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# APPLICATION FEATURES OF HEXANE DIACID POLYCONDENSATION PRODUCTS WITH DIETHYLENE TRIAMINE AND RESIN ACIDS IN PAPER TECHNOLOGY

Article examines the effectiveness of the reinforcing action for the first time received additives based on adipic acid with diethylenetriamine and tall oil rosin acids rosin. It was found that the synthesized polymers exhibit polyaminoamide hydrophobic properties due to the presence in their structure of resin acids . Strengthening effect of these compounds is shown by introducing the structure of nitrogen-containing groups contribute to the formation of additional interfiber bonds. Tests have paper samples containing in their composition nitrogen compounds showed that hardening effect new synthesized polymers are not inferior to imported compound Melapret PAE / A, and hydrophobicity and the wet paper samples with the newly synthesized polymers exceed the value of these indicators for the paper samples containing imported analog.

**Introduction.** Primary fibrous pulpmaking material (cellulose) deficit necessitatesthe use of recycled fiber (waste paper). However, waste paper fibers differ significantly in their properties from the primary ones. Secondary fibrous pulpmaking material goes through several cycles of regeneration, including the processes of defibering, pulp beating and drying.

This results infibre shortening, strength reduction, degradation of their ability to swelling, hydration and internal fibrillation as well as significant suppression of the ability to form interfibre bonding [1].

To eliminate defects the paper pulp composition is doped with hardening additives, which include starch containing materials and their modifications, as well as polyaminoamidepichlorhydrin resins differing by a degree of polymerization. Polyaminoamidepichlorhydrin resin "Melapret PAE/A" (Poland) is highly effective. That is why, despite of the high cost, this compound is widely used in many leading domestic and foreign enterprises.

The use of products, replacing the imported analogue "Melapret PAE /A", is of great scientific and practical interest.

The aim of the research is to identify application features of hexane diacidpolycondensation products with diethylenetriamine and resin acids of a tall oil (oleoresin) rosin in paper technology. At the base of the research is the study of how the above mentioned products influence component composition and consumption of paper properties.

**Main part.** The object of research was paper pulp (dispersed system), containing plant fibres, sizing and strengthening agents, and paper samples on their basis.

Bleached sulphate pulp from hardwoods (GOST 28172–89) was used for modeling papermaking properties of inhomogeneous waste paper fibres, the average length of the fibres being 0.8–1.2 mm, which is the evidence of the content uniformity of fractional composition.

The essence of the fiber suspension preparation was the fact that at first plant material was subjected to defibering in a BM–3 disintegrator, and then the obtained 4% fiber suspension was beaten in NDM–3 mill of LKR–1 unit till 40% ShR [2].

20% aqueous wax emulsion of alkyl ketene dimers (AKD) was used as a sizing agent, trading as "Ultrasaiz 200", TU 2499–004–88593806–2010.

Imported polyamidoaminepichlorhydrin resin (a market product "Melapret PAE/A" manufactured by JSC "Kemiopol", Poland) and synthesized polyaminoamide polymers were used for paper samples hardening.

Polycondensation products of hexane diacid with diethylenetriamines and resin acids of a tall oil (oleoresin) rosin were characterized by mole ratio of initial components (Table 1). These products were synthesized at the Department of Chemical Processing of Wood (BSTU).

The tested paper pulp compositions differed by their type (number 1–3) and consumption of hardening agents (consumption 0.5–2.0%). Distinctions of the tested paper pulp compositions are shown in Table 2.

Paper samples weighing 80 g/m$^2$ were made from paper pulps on a sheet-making apparatus "Rapid-Ketten" (firm "Ernst Haage", Germany) (Table 2).

Physical and mechanical testing of paper samples was performed using a set of devices of the company "Lorentzen&Wettre" (Sweden).

Table 1

**Components ratio for a synthesized polymer**

| Primary components ratio, mole | | | | Synthesized polymernumber |
|---|---|---|---|---|
| Hexane diacid | Diethylenetriamine | Rosin | | |
| | | tall oil | oleoresin | |
| 1.00±0.02 | 1.00±0.01 | – | 0.120±0.005 | Number 1 |
| | | 0.130±0.005 | – | Number 2 |
| | | 0.120±0.005 | – | Number 3 |

Table 2

**Kinds of tested paper pulp compositions**

| Paper pulp compositions | Fibrous pulpmakimg material | Sizing agent | | Hardening agent | |
|---|---|---|---|---|---|
| | | AKD type | Consumption, % of bds | Polymer type | Consumption, % of bds |
| Composition 1 | Cellulose (100 %) | Ultrasaiz 200 | 0.14 | MelapretPAE/A | 0.5 |
| | | | | | 1.0 |
| | | | | | 1.5 |
| | | | | | 2.0 |
| Composition 2 | | | | Synthesized polymer No 1 | 0.5 |
| | | | | | 1.0 |
| | | | | | 1.5 |
| | | | | | 2.0 |
| Composition 3 | | | | Synthesized polymer No 2 | 0.5 |
| | | | | | 1.0 |
| | | | | | 1.5 |
| | | | | | 2.0 |
| Composition 4 | | | | Synthesized polymer No 3 | 0.5 |
| | | | | | 1.0 |
| | | | | | 1.5 |
| | | | | | 2.0 |

The hydrophobic properties of paper samples were characterized by saturation capacity in conditions of unilateral wetting. Physical and mechanical parameters were characterized by breaking length, wet strength and stiffness at break. The test results are shown in Figure (*a–d*).

It is found that paper samples which contain a synthetic polymer number 2 in their structure exhibit the best hydrophobic properties. This is proved by low indexes of saturation capacity in conditions of unilateral wetting, not exceeding 14.65 g/m$^2$. It is ascertained that decrease in the sizing agent consumption from 0.14 to 0.11% of bds followed by a synthesized polymer admixture into the paper pulp (consumption 1.0% of bds) does not cause deterioration in hydrophobic properties of paper samples. This is due to the presence of resin acids in the synthetic polymer which exhibit extra hydrophobic effect on paper samples.

Physical and mechanical properties of paper samples containing synthesized polymers and "Melapret PAE/A" are identical, even when synthesized polymer consumption decreases from 1.5 to 1.0% of bds. Wet strength of paper samples containing synthesized polymer number 2 is 27–30% higher than that of the paper samples with the imported analogue.

It is ascertained that synthesized polymers prepared by polycondensation of hexane diacid (1.00 ± ± 0.02): diethylenetriamine (1.00 ± 0.01): resin acid (0.130 ± 0.005) possess high hardening effect.

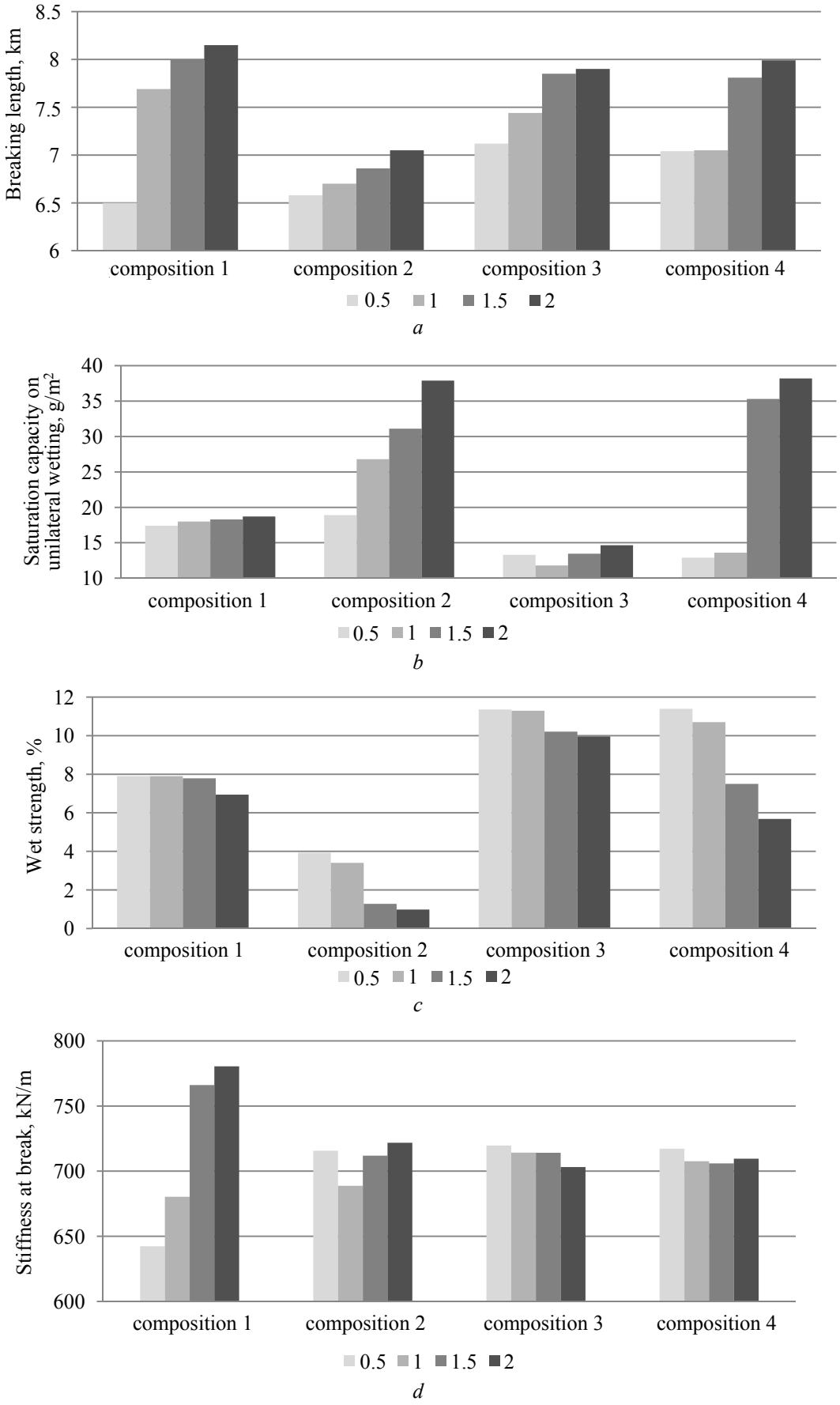


Fig. 1. Saturation capacity on unilateral wetting (*a*), breaking length (*b*), wet strength (*c*) and stiffness at break (*d*) of paper samples depending on paper pulp composition and consumption (% of bds)

**Conclusion.** Hardening effect of the synthesized polycondensation products is identical to the imported analogue "Melapret PAE/A". To get these products it is necessary to carry out the polycondensation of hexane diacid (1.00 ± 0.02): diethylenetriamine (1.00 ± 0.01): resin acid (0.130 ± ± 0.005).

Application features of hexane diacidpolycondensation products with diethylenetriamine and resin acids have been identified: firstly, it is reasonable to admix synthesized products into the paper pulp containing a sizing agent; secondly, sizing agent consumption can be reduced by 10–12% due to resin acids in the synthesized polymer which enhance hydrophobic effect of the sizing agent used; thirdly, in contrast to the traditionally used polymer compound physical and mechanical properties of the samples containing the synthesized product are comparable even in case of reducing the synthesized product consumption from 1.5 to 1.0% of bds, i.e. by 30%, which is of practical importance in the technology of paper.

## References

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