | 5.27                |
|          | 0.4     | -          | 0.98           | 16.36               |
| 5        | 0.5     | -          | 1.14           | 20.13               |
|          | 0.6     | -          | 1.62           | 29.14               |
|          | 0.4     | -          | 1.10           | 21.76               |
| 6        | 0.5     | -          | 1.54           | 28.13               |
|          | 0.6     | -          | 1.83           | 32.84               |
|          | 0.4     | -          | 1.32           | 30.56               |
| 7        | 0.5     | -          | 1.53           | 36.41               |
|          | 0.6     | -          | 1.96           | 38.16               |
|          | -       | 0.3        | 1.01           | 17.20               |
| 5        | -       | 0.4        | 1.29           | 21.17               |
|          | -       | 0.5        | 1.48           | 29.66               |
|          | -       | 0.3        | 1.17           | 22.10               |
| 6        | -       | 0.4        | 1.44           | 29.76               |
|          | -       | 0.5        | 1.55           | 34.12               |
|          | -       | 0.3        | 1.34           | 32.10               |
| 7        | -       | 0.4        | 1.49           | 38.70               |
|          | -       | 0.5        | 1.58           | 40.12               |
| 5        | 0.5     | 0.5        | 1.28           | 22.93               |
| 6        | 0.5     | 0.5        | 1.50           | 34.71               |
| 7        | 0.5     | 0.5        | 1.64           | 41.87               |

Table 2 shows that the viscosity and yield stress of starch modified with GAE and uzkhitan depends on the concentration of polymers. When modified with GAE (with a hydrolyzed acrylic emulsion), a lower viscosity is observed than when it is modified with uzkhitan.

4. Conclusion

It should be noted that when starch is modified with components consisting of a GAE concentration in the order of 0.5% and an uzkhitan concentration in the order of 0.4% (with respect to the size of the
size), the viscosity of the starch increases sharply. For example, when modifying starch in the order of 6% with 0.5% GAE, the viscosity is 1.41 Pa.s, while when modifying starch in the order of 6% with 0.4% uzkhitan, the viscosity is 1.44 Pa.s. As a result of the experiment, it was determined that when modified with 0.5% GAE and 0.5% uzkhitan, the viscosity of starch is 1.50 Pa.s. The fluidity of the modified starch with the above shown components is 22.93-41.87 Pa.s, while the fluidity of the unmodified starch is 2.74-5.27 Pa.s.

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