Web of Scholars: Multidimensional Research Journal (MRJ)
Volume: 02 Issue: 06 | 2023 ISSN: (2751-7543)
http://innosci.org

Application of Cellulose Simple Esters in the Textile Industry

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Abstract: *This article presents the results of experiments on obtaining simple ethers of cellulose and studying the possibilities of their use in the textile industry. Based on the experimental results, it was shown that by using the water-soluble simple ether of cellulose in the weaving of cotton yarns, their strength can be increased by 14.7% and their hairiness can be reduced to 1%.*

Introduction. The development of industries is increasing the demand for textile auxiliaries such as thickeners and fillers, including cellulose ethers. Cellulose simple ethers have the general formula $C_6H_7O_2(OR)_n(OH)_{3-n}$ (here n≈2) and are alkylation products of cellulose. The advantages of cellulose simple ethers are determined by chemical reagents, resistance to water, cold and light effects, low ignition temperature, solubility in common organic solvents, thermoplastic properties, etc.

One of the most important cellulose esters is hydroxypropylmethylcellulose (HPMC), which is currently used in various sectors of the economy and is an environmentally friendly product that does not pose a threat to nature and human health. Hydroxypropylmethylcellulose (HPMC) is a modified cellulose polymer obtained by reacting methylcellulose with hydroxypropyl chloride. HPMCs have unique physical and chemical properties that make them competitive in various fields [1].

The production of HPMCs begins with the extraction of methylcellulose polymer from natural plant materials such as wood pulp or cotton fiber. Methylcellulose is treated with hydroxypropyl chloride, which reacts with hydroxyl groups in methylcellulose molecules [2]. As a result, some of the hydroxyl groups are replaced by hydroxypropyl, which leads to the formation of HPMCs. The process is controlled by the required properties of HPMCs such as viscosity and degree of exchange [3].

Hydroxypropylmethylcellulose (HPMT) is a white or yellowish powder, odorless, tasteless and non-toxic. It dissolves well in cold water and forms a clear viscous solution. The aqueous solution of this product exhibits the property of surfactant to provide emulsification and protection of relative stability, the viscosity of the aqueous solution of hydroxypropylmethylcellulose is relatively stable in the pH range of 3.0-11.0. Hydroxypropylmethylcellulose solution has the characteristics of thickening, viscosity, dispersion, emulsion formation, gel formation, moisture retention and other colloidal solutions.

Hydroxypropylmethylcellulose is widely used in the textile industry due to its unique properties. Some of the main areas of application are listed below:

1. In the production of textile yarns and fibers: HPMTs are used as textile auxiliaries in the process of forming and spinning textile fibers. It forms a film on the surface of fibers, improves their lubrication and reduces mutual friction. As a result, smooth and crisp threads are obtained, and also have a positive effect on spinning and weaving processes.

2. In flower printing and dyeing: HPMTs are used in the textile industry to improve color fastness and improve contrast in the flower printing process. It holds pigments on the surface of the fabric, does not allow them to melt or penetrate into the fibers - pores. The result is bright and strong flowers.
3. Adhesion additives: HPMTs are used as adhesion additives in textile production.
4. Finishing: GPMTs are used in the finishing process to impart properties to textiles. For example, it can be used to provide waterproofing or antistatic properties to textiles. GPMTs are also used in the production of elastic and corrugated textile materials.

Carding, which is the main process of textile, is one of the important processes in the entire cotton-textile production chain. The study of new bleaching agents to reduce costs and environmental pollution is currently a hot topic, and many researches are being carried out for this purpose. Currently, Chinese inventive scientists have proposed methylcellulose (MT) and ethylcellulose (ET) simple esters mainly obtained from hemp cellulose, and they are used as fabric softeners in the textile industry. Simple esters such as these were prepared from cellulose obtained from hemp seeds and later used as textile glues [4]. HPMTs are also used in the process of printing flowers on fabric. Importantly, when a mixed fiber fabric of two different natures is treated with HPMTs before printing, it is possible to form non-melange flowers on the surface of the fabric [5].

In the experiments, 100% cotton yarn with a linear density of 20 tex, hydroxypropylmethylcellulose in white powder form, with a pH value of 4.0-8.0, was taken as an object. The spinning process is at a temperature of 30-40^{0}C, the speed of thread passing through the spinning is 30 m/min. was carried out in China ARCI:200605 electromechanical polishing machine of Guige Xinghao company. The linear density of the thread is determined according to GOST 6611.1-73 ISO 2060-72. Elongation and strength at break were determined in the FR device according to GOST 3813-72 ISO 5081-77 (ISO 5082-82) Textile testing technology, fluffiness according to GOST 28003-88.

Experimental results and their discussion. Cotton roving is an important process in the textile industry to improve the quality and properties of yarn [6]. Carding is a yarn treatment process performed after the spinning process, the main purpose of which is to improve yarn quality, eliminate defects, and create favorable conditions for further use of yarn in the textile industry. The bleaching process may include various steps such as soaking, steaming, dyeing, and treatment with special chemicals [7].

The quality of the spinning process is evaluated by the physico-mechanical properties of the yarn. In the research, the influence of the concentration of hydroxypropylmethylcellulose (considered as the concentration of the main substance in the hydroxypropylmethylcellulose) on the quality parameters of the yarn was studied (Figure-1)

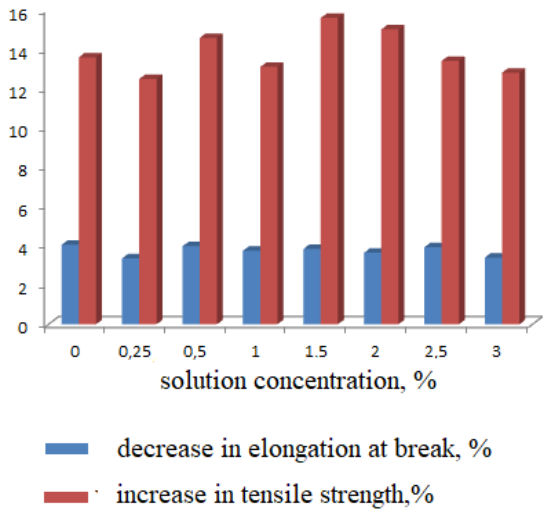

Figure 1. Effect of oxal concentration on elongation and tensile strength of yarn.

The cited experimental results show that the strength of the thread increased by 14.7% when the concentration of the main substance - hydroxypropylmethylcellulose in the composition of the oxar composition was 1.5%.

Dyeing has a significant effect on the properties of cotton yarn, that is, it improves the quality of the yarn and gives it the desired properties. It is also important in removing debris, dust and other substances that can affect the appearance and performance of the thread. In addition, the annealing process increases the strength and elasticity of the yarn, which increases its resistance to abrasion and elongation [8]. The results of the experiment on the influence of the concentration of the dye on the quality of the thread are presented in the table.

Table-1 Dependence of the linear density and hairiness of the thread on the concentration of the softening agent.

Thread quality indicators	Detergent concentration, %							
	-	0.25	0.5	1.0	1.5	2.0	2.5	3.0
Linear density, tex	20.0	20.6	20.8	21.0	21.4	22.0	22.8	23.2
Hairiness, hair >0.5mm/m	42.6	85.2	47.6	1.0	1.0	1.0	1.0	1.0

The results of the cited experiment show that the hairiness of the thread is reduced to 1% when the concentration of oxal is 1.5%. In order to increase the efficiency and quality of yarn produced in the modern textile industry, new technological developments are constantly being introduced into the spinning process [9].

The de-anchoring process of the annealed yarn according to the selected concentration is carried out by washing in cold water. As a reference: degreasing of fabric woven from cotton yarn is carried out by treatment in a solution of sulfuric acid (3-5 g/l) or caustic alkali (3-5 g/l) at a temperature of 30-40^{0}C for 12 hours. In this, the starch is partially hydrolyzed, and then it is removed from the fabric by washing in clean water. The proposed new finishing composition provides resource saving while increasing the efficiency of weaving-finishing processes.

Some of the latest innovations include the use of safer and more environmentally friendly chemicals, the development of automated quality control systems, and the need to determine the technological parameters of the optimal bleaching process depending on the type of yarn.

Summary. Hydroxypropylmethylcellulose (HPMT) is important in the textile industry due to its unique properties and wide application. The process of obtaining GPMTs is based on the modification of methylcellulose with hydroxypropyl chloride. The result is a modified polymer that can be used to improve textile spinning, dyeing, dyeing, and finishing processes. The use of HPMTs in the textile industry improves the quality and functionality of textile materials.

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