TACKINESS REDUCING OF STICKIES SURFACES BY INORGANIC AGENTS AND ORGANIC POLYMERS

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ABSTRACT

This paper present the results of application of inorganic minerals and organic polymers for elimination of sticky impurities "macrostickies" in the processing of recovered paper. The impact of individual agents has been monitored on different species of suspensions. On the dark suspension of recycled fibres VL5 with a brightness 53% ISO and an ash content of 17.6%, and the suspension VL1 with a brightness 64% ISO and an ash content of 29.4%. From inorganic minerals, the highest efficiency was achieved in the elimination of macrostickies using bentonite Hydrocol OT. At a dose of 5kg bentonite.t^{-1} b.d. recycled fibres efficiency of 65.1% for suspension VL5 and 58.7% for VL1 was achieved. The highest performance of the Acefloc 2550 was achieved from the polymers. When applied to the VL5 suspension, the macrostickies were reduced by 57.1%, and when applied to the VL1 suspension, the macrostickies content dropped by 56.5%.

KEYWORDS: macrostickies, organic polymers, inorganic fillers, average particle size, montmorillonite

INTRODUCTION

Increasing the recycling of paper also increases the content of impurities and undesirable substances in the recovered paper (Kuňa et al. 2016), thereby deteriorating its quality. There are various sources and types of impurities in the recovered paper (Holik 2000). These are various microbiological impurities, insoluble impurities such as adhesives, resins, fillers, wet strength agents, and soluble colloidal materials such as coatings, latexes, which combine a variety of sticky impurities called micro and macrostickies.

The major source of stickies are pressure sensitive adhesives (PSA) due to their permanent thermoplastic state which ensures lasting tack. These substances are contained in post-it notes, labels used for marking prices on different products etc. Another group of substances that are considered as stickies are hot melt adhesives which are solid at room temperature and soften at temperatures between 65°C and 120°C, but it can also occur at room temperature which is mainly predetermined by their chemical composition. Stickies of this type tend to deposit mainly on stationary parts of the equipment such as pipes and chest walls. However, they influence movable parts as well, predominantly wires, felts and rolls. Materials classified as hot melts are mainly plastics, such as polyethylene and polypropylene (Putz 2000).

Virgin pulps may contain stickies in form of wood pitch. Wood pitch is a mixture of resin acids, fatty acids, natural oily materials which are of hydrophobic nature. Moreover, they tend to be sticky and therefore are prone to contribute to the deposit formation in the paper machine (Hubbe 2000). There are two major ways of classifying stickies (Putz 2000):

- According to their origin:
  - Primary stickies;
  - Secondary stickies.
- According to their physical or chemical properties:
  - Micro stickies;
  - Macro stickies.

Primary stickies are tacky substances that enter the process with the raw material. These substances are adhesives coming from hot melt glues, binders present in book-backs, envelopes, sticky notes, magazine coatings etc. They mainly consist of organic materials, e.g. styrenebutadiene, styrene acrylic latex binders, rubber, vinyl acrylates, polyisoprene, polybutadiene etc. (Gribble et al. 2010).

Secondary stickies are formed as a result of physical and chemical interactions occurring during the manufacturing process (Sarja 2007). A potential reason for formation of the secondary stickies is shock-type alteration in critical process parameters, such as temperature, pH and charge which promote colloidal destabilization and agglomeration of dissolved and colloidal substances (Putz 2000).

Classification into micro and macro stickies is performed by the size of the tacky substances. This is determined by laboratory screening where macro-stickies are the particles retained on 100 μm or 150 μm laboratory screens and micro-stickies refering to the tacky particles that pass through these screens but are larger than 1-5 μm (Sarja 2007). According to Doshi, micro-stickies can be further classified into suspended stickies (20-100 μm), dispersed stickies (1-20 μm), colloidal stickies (5-0,01 μm) and dissolved stickies (<0,01 μm) (Doshi et al. 2003).

The classification according to the size is necessary due to different removal approaches for micro and macro stickies, specific methods used for their quantification and different strategies for minimizing their impact on papermaking (Doshi and Dyer 2000). Moreover, size and concentration of stickies have a great influence on the paper quality and the runnability of the paper machine (Putz 2000).

Mechanism of stickie formation in the process of recovered paper

In order to tackle the formation of stickies in the process it is important to understand their formation and accumulation mechanisms. The first step is to understand what kind of stickies that are involved (micro, macro, primary, secondary). There are two main mechanisms due to which deposition may occur: impact deposition due to the tacky nature of stickies and flow deposition due to destabilization of colloidal material (Monte et al. 2010).

Figure 1 schematically describes possible interactions between recovered paper, virgin pulp and chemical additives. Pitch present in virgin pulp may create a synergic effect with microstickies present in deinked pulp and destabilize each other (Monte et al. 2004). Chemicals used in the process may destabilize the detrimental substances present in the process and cause formation of secondary stickies (Monte et al. 2004 and 2012,Laurila-Lumme et al. 2003 and Jansson 2009). As it was mentioned before, stickies are rather complex substances and might incorporate both organic and inorganic matter.

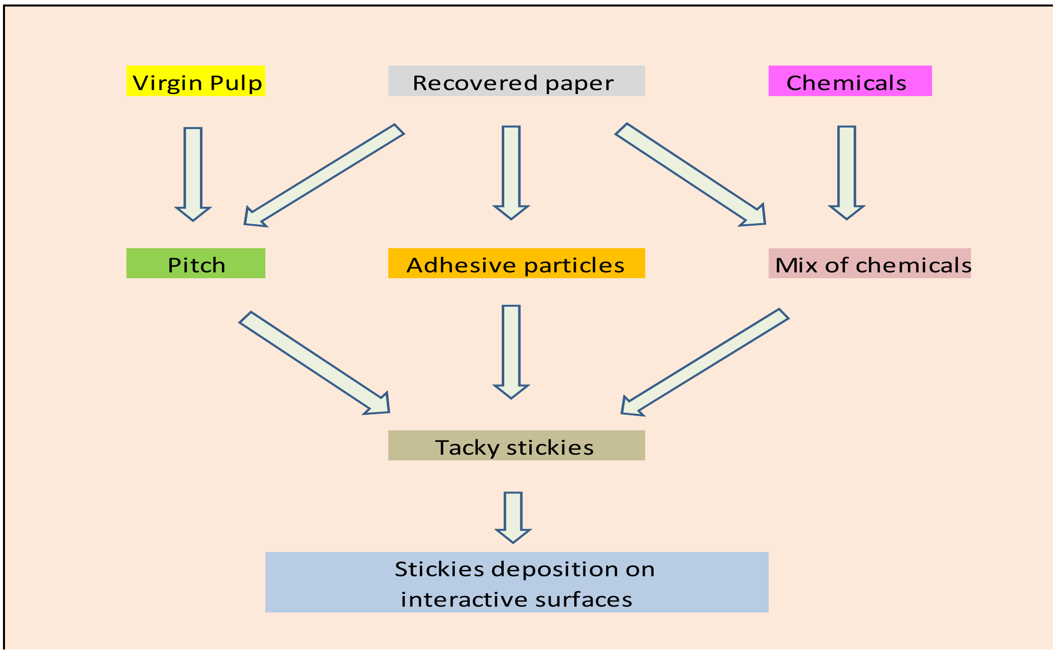

Fig.1 Interactions contributing to deposition of stickies (Putz 2000)

MATERIAL AND METHOD

Used species of suspensions:

VL5 suspension - brightness 53% ISO, ash content 16-18% (450 °C)

VL1 suspension - brightness 64% ISO, ash content 28-30% (450 °C)

Composition of recovered paper for used suspensions:

VL5 suspension – 92.5% mix of newspapers and magazines + 7.5% broke PM2

VL1 suspension - 13% mix of newspapers and magazines + 79.5% white office waste + 7.5% broke PM2

Used chemicals

Hydrocol OT - alkalized micronized bentonite with an average particle size of 4 µm (Clariant), HOT

Bentonite 4 - alkalized micronized bentonite with an average particle size of 6 μm (POL), B4
Bentonite 7 - alkalized micronized bentonite with an average particle size of 10 μm (POL), B7
CaCO3 - micronized calcium carbonate with an average particle size of 5 μm (Omya), CC3
Finntalc 10 - micronized talc with an average particle size of 3 μm (FIN), FIN
Acefloc 2550 - spatially crosslinked polyamine (Allied Solutions) A255
Acefloc 4450 - Polydadamac (Allied Solutions) A455
Polymine SK - modified polyethyleneimine (BASF) PSK

Homogenisation of suspension and dosage of chemicals

The suspension of recycled fibers with a 3% consistence, was homogenized by laboratory mixer at 500 rpm for 5 minutes. After 5 minutes of homogenization, the required amount of chemicals was added and was stirred for 30 minutes.

Determination of stickies

1. For the determination of sticky impurities, a sample of 30 g b.d. is used, which is sorted in a laboratory sorter Sommerville on a 150 micron slice plate under constant rinsing. Sorting time is 20 minutes.

2. The material captured on the sorting plate is quantitatively transferred using a Rapid-Kothen sheet-cutter to a filter paper of 220 mm diameter so that it is distributed evenly over its entire surface. Filter paper with the sorted substance is allowed to dry freely in the air.

3. Sheets of sorted and dried material are placed between two clean filter sheets with a diameter of 220 mm. They are pressed in a press with heated plates at a temperature of 160°C and a pressure of 2.5 MPa for 4 minutes.

4. After pressing and cooling, the sheets are separated from each other and impurities greater than 0.1 mm^2 are counted, which are compressed or bonded to the filter paper. Evaluation of the number of sticky impurities is given in $pcs.kg^{-1}$ b.d. substances.

RESULTS AND DISCUSSION

During the laboratory tests, the effect of various chemical agents on the content of sticky impurities (macrostickies) was monitored in the fiber suspension. The influence of the chemical agents on the macrostickies content in the VL5 suspension is shown in Fig. 2. The best results in the elimination of macrostickies were achieved with the application of modified micronized bentonite Hydrocol OT. At dose of 5 kg $HOT.t^{-1}$ b.d. VL5 suspension, the macrostickies were reduced from 630 $pcs.kg^{-1}$ to 220 $pcs.g^{-1}$, which represents an efficiency of 65.1%. A very good efficacy in the elimination of macrostickies was also achieved with the application of bentonite B4, where the macrostickies content was reduced from 630 pcs . kg^{-1} to 310 $pcs.kg^{-1}$, which is 50.8 % efficiency. At the same time the tests confirmed the fact, that the lower is granularity of the bentonite, the better the elimination of macrostickies is achieved. The application of micronized talc FINNTALC 10 was justified only to a dose of 2 kg.t^{-1}, when the macrostickies drop was achieved by 230 pcs.kg^{-1}, which represents an efficiency of 36.5%. Higher doses of talc did not have a positive effect on the reduction of macrostickies. The application of micronized carbonate had virtually no effect on the content of macrostickiess in tested suspension of recycled fibres.

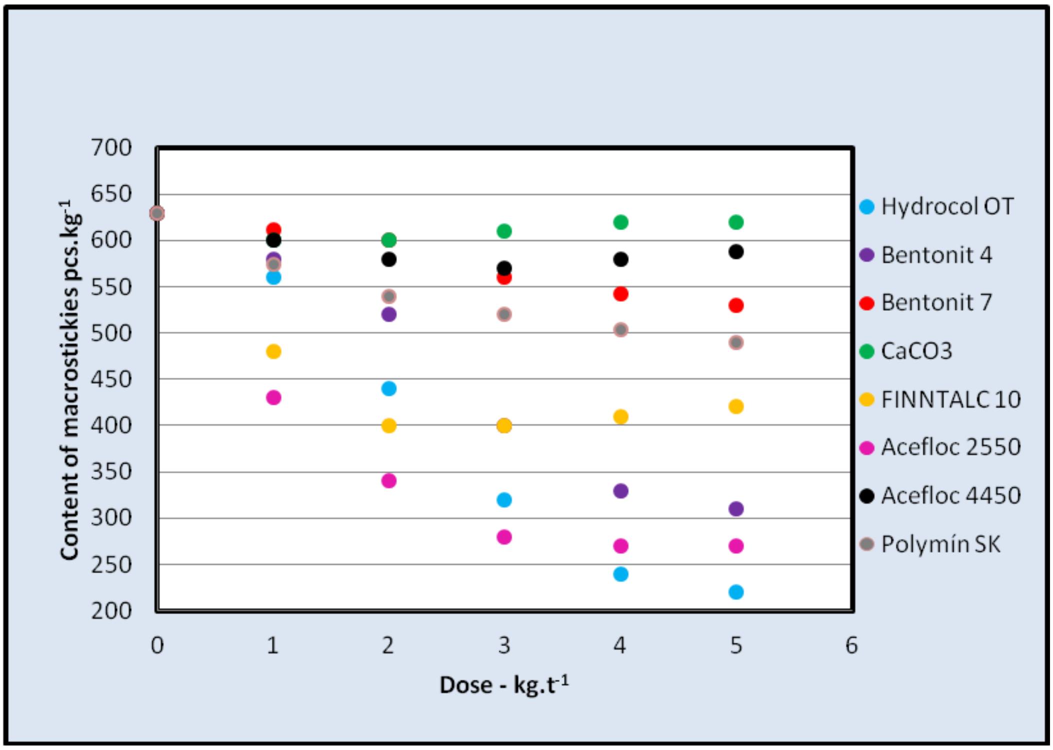

Fig.2 Effect of chemicals on the content of macrostickies, VL5 suspension

Of the organic polymers used, the highest efficiency of macrostickies elimination was achieved when Acefloc 2550 was applied. At a dose of 5 kg.t^{-1}, the macrostickies drop by 360 pcs.kg^{-1} was achieved, which is 57.1% efficiency of macrostickies elimination.. Other organic polymers used, showed significantly lower efficiency in the elimination of macrostickies. Polymine SK, at a dose of 5 kg.t^{-1}, achieved an efficiency of 22.2%, and Acefloc 4450 only 9.5% efficiency.

The influence of chemical agents on the content of macrostickies in the VL1 suspension is shown in Fig.3. The best results for macrostick elimination were, as with VL5 and VL1, achieved with the application of modified micronized bentonite Hydrocol OT. At the dose of 5 kg HOT.t^{-1} b.d. a decrease of the macrostickies from 920 pcs.kg^{-1} to 380 pcs.kg^{-1} was achieved, which represents an efficiency of 58.7%. High efficiency of macrostickies elimination was also achieved with the application of bentonite B4, which achieved a 490 pcs.kg^{-1} decrease in macrostickies, which is 46.7% efficiency. The effectiveness of micronized talc FINNTALC10 was confirmed, up to a dose of 2 kg.t^{-1}, where a decrease in the number of macrostickies was achieved by 250 pcs.kg^{-1}, which is an efficiency of 27.2%. Laboratory tests on VL1 suspension confirmed the very low efficiency of micronized carbonate to the content of macrostickies in the suspension of recycled fibres. Of the organic polymers used, the highest elimination efficiency of macrostickiess was again achieved with spatially crosslinked polyamine Acefloc 2550 application. At a dose of 5 kg.t^{-1}, the macrostickies dropped by 400 pcs.kg^{-1}, which is 56.5% efficiency. Polymine SK, at a dose of 5 kg.t^{-1}, achieved an efficiency 17.4% in the elimination of macrostickies and Acefloc 4450 8.7% efficiency. . In Tab. 1 we present the effects of individual agents in eliminating of macrostickies.

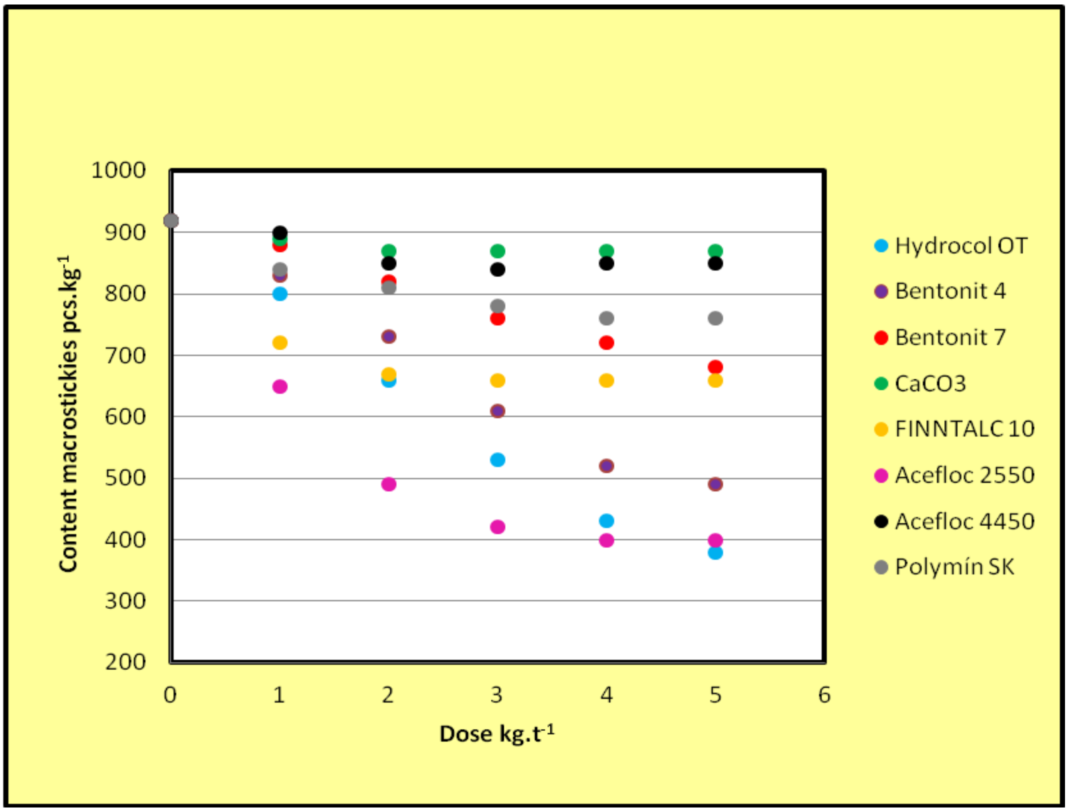

Fig.3 Effect of chemicals on the content of macrostickies, VL1 suspension

Tab.1 Effect of agents to eliminate macrostickies

Agent	Elimination of macrostickies - %	
Dose – kg.t^{-1}	Suspension VL5	Suspension VL1
Hydrocol OT - 5	65,1	58,7
Bentonit 4 -5	50,8	46,7
Bentonit 7 - 5	15,9	26,1
$CaCO_3$ - 2	5,0	5,4
FINNTALC 10 - 2	36,5	27,2
Acefloc 2550 - 5	57,1	56,5
Acefloc 4550 -3	9,5	8,7
Polymín SK - 5	22,2	17,4

CONCLUSIONS

The results of the laboratory tests have confirmed, that by the application of suitable inorganic and organic agents, it is possible to eliminate the negative effect of sticky impurities so called macrostickies.

The highest efficiency in the elimination of macrostickies was achieved by applying the modified micronized bentonite Hydocol OT. With the dose of Hydrocol OT 5 $kg.t^{-1}$, 65.1% efficiency reduction of macrostickies in VL5 suspension was achiewed, and 58,7 % efficiency in VL1 suspension. Excellent results have also been achieved with the use of Acefloc 2550 spatially crosslinked polyamine. At the VL5 suspension, the macrostickies have been reduced by 57.1% and 56.5% in the VL1 suspension.

The application of suitable inorganic and organic agents for eliminating sticky impurities "macrostickies" results in an improvement in the properties of the recycled fibres suspension and creates better conditions for paper dewatering at the site of the papermaking machine. Elimination of macrostickies in the fabric preparation process contributes to increasing the runnability of the paper machine.

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