



INFLUENCE OF MULTICOMPONENT WATER EMULSIONS ON THE STRUCTURE OF COTTON FIBER

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ABSTRACT

The possibility of regulating the properties of cotton fibre from an early stage of its processing, that is, at the stage of separating the fibre from cotton, is always of great interest, but unfortunately, it is not carried out in the conditions of cotton ginning plants. The most important thing is to bring the moisture content to optimal values after drying it before ginning, that is, before separating the fibre from the seed. At the initial stage of research, a composition consisting only of surfactants was proposed to increase the moisture content of the fibre before boiling it. Initially, it was widespread to treat cotton fibre with various aqueous and non-aqueous compositions, both at the spinning stage and in the weaving or spinning stages. The purpose of this study was not only to increase the moisture content of the fibre, but also to improve its other characteristics by treating it with compositions consisting of a water-soluble polymer, polyhydric alcohol, and a surfactant dissolved in water.

KEYWORDS: cotton fibre processing, humidity value, water-soluble polymer, surfactants, multicomponent water emulsions.

INTRODUCTION

The actual issue of processing cotton fibre in the conditions of ginneries is bringing the moisture content of the fibre to the value required by the standard. Typically, for good ginning, the fibre is overdried and does not have time to reach the desired moisture value before boiling [1]. Several studies have been carried out that have revealed a positive effect on the properties of cotton fibre by treatment with a composition consisting of a water-soluble polymer, polyhydric alcohol and a surfactant (surfactant) dissolved in water [2-4]. In addition to increased moisture, they also increase other characteristics of the cotton fibre. Most often, a composition is proposed consisting of polyethylene glycol (PEG-115) as a water-soluble polymer, glycerol as polyhydric alcohol and sulpanol (sodium salt of alkyl aryl sulfonic acids) as a surfactant. To elucidate the mechanism for improving the technological properties of cotton fibre, it was interesting to elucidate the effect of individual components of the polymer solution on its structure. Therefore, at first, we studied the change in

mechanical properties, as well as the structure of the fibre during its processing with individual components and their mixtures (Table 1).

From the data in Table 1, it can be seen that the application of solutions of sulfanol, glycerol, or PEG-115 to the fibre separately does not contribute to a change in the tensile strength and elongation, as well as the coefficients of variation. The application of mixtures of the two components to the fibre also practically does not affect the mechanical and fatigue properties of the fibre. A slight improvement in these indicators can be observed only when the fibre is treated with a mixture of polymer and surfactants. In addition to studying the coefficients of variation for various mechanical properties, research has also been carried out to study the structure of processed fibres. At the same time, similar phenomena were observed. The presence on the fibre surface of solutions of individual components and their binary mixtures practically does not affect the heat of fibre wettability with water, sorption characteristics and porosity,



specific surface area, volume and average radius of pores (Table 2).

Therefore, in subsequent experiments, fibres of various grades treated with a three-component solution were tested. This solution consisted of PEG-1.5%, glycerol - 5.0% and sulfanol - 0.5% dissolved in 93% water. From the data in Table 3, it can be

seen that the application of these solutions to the fibre in all cases contributes to an increase in their tensile strength and this indicator is greater in cases where the fibre has a low grade. For example, for grade I fibre it is 0.4 cH (from 4.4 cH to 4.8 cH), grade II 0.5 cH (from 3.9 cH to 4.4 cH) and grades III 0.8 cH (from 3, 4 cH to 4.2 cH).

Table 1. Influence of the components of the solution on the mechanical properties of the second-grade fibre (the amount of solution in the fibre is 2.0-2.5%)

Composition of the solution	Breaking load, cH/vol.	Breaking elongation, %	Coefficient of variation, %		Stability, cycles	
			Breaking load	Breaking elongation	Multiple stretching	Multiple bending
The original	3.9	13.0	29.0	20.1	9840	9350
0.5% Sulfanol	3.8	13.0	29.5	20.8	9760	9400
5.0% glycerin	3.8	14.0	29.0	20.9	9600	9400
1.5% PEG-115	3.9	13.0	29.1	20.8	9850	9500
0.5% sulfanol 1.5% PEG-115	4.1	15.0	26.5	19.0	10300	10000
5.0% glycerin 1.5% PEG-115	3.9	14.0	28.0	20.3	10500	10100
5.0% glycerin 0.5% sulfanol	3.9	14.0	29.0	20.2	10800	9900

Table 2. Influence of the components of the solution on the structure of the fibre of the 2nd grade (the amount of solution in the fibre is 2.0-2.5%)

Solution composition	The heat of fibre wetting, cal/g	Sorptions of water vapour, at humidity		Specific surface, m ² /g	Total pore volume, cm ³ /g	Average pore radius, A
		65%	100%			
Original fiber	12.3	6.9	30.5	100.74	0.31	58
0.5% sulfanol	11.9	6.8	30.5	104.81	0.32	58
5.0% glycerin	12.4	6.9	30.7	104.9	0.31	58
1.5% PEG - 115	12.4	6.7	30.6	104.8	0.30	58
0.5% sulfanol and 1.5% PEG-115	12.0	6.8	29.5	100.7	0.28	49
5.0% glycerin and 1.5% PEG - 115	12.8	6.9	30.1	103.5	0.30	56
5.0% glycerin and 0.5% sulfanol	12.7	6.7	30.2	103.8	0.31	59

As has been shown, in previous works [2-5], polymer solutions applied to the fibre contribute to the partial

elimination of defects and defects on its surface and thereby improve the strength properties.



Table 3. Influence of emulsification (emulsion composition: 1.5% peg-115, 5.0% glycerin and 0.5% sulfanol) on the mechanical properties of various fiber types.

Variety	Characteristic	Breaking load, cH/vol.	Breaking elongation, %	The coefficient of variation, %		Cycle stability	
				Breaking load	Breaking elongation	Multiple stretching	Multiple bending
I	The original	4.4	10.0	26.5	20.5	10500	11400
	emulsifier	4.8	12.0	24.6	19.1	28900	14600
II	The original	3.9	13.0	29.0	20.1	9840	9350
	emulsifier	4.4	16.0	24.2	18.3	24700	12650
III	The original	3.4	6.2	27.7	22.3	8710	7800
	emulsifier	4.2	8.8	25.0	19.8	15840	11680

Table 4. Influence of emulsification (emulsion composition: 1.5% PEG-115, 5.0% glycerin and 0.5% sulfanol) on the structure of various fibers (the amount of solution is 2.0-2.5% by weight of the fiber).

Variety	Characteristic	The heat of wetting with water, cal/g	Sorption of water vapour, % at humidity		Specific surface m ² / g	Total pore volume, cm ³ /g	Average pore radius A
			65%	100%			
I	The original	11.8	6.5	28.5	100.5	0.29	55
	emulsifier	11.6	6.6	20.6	94.6	0.21	35
II	The original	12.3	6.9	30.5	104.74	0.31	58
	emulsifier	11.5	6.8	21.1	94.94	0.21	36
III	The original	12.5	6.9	30.9	100.70	0.34	61
	emulsifier	11.5	6.8	21.5	96.65	0.23	39

The data in Table 3 also confirm this assumption, since as the grade decreases, the number of defective fibres and defects on their surface increases. The application of the solution also reduces the tensile strength and elongation coefficient of variation of the fibre. Elimination of defects and defects in fibres of all grades will also make it possible to improve their fatigue properties. For example, if the tensile strength of the original fibres is from 8710 to 10500 cycles, then after processing this figure increases to 15800-28000 cycles.

The flexural strength of the fibres increases in a similar way. This trend is also observed when studying the indicators presented in Table 4. To determine the stability of the mechanical properties, cotton fibre treated with a mixture of polymer, glycerin and sulfanol was stored various times and

washed with hot water. Since all the components of the solution are slightly soluble in water, they were washed by extraction in Soxhlet apparatus for 24 hours and after drying at 90 °C -100 °C and storage under conditioned conditions and was tested. The storage of the fibre was carried out at 25-3 °C in a desiccator with an air humidity of 60% -70%.

From table 5 it can be seen that the indicators of the mechanical properties of both the original and the experimental fibre of all three grades are practically preserved. The fatigue (resistance to repeated stretching and bending) properties of all types of fibre remain constant.



Table 5. Stability of mechanical properties of emulsified (emulsion composition 1.5% peg-115, 5.0% glycerin and 1.5% sulfanol) fibres (average amount of emulsion 2.0-2.5% by weight of fibre).

Variety	Characteristic	Breaking load, cH/vol.	Breaking elongation, %	The coefficient of variation, %		Cycle stability	
				Breaking load	Breaking elongation	Multiple stretching	Multiple bending
I	The original	4.4	10.0	26.5	20.5	10500	11400
	Initial after washing	4.2	10.6	27.6	21.5	10000	10800
	Emulsified	4.8	12.0	24.6	19.1	28900	17650
	Emulsified after washing	4.7	12.6	24.8	19.3	28500	17400
II	The original	3.9	13.0	29.0	20.1	9840	9350
	Initial after washing	3.8	13.5	28.8	20.4	9900	9400
	Emulsified	4.4	16.0	24.2	18.3	24700	12650
	Emulsified after washing	4.3	15.8	24.6	19.1	21800	11450
III	The original	3.4	6.2	27.7	22.3	8710	7800
	Initial after washing	3.4	6.7	27.5	22.4	8800	7650
	Emulsified	4.2	8.8	25.0	19.8	15840	11680
	Emulsified after washing	4.1	8.5	25.4	19.9	15100	10600

After extraction with water, the structure of all types of fibres also does not change, as evidenced by the data in Table 6.

Table 6. Stability of the structure of emulsified (emulsion composition 1.5% peg-115, 5.0% glycerin and 0.5% sulfanol) fibres to water treatment (the amount of emulsion is 2.0-2.5% by weight of the fibre)

Variety	Characteristic	Heat wetted with water, cal/g	Sorptions of water vapour, % at humidity		Specific surface m ² /g	Total pore volume, cm ³ /g	Average pore radius A
			65%	100%			
I	The original	11.8	6.5	28.5	100.5	0.29	55
	Initial after washing	11.6	6.6	28.9	101.6	0.30	54
	Emulsified	11.6	6.6	20.6	94.6	0.21	35
	Emulsified after washing	11.8	6.8	20.9	95.1	0.22	38
II	The original	12.3	6.9	30.5	104.74	0.31	58
	Initial after washing	12.8	7.0	30.1	103.81	0.30	55



	Emulsified	11.5	6.8	21.1	94.94	0.21	36
	Emulsified after washing	11.6	6.7	20.8	95.04	0.22	38
III	The original	12.5	6.9	30.9	100.70	0.34	61
	Initial after washing	12.6	6.7	30.1	101.61	-	-
	Emulsified	11.5	6.8	21.5	96.65	0.29	39
	Emulsified after washing	11.9	7.0	20.9	94.74	0.30	41

Table 7. Stability of the indicators of the mechanical properties of the fibre during storage (25-30°C and 60-70% humidity).

Variety	Shelf life	Breaking load, cH/vol.	Breaking elongation, %	Coef. variations, %		Cycle stability	
				Differential load	Breaking elongation	Multiple stretching	Multiple bending
I	Original fiber	4.4	10.0	26.5	20.5	10500	11400
	6 months	4.3	10.1	26.0	20.4	10100	11000
	12 months	4.4	10.3	27.0	19.5	9800	11100
	24 months	4.4	9.8	26.6	20.0	10500	11200
	Emulsified fiber	4.8	12.0	24.6	19.1	28900	17650
	6 months	4.7	11.6	24.8	19.0	29100	17500
	12 months	4.9	11.5	25.1	19.8	28500	17600
	24 months	4.8	11.8	24.8	20.1	28600	17800
II	Original fiber	3.9	13.0	29.0	20.1	9840	9350
	6 months	3.8	12.5	28.5	20.5	10000	9500
	12 months	4.0	13.0	28.4	19.6	9900	9400
	24 months	3.9	12.8	28.0	19.9	10000	9200
	Emulsified fiber	4.4	16.0	24.2	18.3	24700	12650
	6 months	4.6	15.5	24.0	18.0	24000	12500
	12 months	4.5	15.0	25.0	19.0	23900	12000
	24 months	4.4	16.0	24.5	18.5	24500	12400
III	Original fiber	3.4	6,2	27.7	22.3	8710	7800
	6 months	3.4	6,2	27.7	22.3	8710	7800
	12 months	3,3	6,1	27.7	22.3	8620	7700
	24 months	3,3	6,1	27.7	22.3	8610	7670
	Emulsified fiber	4.2	8.8	25.0	19.8	15840	11680
	6 months	4.1	8.5	24.9	19.9	15700	11000
	12 months	4.0	9.0	25.5	19.5	15000	11400
	24 months	4.1	9.2	25.6	20.1	15500	11500

The sorption capacity, specific surface area, total pore volume and average pore radius of fibres treated with a solution of polymer, glycerol and sulfonol do not change after water treatment. The mechanical

properties of the original and processed fibres are also stable when stored for up to 12 months (Table 7).



CONCLUSION

Thus, a study of the mechanical properties and structure of fibres treated with individual components with their mixture showed that an improvement in property indicators is observed only in those cases when the fibre contains a mixture of polymer, glycerin and sulfanol solutions and such an improvement in properties is stable during storage and processing with hot water, i.e. ... after removing the applied solution of the components from the fibre composition. This fact once again confirms the assumption that a solution of polymers, glycerol and sulfanol contributes to an irreversible change in the structure of the fibre, mainly due to the elimination of defective areas and other damage on its surface.

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