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THE INFLUENCE OF PAPER MASS COMPOSITION ON EFFECTIVENESS OF APPLYING SYNTHETIC FILLERS

Efficiency of application of synthetic filler (barium sulfite, having an average particle size of 1.05–1.27 μ) increases the management of structure of the sized filled pulp. Reducing the particle size from 1.0−5.0 to 1.05−1.27 μ increases the degree of filler retention in the paper structure and, therefore, increases the ash content of the paper and decreases twice the content of suspended solids in the water sub grid. It is possible to explain by the filling process in the geteroadagulation mode. The preferred pulp composition is set to obtain paper with high indices (ash content, brightness, absorbency at unilateral wetting, breaking length). The pulp should be obtained in the following manner. For maximum preservation of the mechanical strength of the fibers it is advisable to sequentially introduce into the fibrous pulp slurry barium hydroxide at defibering stage (dispersion process), and sodium sulfite at the grinding stage (the process of internal and external fibrillation). The components are taken in stoichiometric ratio to obtain a finely divided filler in amount 10% a. d. s.; then aluminum sulfate (0.8% of the flow rate a. d. s.) is added and synthetic sizing agent based on dimers of alkyl ketenes AKD (0.4% of the flow rate a. d. s.), to provide absorbency index under one-sided wetting no more than 20 g/m^2.

Key words: barium sulfite, fibrillation, paper, strength, electrolyte, sizing agent, the pH of the pulp, ash, whiteness, hydrophobicity.

Introduction. The necessity to use some natural fillers, for example, barium sulfite [1], in the composition of high quality types of paper is caused by the following reasons: first, possibility of partial saving of the primary fibrous (pulp) raw materials, second, to provide the required press-room properties for paper. However coarse fractions of the natural fillers are of non-homogeneous nature, thus leading to the performance of the filling process in the homocoagulation mode characterized by uneven distribution and poor adhesion of the particles of fillers on the surface of fibers and reduction of paper sheet mechanical strength.

The change of the natural filler (barium sulfite) for a synthetic one that according to our innovative proposal shall be produced by the chemical interactions of two compound will provide the shift, to our opinion, of the filling process from the traditional mode of homocoagulation to more efficient heterocoagulation mode characterized by even distribution and good adhesion of fine particles on the surface of fibers and, consequently, maximum preservation of the initial strength of fibers.

The study of the peculiarities of the filling of paper mass with a new finely-dispersed synthetic filler (barium sulfite) instead of the natural one is of scientific and practical interest [2−5].

The aim of the work – the study of the effect of the composition of paper mass on the efficiency of synthetic filler (barium sulfite) use.

Main part. The work was carried out in three stages: the first stage – obtaining of the synthetic filler (barium sulfite) and determination of the particle size of the filler's dispersion phases; the second stage – studying of the effect of electrolyte consumption (aluminum sulfate) on pH value of the filled fibrous suspension and the contents of suspended materials in tray water, ash content and whiteness of the samples of paper; the third stage – studying of the effect of the consumption of sizing compounds (AKD and TM) on the whiteness and hydrophobic capacity of the samples of paper.

During the research the following fibrous semi-finished products and chemicals were used. Bleached sulfate cellulose produced of hard wood was used as fibrous raw materials (TU 5411-029-00279195-2006), in order to receive new finely-dispersed compound used for the filling of fibrous suspension barium hydroxide GOST 4107−78 (the first component) and sodium sulfite GOST 5644−75 (the second component) were used. Aluminum sulfite (GOST 12966–85) was used as electrolyte and AKD synthetic substance based on dimers of alkylketens of Ultrasize 200 brand (TU 2499-004-88593806-2010) and strengthened glue paste of TM brand (TU RB 00280198-017-95) were used as sizing substances.

On the first stage to obtain the synthetic filler (barium sulfite) the solutions of barium hydroxide and sodium sulfite were used. The reaction was performed in aqueous (dispersion) media:

$$Ba(OH)_2 + Na_2SO_3 = BaSO_3\downarrow + 2NaOH.$$

The process of filling started with the introduction of 10% solution of the first component (barium hydroxide $Ba(OH)_2$) into 1% fibrous suspension at the stage of dissolution (process of dispersion) and the second component (sodium sulfite Na_2SO_3) – at the milling stage (processes of internal and external fibrillation. The received dispersed system was mixed for 150 s. The quantity of the introduced components (the first and the

second) conformed to 10% contents of the filler in paper mass. The degree of grinding of fibrous suspension was 40°ShR [6–9]. Electrolyte (aluminum sulfate) was added on the second stage after the filling of paper mass, electrolyte consumption was increased from 0 to 1.0% of absolutely dry fiber (absolutely dry fiber); the attention was also paid to the alteration of pH value of the dispersed system and determination of the quantity of suspended materials in tray water, whiteness and ash content of the produced samples of paper.

After adding of the required quantities of electrolyte the estimated amounts of sizing substances with consumption changes from 0 to 0.8% of absolutely dry fiber were added.

The produced paper mass was used for the manufacture of the samples of paper with weight of 1 m^2 equal to 80 g using the sheet paper machine of Rapid-Ketten brand (Ernst Haage, Germany). Paper whiteness was determined using Kolir spectrophotometer (Ukraine) in compliance with CIED 65/10. Ash content and blotting capacity after wetting of paper samples on one side were determined using the standard methods [1].

Synthetic barium sulfite was produced on the first stage, then the average number of particles was calculated using the standard method [1] of the settling rate in compliance with Stokes' law

$$r = K \cdot \sqrt{v}\,, \qquad (1)$$

where r is the average size of particles, mcm; K is constant equal to 0.537; v is particle velocity, m/s.

It was established that the size of the particles of the produced filler fall in the range of 1.05–1.27 mcm that is significantly smaller than that of the natural one (1.00–5.00 mcm).

During the second stage in order to determine the acidity of paper mass electronic membrane pH-meter of HI 8314 brand (Hanna Instruments, Romania) was used.

In order to determine the contents of the suspended substances in tray water filtrate V, dm^3, where $V = 0.7$ dm^3, remaining after the dehydration of the filled paper mass was filtered through Bunsen's flask, Buchner funnel, pump and previously dried to the condition of the constant mass (m_1, mg) tared filter ("blue" ribbon). Than it was dried in the dry cabinet together with the precipitate until the constant mass (m_2, mg) at the temperature of (103 ± 2)°C.

The contents of the suspended substances in tray water B, mg/dm^3 were calculated according to the following formula

$$B = (m_2 - m_1) / V. \qquad (2)$$

As you can see from Fig. 1 and 2 the increase of electrolyte consumption from 0 to 0.8% of absolutely dry fiber provides the reduction of pH value from 8.7 to 7.0. This technological method allows the alteration of pH value of the filled paper mass from alkaline medium to a neutral one, thus, to our opinion, providing the increase in the efficiency of the following gluing process.

The established dependencies of the effect of electrolyte (aluminum sulfate) consumption on pH value of the filled paper mass and contents of suspended substances in tray water are demonstrated in Fig. 1 and 2.

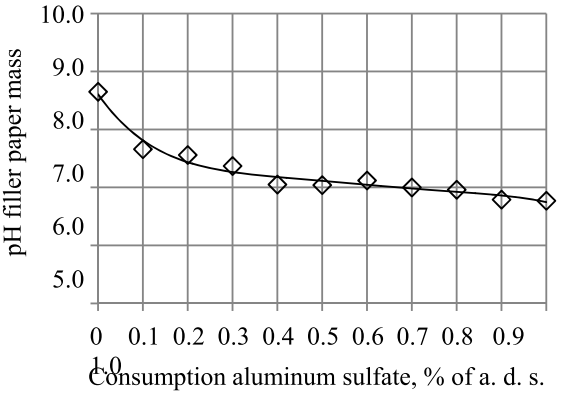

Fig. 1. Effect of aluminum sulfate consumption of pH value of the filled fibrous suspension

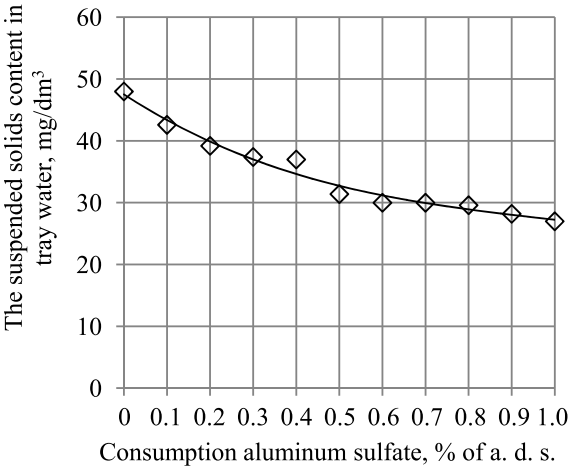

Fig. 2. Effect of aluminum sulfate consumption on the contents of suspended substances in tray water

The comparative analysis of the data provided in Fig. 1 and 2 speaks of the fact the shift of pH value of the filled paper mass from alkaline medium to neutral medium is accompanied by twofold reduction of the contents of suspended substances. It was concluded that aluminum sulfate played the role of not only acidity regulator of the filled paper mass but had a flocculating effect. The preferable consumption of electrolyte was 0.8% of absolutely dry fiber.

Ash content and whiteness of the samples of paper produced from the filled paper mass depend-

ing on the consumption of aluminum sulfate are provided in Fig. 3 and 4.

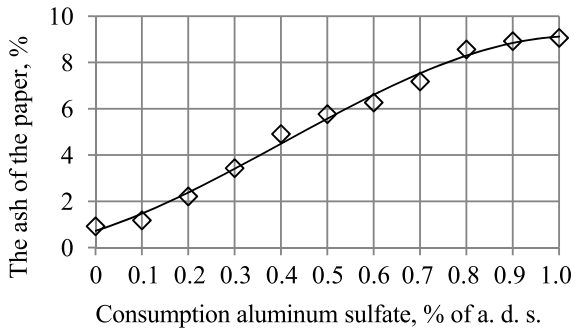

Fig. 3. Effect of aluminum sulfate consumption on the ash content of paper

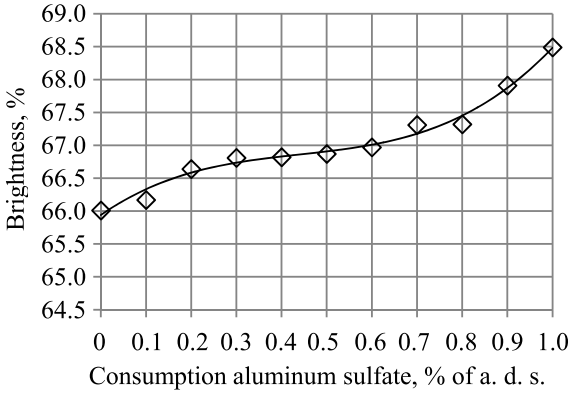

Fig. 4. Effect of aluminum sulfate consumption on paper whiteness

The increase of aluminum sulfate consumption from 0 to 1% of absolutely dry fiber is characterized by the increase of the retention rate of the synthetic filler (barium sulfite) from 58–62% to 95–98%. It is also confirmed by the increase of ash content from 1% to 9% and whiteness from 66 to 68%. Such positive effects are explained by the presence of aluminum sulfate at the amount of 0.8% of absolutely dry fiber.

After the completion of the third stage of the work we studied the effect of the consumption of the sizing substance (AKD/TM) on the whiteness and hydrophobic capacity of the samples of paper. The filled paper mass contained aluminum sulfate (consumption of 0.8% of absolutely dry fiber). The effect of the consumption of sizing substances on pH value of the filled paper mass, whiteness and blotting capacity after wetting of the samples of paper on one side can be seen in Fig. 5–7.

The obtained dependencies (Fig. 5–7) speak of the increase in the efficiency of the sizing process of the filled paper mass due to the decrease of its pH value prior to the addition of either synthetic sizing substance (AKD) or the natural one (TM). The comparable high values of "blotting capacity after wetting of the samples of paper on one side" parameter (not exceeding 20 g/m^2) are achieved at the following consumption rate: AKD – 0.4% of absolutely dry fiber and TM – 0.8% of absolutely dry fiber. At the same time pH value of the filled paper mass was 7.3.

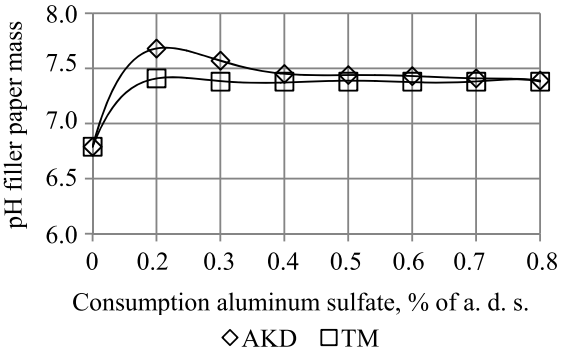

Fig. 5. Effect of the type and consumption of the sizing substance on pH value of the filled paper mass

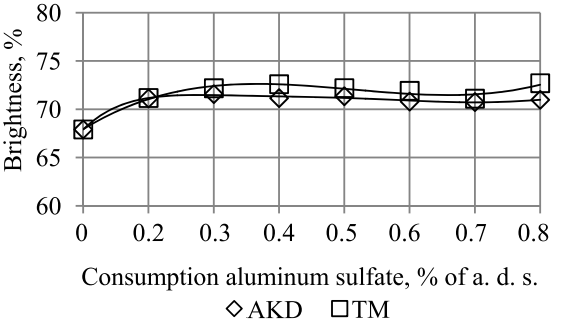

Fig. 6. Effect of the type and consumption of the sizing substance on the whiteness of the samples of paper

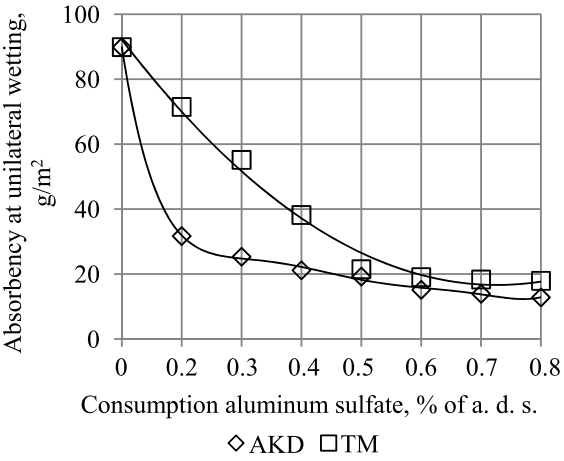

Fig. 7. Effect of the type and consumption of the sizing substance on blotting capacity after wetting of the samples of paper on one side

The technological mode developed for the application of the synthetic filler in paper production provides whiteness value of 73%, blotting capacity after wetting of the samples of paper on one side of 20 g/m^2, and maximum preservation of a paper sheet strength (breaking length value exceeds 6,000 m).

Conclusion. The peculiarities of the use of new finely-dispersed compound (barium sulfite) in paper production: sequence of the addition of chemicals (barium hydroxide, sodium sulfite, aluminum sulfate, synthetic sizing substance based on dimers of alkylketens (AKD) to fibrous suspension, their consumption and pH values of the finished paper mass. Efficiency of the application of the synthetic filler is increased if the paper has certain composition and it is produced in the following way. At the dissolution stage 10% solution of barium hydroxide is added to 1% fibrous suspension and at the milling stage – sodium sulfite to the dissolved fibrous suspension. The quantity of the added components shall correspond to 10% of absolutely dry fiber. The solution of aluminum sulfate is added to the filled fibrous suspension (consumption 0.8% of absolutely dry fiber) and the synthetic sizing substance based on dimers of alkylketens AKD (consumption 0.4 of absolutely dry fiber) is added on the next stage. pH value of the paper mass is neutral (pH = 7.3). The samples produced of such paper mass have high quality parameters: blotting capacity after wetting of the samples of paper on one side and whiteness are 15.2 g/m^2 and 73% respectively. Also the maximum preservation of the initial paper sheet strength is preserved (breaking length value of more than 6,000).

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