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Fine Particles Separation in Recovered Paper Suspensions

Introduction

Recovered paper is the most important fibre resource in the German paper industry. The recovered paper utilization rate adds up to 69 %. Stock preparation systems for recycling paper production deliver furnishes of high quality with defined properties, although their input is a heterogeneous material of varying qualities. This is reached by complex screening and separation systems.

Such stock preparation systems are supposed to pulp and dilute recovered paper. The suspensions obtained have passed screens and hydrocyclones removing contaminations like plastics or paper clips. If an ink removal is necessary additional flotation or washing processes are installed. The stock preparation is designed and operated in order to achieve the demands of a stable paper production.

This paper deals with the separation of organic and inorganic fine particles. High inorganic content and landfill problems arising with huge tonnage of rejects require the investigation of the fine particles. Increasing ash contents in recovered paper result in a reduction of strength properties. Particularly in packaging paper production, much effort is applied in order to compensate strength decreases. The removal of ash leads to high losses of organic fines which are bought dear and disposed of later. Land filling in Germany is forbidden when the organic content is higher than 5 %. The incineration efficiency of blended organic and inorganic fines is reduced with rising part of inorganic material.

The paper industry is looking for a solution to selectively remove the inorganic particles, since there are no suitable techniques so far. Organic fines are defined as fibrils, fibre broke and small fibres. These particles differ in sedimentation behaviour to inorganic fines being calcium carbonate and clay particles [1]. A possible solution of the separation problem can be a counter flow sedimentation process.

1. Research target

The separation potential of a counter flow sedimentation process is to be discovered. Because of experiences from previous work we know, that it is not enough to just mix and examine virgin particles, because chemical aids in paper and paper producing processes change the interactions between the particles. There are more agglomerates in the fine fractions of a recovered paper suspen-

Das Papier · Summary

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Separation of organic and inorganic fine particles causes problems not yet satisfactorily solved by the paper industry because there are no suitable techniques. Generally, sedimentation processes should be successful because of the differences in component sizes, but they could change the interactions between the fine particles. This article describes the separation trials of fine particles in model and real suspension.
A REM picture is shown which describes the fine particles to be separated. The separation strategy is explained by means of a two-step process.
A sufficient splitting of fines in an organic and inorganic fraction by counter flow sedimentation demands trials with a suitable suspension.

sion than of a virgin paper suspension. Therefore, an adequate model suspension has to be found which is able to reflect reality for studying improvements of the separation process in lab experiments.

2. Experiments

Recovered paper suspensions contain organic and inorganic fines as well as long fibres and chemicals. The long fibres dominate the sedimentation process because of their size and their agglomeration behaviour. For investigation of a separation process for the fine fraction, the long fibres are removed by screening with a 150 µm holed screen [2]. The suspension passing the holes contains mainly fines and chemicals (fines suspension). **Fig. 1** shows fines embedded in a flotation foam.

After the removal of long fibres by screening, the fines suspension is treated in a counter flow sedimentation process. Several separation trials with a counter flow sedimentation were made with different fines suspensions in order to find a realistic composition of a model suspension. A mixture of native fines, fines of an uncoated paper, fines of a coated paper and two industrial samples (one washer filtrate and one flotation foam) were tested on the sedimentation and separation behaviour of the fine particles. The results of the counter flow sedimentation were compared and estimated.

3. Results and discussion

The results of the separation by the counter flow sedimentation have shown that the separation of native fines works perfectly well. The organic fines build flocks which settle fast, whereas the inorganic fines settle slowly, although the inorganic fines own a clearly higher specific gravity than the organic fines [1]. In the counter flow sedimentation process the organic fines are concentrated in a sediment and the inorganic fines are concentrated in the overflow.

Investigations with recovered fines have shown that the separation of recovered fines in the sedimentation process is very poor. The organic fines are slightly

Fig. 1: Inorganic and organic fines in a flotation foam of a graphic recycling paper production line

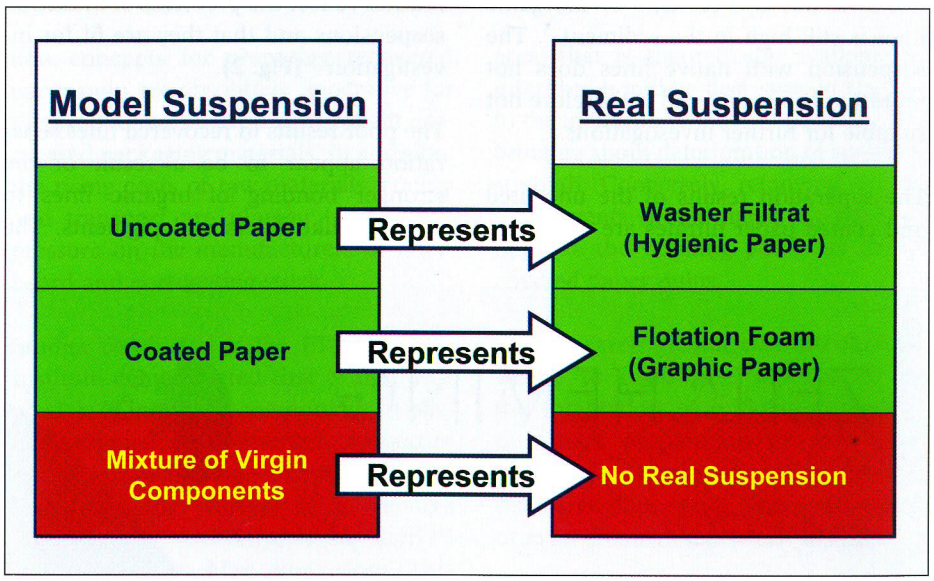

Fig. 2: Representation of the model suspensions for real suspensions

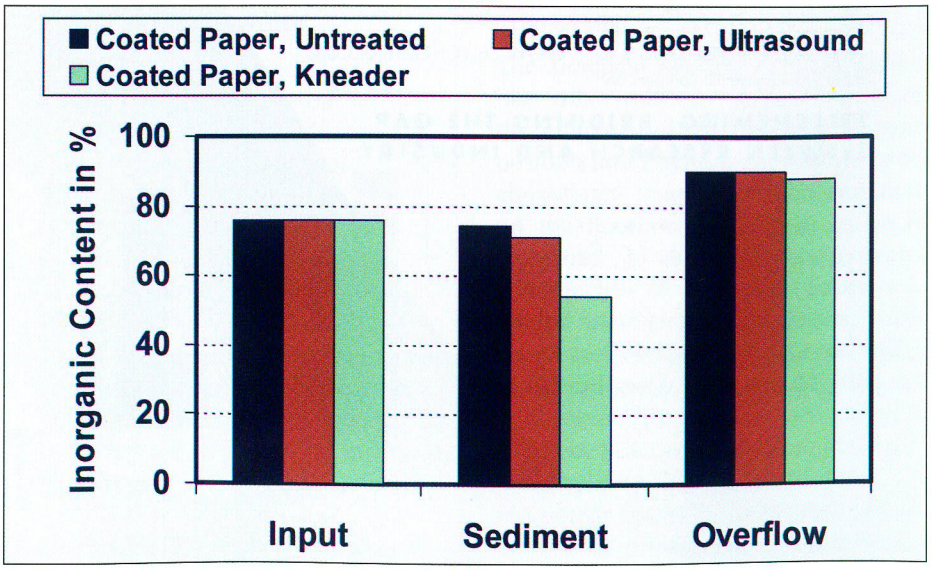

Fig. 3: Inorganic content of a coated paper fines suspension without and with mechanical treatment

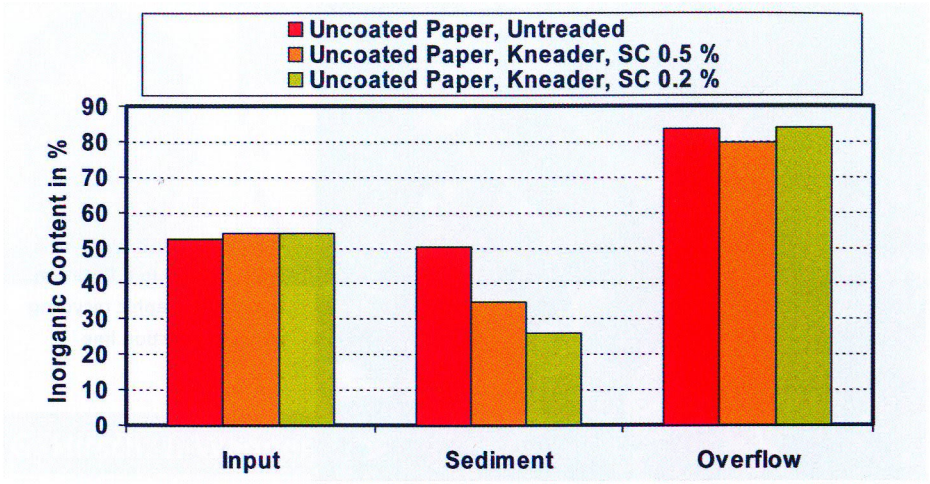

Fig. 4: Inorganic content of an uncoated paper fines suspension at different stock consistency (SC)

concentrated in the sediment and the inorganic fines are concentrated in the overflow but the content of inorganic fines is still high in the sediment [3]. The suspension with native fines does not represent the reality and is therefore not suitable for further investigations.

The separation results of the uncoated and coated paper filtrates are very similar to those of the two industrial samples. Therefore, we can say that the two paper filtrates reflect the problems of industrial suspensions and that they are fit for investigation [3] **(Fig. 2)**.

The poor results in recovered fines separation appear to be a result of the stronger bonding of organic fines to minerals like fillers and pigments. The use of chemicals like retention agents or binders in paper production could be the reason. These chemicals seem to strongly bind the organic and inorganic fines after the drying process in the paper machine and after natural aging of the paper. The organic fines cannot be efficiently separated from the fillers and pigments.

Energy and/or dispersing chemicals are necessary to break the connection between the different fines. First trials with ultrasonic and kneading treatment show that mechanical energy is improving the separation as shown in **Fig. 3**.

A preliminary thermo-mechanical treatment by kneading shows the best results for the separation. Mechanical forces can break the strong bonding between the organic and inorganic fines.

Studies with chemicals and different process parameters are currently performed. First results display that the stock consistency affects the separation process **(Fig. 4)**.

Supposedly the sedimentation process is affected by the content of organic fines.

By means of the results the sedimentation device and process is optimised. After the optimisation a scale up of the process is planed into pilot plant size.

References

1 Hirsch, G.: Physikochemische Wechselwirkungen bei der Trennung von Füll- und Feinstoff in Altpapiersuspensionen. Technische Universität Darmstadt, Ernst Berl-Institut für Technische und Makromolekulare Chemie, Studienarbeit, 2005

2 Wagner, J.; Putz, H.-J.; Schabel, S.: Fine Particle Separation in Recovered Paper Suspension. 8th Research Forum on Recycling, Niagara Falls, 2007, 284-291

3 Lauter, J.: Quality Characterization of Organic Fines Fractions in Recycling Paper Suspensions. Technische Universität Darmstadt, Fachgebiet Papierfabrikation und Mechanische Verfahrenstechnik, Diplomarbeit, 2007