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INFLUENCE OF FLOCCULANTS ON THE PRECIPITATION OF PAPER PRODUCTION WHITE WATERS

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ABSTRACT

The precipitation of the white waters obtained from paper production of 100% secondary fiber material is investigated in presence of cationic flocculants from the Organopol® range of CIBA® Specialty Chemicals at different pH value assured by adding of coagulant – alum.

It is established, that for the accelerating of the precipitation of the waters and decreasing of the turbidity it is advisable to reduce the pH value of 0.5 points by alum and than adding of 0.5 ppm CIBA® Organopol® 5445 (copolymer of acryl amide with medium molecular mass and cationic charge).

Keywords: white water, clarification, flocculation, polyacrylamide, recovery paper.

INTRODUCTION

In paper manufacture, water is an irrevocable compound. Its utilization and clarification is inextricably bound up with the environmental protection. Through these reasons the rational water circulation is a significant problem in every modern paper mill [1-3].

In this aspect the effective purification of white water is important goal in accordance with its repeatedly utilization and reduction of water consumption.

Three methods for water clarification are usualy used: flotation, filtration and sedimentation. All these methods achieve mechanical separation of dispersed solid particles [4].

In fact the fines from fibers, fillers and other substances, part of which are with size and properties close to these of colloids are very difficult to be mechanically separated. The problem of its separation is enhancing if the fiber material is from recovery paper.

This necessitates the need for utilization of chemical additives with coagulation and flocculation properties [5-8]. Under their influence agglomerates are formed, which are easily separated by precipitation, flotation or filtration [9]. The aim of the study is to examine the influence of flocculants of CIBA® Organopol® range over the clarification of white waters.

EXPERIMENTAL

Materials and methods

The experiments are carried out with white water from one of the Bulgarian paper mill. The characteristics are:

- Suspended solids – 1.1 g dm^{-3}
- Dry solid residue (evaporation) – 2.3 g dm^{-3}
- pH – 6.8
- Turbidity – 978 NTU
- Conductivity – 1142 μS.

Table1. Characteristics of cationic flocculants CIBA® Organopol® .

Type	Molecular mass	Cationic charge	μS
Ciba®Organopol® 5040	Low	High	136
Ciba®Organopol® 5405	Very high	Very low	46
Ciba®Organopol® 5420	Very high	Low	64
Ciba®Organopol® 5425	High	Low	66
Ciba®Organopol® 5445	Medium	Medium	96

The white water is wasted from the production of wrapping paper from 100 % mixed recovery paper (1.02 – EN643). This fact explains its higher saturation with "detrimental substances" and its difficult purification.

• As a flocculants are used products from the Organopol® range of Ciba Specialty Chemical, which are synthetic copolymers of acryl amide with cationic or anionic charge and with different molecular mass. The investigations are carried out with cationic copolymers (Table 1).

• As a coagulant is used alum $Al_2(SO_4)_3$.

The experiments are carried out in laboratory precipitation container with 1dm^3 white water samples. For pH regulation is used coagulant - alum with concentration 100 g dm^{-3}. At a slow agitation at 45 rpm defined quantity of watered polymer (concentration 0.05 %) is added. The time (*t, s*) for the movement of the clarified front to a defined high (*h, mm*) is determined. The rate of precipitation (*v, m/min*) is calculated as a ratio of *h/t*. The volume of the sludge is determined after 5 min in % as a part of the entire volume of the white water sample. With nephelometer – Turb 350IR (ISO 7027) the turbidity (*NTU*) of the clarified water is analyzed.

RESULTS AND DISCUSSIONS

Influence of flocculants over the precipitation of the white waters

When the flocculant is added into the white water at pH=6.8 the precipitation is weakly accelerated while the turbidity does not decrease, mainly because of the larger amount of dissolved, colloidal and dispersed substances in the recycled paper. Based on to their positive effect over the precipitation at pH=6.8 , the five investigated cationic flocculants can be arranged in the following order:
ORP5445>ORP5420>ORP5425>ORP5040> ORP5405.

Best results are obtained in presence of cationic copolymer with medium charge and molecular mass.

The experiments show that the effectiveness of the clarification could be enhanced if the pH is reducing by adding of coagulant.

Influence of flocculants over the precipitation of the white waters at pH=6.4, obtained in the presence of a coagulant

Fig. 1 shows that adding of the CIBA® Organopol® flocculants in quantity 0.5 ppm decreases the time for the precipitation and for the movement of the clarified front to a defined high on the average of 2 to 5 points.

The presence of alum as a coagulant assists the decreasing of the thickness of the double layer of the colloidal particles, which could allow van der Waals bonding forces to establish. In presence of flocculants extra aggregation is achieved [10].

According to the influence on the process the copolymers establishe the following order:
ORP5445>ORP5420>ORP5405>ORP5040>ORP5425.

The best effect is obtained with CIBA® Organopol® 5445, which is with the medium molecular mass and cationic charge.

Figs. 2, 3 and 4 shows the influence of flocculants CIBA® Organopol® 5040, Organopol® 5420 and Organopol® 5445 consumption over the time of precipitation.

It is determined that the optimal consumption of CIBA® Organopol® is 0.5 ppm.

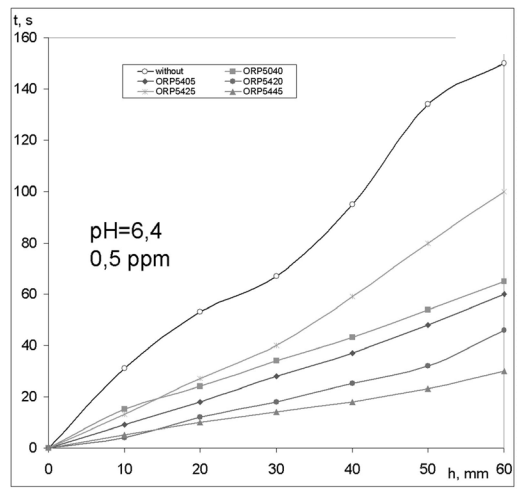

Fig. 1. Dependence between the time and the height at presence of different types of flocculants and pH 6.4.

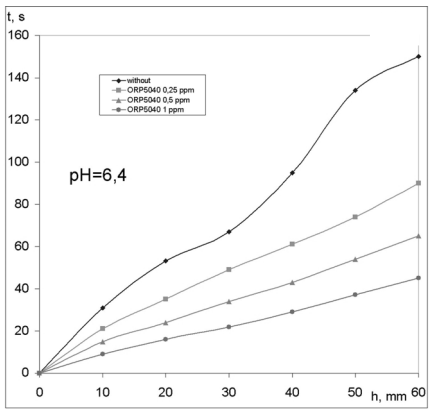

Fig. 2. Dependence between the time and the height at presence of ORP5040 (0; 0.25; 0.5; 1ppm) and pH 6.4.

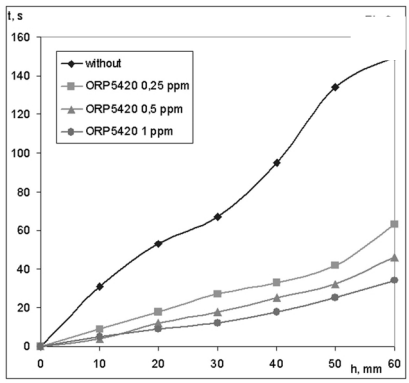

Fig. 3. Dependence between the time and the height at presence of ORP55020 (0; 0.25; 0.5; 1ppm) and pH 6.4.

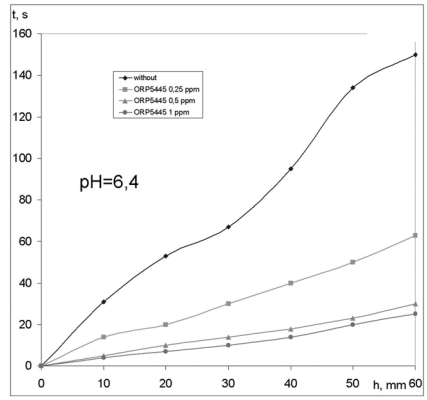

Fig. 4. Dependence between the time and the height at presence of ORP5445 (0; 0.25; 0.5; 1ppm) and pH 6.4.

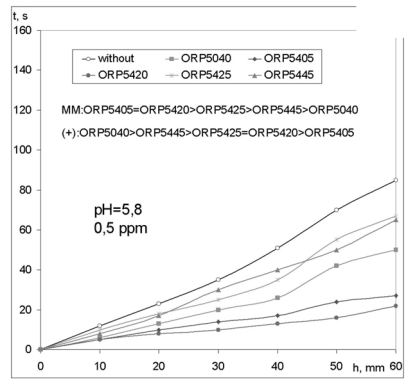

Fig. 5. Dependence between the time and the height at presence of different types of flocculants and pH 5.8.

Influence of the flocculants on the precipitation of the white waters at pH=5.8, obtained in presence of a coagulant

In presence of bigger quantity of coagulant (Alum) the effectiveness of the cationic coagulants Organopol® is lower marked, because of the higher presence of cationic charges in the system. Over the influence of the process at pH=5.8 the copolymers establishes the following order: ORP5420 > ORP5405 > ORP5040 > ORP5445 > ORP5425. At that lower pH value the CIBA® Organopol® 5420 is with best effect, which is with lower cationic charge (Fig. 5).

In Fig. 6 is presented the influence of the pH over the time of precipitation when 0.5 ppm ORP5420 and ORP5445 is added. The finding from the results obtained is that the rational way of working is lowering the pH value of the system with about 0.5 points than the flocculant could be added.

Characteristics of the process of precipitation of the white waters when CIBA® Organopol® 5445 and Organopol® 5420 is used

The dependencies of the rate of precipitation are shown in Fig. 7. In these conditions the highest rate of precipitation is established at pH=6.4 by adding of 0.5ppm CIBA® Organopol® 5445, which is with the higher cationic charge (Table 1). During the investigation it is established that the increasing of the rate of precipitation leads to a more compact sludge characterized with smaller volume (Fig. 8). The experiments which were carried out show that the turbidity of the clarified white water decreases of 2 points after adding of the CIBA® Organopol® flocculants (Fig. 9).

CONCLUSIONS

The study on the white water clarification showed that to accelerate the rate of precipitation and to decrease the turbidity of the white water it is advisable pH value to be lowered with about 0.5 points by adding of alum and then adding of CIBA® Organopol® 5445 *(copolymer of acryl amide with medium molecular mass and cationic charge)* in quantity 0.5 ppm.

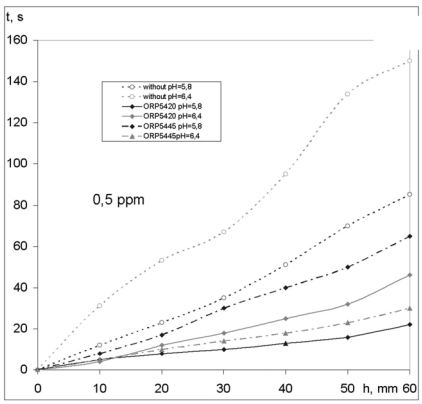

Fig. 6. Dependence between the time and the height at presence of ORP5420 (0.5 ppm), ORP5445 (0.5ppm) and pH 6.4 and 5.8.

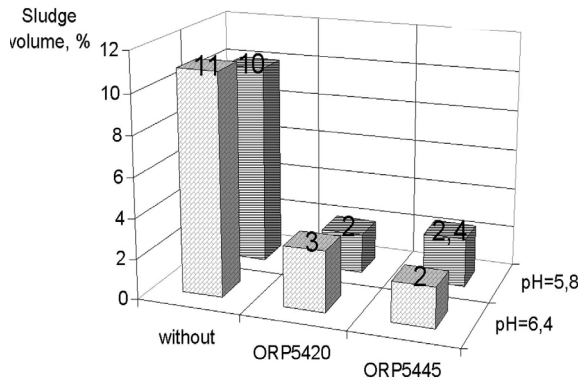

Fig. 8. Volume of the sludge (%) of white waters at different pH value, without and with ORP5420 (0.5ppm) and ORP5445 (0.5ppm).

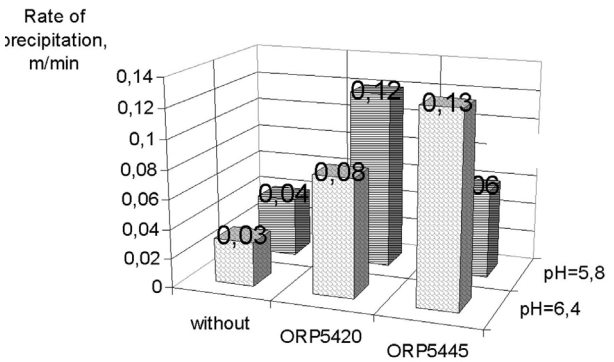

Fig. 7. Rate of precipitation (m/min) of white waters at different pH value, without and with ORP5420 (0.5ppm) and ORP5445 (0.5ppm).

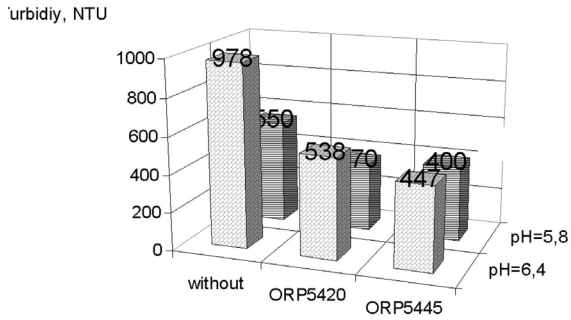

Fig. 9. Turbidity (NTU) of white waters at different pH value, without and with ORP5420 (0.5ppm) and ORP5445 (0.5ppm).

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