Chemical and thermal Properties Properties of compositions based on PAA, PVA and Na-CMS for printing flowers on silk fiber fabrics

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Abstract. In the article, the rheological properties of the adhesive-binding systems used in production enterprises and the newly developed polymer systems are studied. In order to determine the thermal stability of the developed systems, a thermal analysis of thickeners with different compositions was carried out. Mass loss was observed in the heating curve of the thickener based on PAA, PVA and Na-CMS. Endothermic effects observed during heating can be caused by physical phenomena such as liquefaction, evaporation, changes in crystal structure, or chemical reactions such as dehydration. The rheological properties of imported sodium alginate, a thickener based on PAA, PVA and Na-CMS, were compared with the properties of the adhesive-binding polymer system with a new composition. It was found that the rheological properties of the proposed new composition thickener are close to the rheological properties of sodium alginate. It was proved during the experiments that the level of thixotropic recovery is especially high in the polymer system with a new composition. When used as an adhesive-binder for silk fiber fabrics with newly developed thickeners, in addition to improving the physical and mechanical properties of the fabric, the wastewater generated at the stage of washing the fabric after flower pressing does not have a negative impact on the environment and the world of living plants. **Keywords:** Polymer, composition, rheological properties dressing, cotton fabric, yarn, preparation, adsorption, glue, polyvinyl alcohol, starch, Na-CMS.

1 Introduction

Obtaining thickening compositions based on natural and synthetic polymers and determining their properties is of great importance from the theoretical and practical point of view. Today, it is important to achieve high efficiency from an environmental point of view by using such thickening compositions as a drilling agent, stabilizing solution in the oil and gas industry, softeners and binders in the textile industry, and in various industries.

In recent years, research on the synthesis and properties of new binder compounds based on water-soluble natural and synthetic polymers, as well as their practical application, has been carried out in Japan. Particular attention is being paid to the synthesis of target

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compositions aimed at improving the high performance and caloristic properties of silk fiber-based fabrics from new thickeners containing water-soluble polymers such as cellulose ethers and polyacrylates. [1-4].

2 Materials and Methods

Differential thermal analysis, colorimetry and physico-chemical methods of analysis have been used in the research work.

3 Results and Discussion

Adhesive-bonding systems play an important role in the process of printing flowers on silk fiber fabrics. The cost of adhesive-binding compositions has a great economic impact on the production of silk fabrics. The improvement of the technology of obtaining and using thickeners helps to increase the quality indicators of fabrics printed with flowers with dyes. At present, many silk fabric manufacturing enterprises use thickening systems imported from abroad for dyeing with active dyes. This, in turn, increases the cost of the fabric.

A mixture of oxidized starch with synthetic polymers is mainly used in the silk production industry. Technological and mechanical properties of this system can be explained by their dispersion level and size of colloid solutions.

In the textile industry of our country, mainly oxidized starch is used together with various synthetic polymers for dyeing fabrics with active dyes. These thickening systems are important in improving the coloristic and operational properties of the fabric and are economically unprofitable.

In the production of silk fiber in our country, in addition to oxidized starch, imported products such as sodium alginate and DGT are also used. The use of sodium alginate and DGT in the process of flower printing on silk fiber fabrics leads to high efficiency, but due to the fact that these polymer systems are imported from abroad, it leads to an increase in the cost of economically produced products. Therefore, the development of thickening systems that can replace imported products and have high efficiency is considered the most important of our main goals and tasks.

Therefore, we studied the properties of various three- and four-component polymer systems based on PAA, PVA, starch and sodium salt of carboxymethyl cellulose. The results of the research are presented in Table 1.

Table 1. Viscosity of compositions at $\varepsilon = 3.122\cdot 10^{3}$ sec^{-1} (303 K) and degrees of thixotropic recovery.

Types of adhesive-binding compositions (concentration in solution %)	**Viscosity. lg η Poise**		**Thixotropic recovery rate. P. %**
	η_1 When ready	**η_2 After 2 days**	
Adhesive-bonding systems used in production			
OK (3.5 %)	2.73	2.184	80
CMS (4.0 %)	2.42	1.8876	78
Polymer systems with a new composition have been developed			
Starch (2%) – PVA (0.8 %)	2.19	1.9053	87
Starch (2%) - PAA (0.5 %)	2.22	1.887	85
Starch (2%)-Na-CMS (0.6 %)	2.20	1.848	84

Starch (1.5%) – PVA (0.8 %) - PAA (0.5 %)-(Na-KMC 0.6%)	2.27	2.043	90
Starch (2%) – PAA (0.5%) - PVA(0.8%) - Na-CMS (0.6 %)	2.38	2.237	94

Table 1 presents the rheological properties of the adhesive-binding systems used in production enterprises and the newly developed polymer systems. In order to determine the degree of thixotropic recovery of polymer compositions, the viscosity was determined when the thickener was ready immediately, and after keeping these polymer systems for two days, their viscosity was determined again. Viscosity values are expressed in Poise. The degree of thixotropic recovery of polymer compositions based on the formula was found through the obtained viscosity indicators. Based on the results of the research, the following conclusions can be drawn:

-in practice, the levels of thixotropic recovery of adhesive binders (OK and CMS) in production enterprises were 80 and 78%;

- the thixotropic recovery rate of the newly developed four-component adhesive-binding polymer system was 94%, after the flower was printed, the fabric was washed. It has been studied that the amount of dyes, various organic and inorganic substances in the produced wastewater was low, which gave a high effect from the ecological point of view;

- it has been determined during the experiments that the proposed polymer system is a stable system;

- it has been determined that the thickener with the proposed new composition will be competitive with the thickeners currently used in production enterprises.

In order to determine the thermal stability of the developed systems, a thermal analysis of thickeners with different compositions was carried out. Derivatogram and obtained results are presented in Figures 1-2 and Tables 2-3.

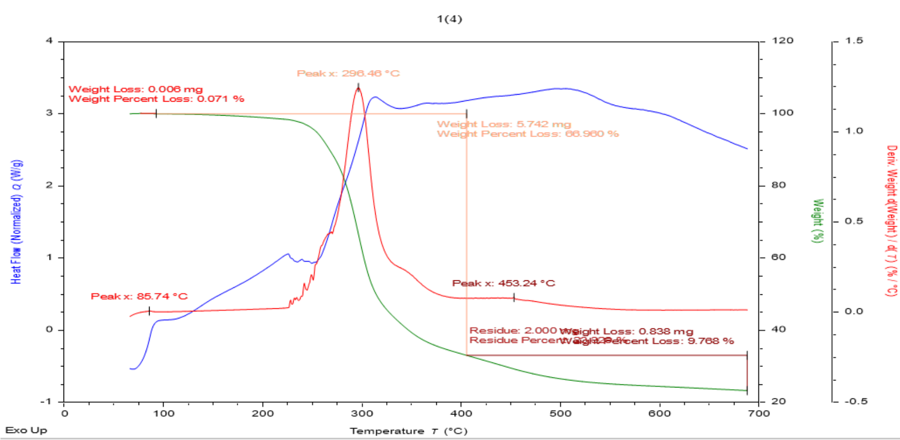

Fig. 1. Derivatogram of thickener developed on the basis of sodium salt of starch, polyvinyl acetate and carboxymethylcellulose.

Table 2. Derivatogram analysis of the thickener obtained on the basis of starch, PVA and Na-CMS.

№	Temperature.°C	Mass lost. %	The rate of decomposition of matter. mg/min	The amount of energy consumed (μV*s/mg))
1	50	0.825	0.137	1.45
2	100	1.985	0.465	2.88
3	200	15.25	0.453	2.01
4	300	41.35	0.087	3.02

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5	400	63.85	0.147	1.02
6	500	68.49	0.455	2.03
7	600	75.15	2.499	1.59
8	700	84.07	2.125	1.69

Mass loss was observed in the heating curve of the thickener based on PAA, PVA and Na-CMS. Observed during heating endothermic effects can be caused by physical phenomena such as liquefaction, evaporation, changes in crystal structure, or chemical reactions such as dehydration. In the temperature range of 100 C°, the mass loss is 2.985%.

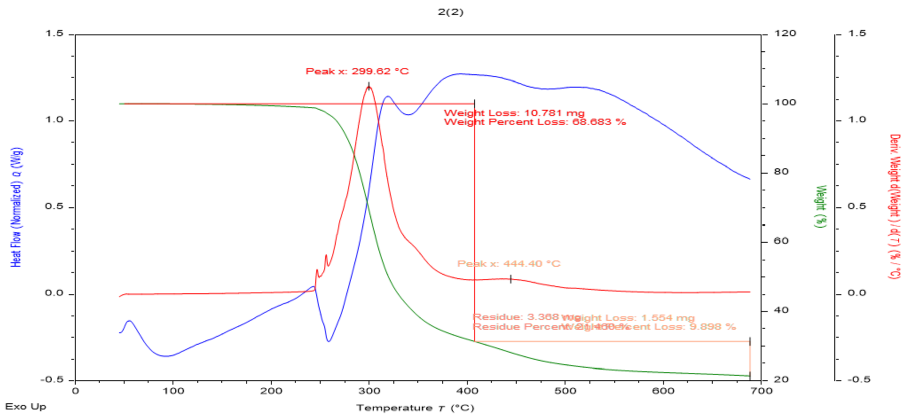

Fig. 2. Derivatogram of thickener developed on the basis of starch, PAA, PVA, Na-CMS.

The nature of the subsequent thermal effects will depend on the gradual decomposition of the anhydrous compound. The loss of mass in the temperature ranges of 200-300-400-500-600-700 C° is 24.25-38.35-42.85-54.49-63.15-76.07 %, respectively. According to the curve of thermogravimetry, the total mass loss in the temperature range of 50-700 C° is 76.07%.

Table 3. Derivatogram analysis of a thickener based on sodium salt of starch, polyacrylamide, polyvinyl acetate and carboxymethyl cellulose.

№	**Temperature. °C**	**Mass lost. %**	**The rate of decomposition of matter. mg/min**	**The amount of energy consumed (µV*s/mg))**
1	50	0.988	0.145	1.44
2	100	2.985	0.496	2.96
3	200	24.25	0.441	2.11
4	300	38.35	0.014	3.87
5	400	42.85	0.201	1.02
6	500	54.49	0.852	3.03
7	600	63.15	2.987	1.54
8	700	76.07	2.111	1.88

The rheological properties of sodium alginate imported from abroad were compared with the properties of the adhesive-binding polymer system with a new composition. The results of this study are presented in Table 4. A 2% solution of sodium alginate is used in textile enterprises in our country as a thickener for printing flowers on silk fabrics. But this thickener is expensive because it is imported from abroad and derived from seaweed. It was found that the rheological properties of the proposed new composition thickener are close to the rheological properties of sodium alginate. It was proved during the experiments that the level of thixotropic recovery is especially high in the polymer system with a new composition [5-7].

Table 4. Comparison table of adhesive-bonding systems. The temperature is 303 K.

Types of adhesive fasteners	Viscosity. lg η Poise	Yield strength. g/см^2. P	Thixotropic recovery rate.%	Components of wastewater	
				Before washing. mg/l	After washing. mg/l
Sodium alginate 2%	2.43	11.5	92	7.4	0.8
Starch 1.5%	1.97	33.76	82	9.3	2.1
Starch (1.5%) – PVA (0.8 %) - PAA (0.5 %)-Na-KMC 0.6%	2.27	14	90	4.2	0.7
Starch(2%)PAA(0.5%)-PVA(0.8%)- Na-CMS (0.6 %)	2.38	12	94	3.4	0.4

As can be seen from the table, it was found that the difference between the relative viscosity, yield point and thixotropic recovery level of sodium alginate imported from abroad and the rheological properties of the polymer systems proposed by us is very small. The relative viscosity of the 2% solution of sodium alginate was 2.43 Poise, the yield point was 11.5 g/cm^2, and the thixotropic recovery rate was 92%. Experiments have proven that the rheological properties of the newly developed polymer systems can be competitive with the properties of sodium alginate. The thixotropic recovery rate of the proposed polymer system was 94%, which showed a higher rate than the thixotropic recovery of sodium alginate.

4 Conclusion

Experiments showed that the thixotropic recovery rate and yield strength of 1.5% starch solution were 82% and 33.76 g/cm^2, and after modification were 90% and 14 g/cm^2. The presence of modifiers in the composition ensures an increase in the level of thixotropic recovery, an increase in the viscosity of the system, and a normal flow limit.

The results of the research showed that the increase in viscosity and thixotropic recovery led to a decrease in the yield strength of the polymer system. When using the developed new composition as an adhesive-binder for silk fiber fabrics, along with the improvement of the physical and mechanical parameters of the fabric, the wastewater generated at the stage of washing the fabric after flower pressing does not have a negative effect on the environment and the world of living plants.

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