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Fillers & Pigments

Separation of fibre fines and inorganic fines in recovered paper suspensions

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Recovered paper is today the most important fibre resource for producing new paper. Recovered paper has many advantages over chemical and mechanical pulp such as lower energy consumption in stock preparation and lower purchase cost. But recovered paper has also disadvantages, e.g. higher concentration of undesirable material.

In order to remove undesirable components, the stock preparation requires many separation and cleaning techniques. But not all materials were undesirable when the use of recovered paper began. Fillers and pigments got problematical only for the last years. Due to the stronger use of fillers in paper production and the closed recycling chain the concentration of inorganic fines in the recovered paper increases. Today, such a level of inorganic fines has been reached that it causes problems in producing high quality new paper from recovered paper. Producers of packaging paper have to contend against losses in strength properties, because strength properties of paper and board decrease with increasing filler content. Producers of graphic paper have to fight against variations in pulp quality to assure constant conditions for the paper machine. And producers of hygienic paper have to accept increasing losses, because they have to remove nearly all inorganic particles. Therefore, one aim of the paper industry is the selective removal of fillers during the paper production process.

The separation equipment used in the paper industry includes flotation cells, screens and hydro cyclones. All these techniques can reduce the content of inorganic fines in the pulp, but not selectively. A large amount of fibre fines is also always removed along with the fillers by using established technologies. The rejects of these techniques contain an organic content between 45% and 65% [1]. Hence, the removal of inorganic fines by common technique leads to large losses of useful fibre fines and to problems in disposal. Therefore, a different separation technique with a better separation ratio is necessary to remove inorganic fines more selectively.

This paper deals with a new separation technique to remove inorganic particles (fillers and pigments). The new technique consists of two separation steps and is based on screening and sedimentation.

Research target

Target of the project was the development of a new selective separation technique to remove inorganic particles from recovered paper suspensions. The new technique should lead to improved separation efficiency and a better yield than the common technique. The new separation process should consist of two steps. In the first step the fibres of the suspension are removed by screening. After the screening step only the fines suspension is treated with a new device. The new device is based on sedimentation and separates fibre fines from inorganic particles. That a sedimentation process can solve the separation problem has been shown in pre-studies.

Experiments

Initial investigations were carried out with suspensions which only contained native fibre fines and native inorganic fines. These fibre fines and inorganic fines had not passed the paper production process. For the investigations a counter-flow sedimentation cell was built. The separation results showed that a counter-flow sedimentation process has a very good separation efficiency. Because the separation process should separate fines of recovered paper, two paper grades were produced with simple compositions: an uncoated paper and a coated paper. The uncoated paper had only $CaCO_3$ as filler and formed the base

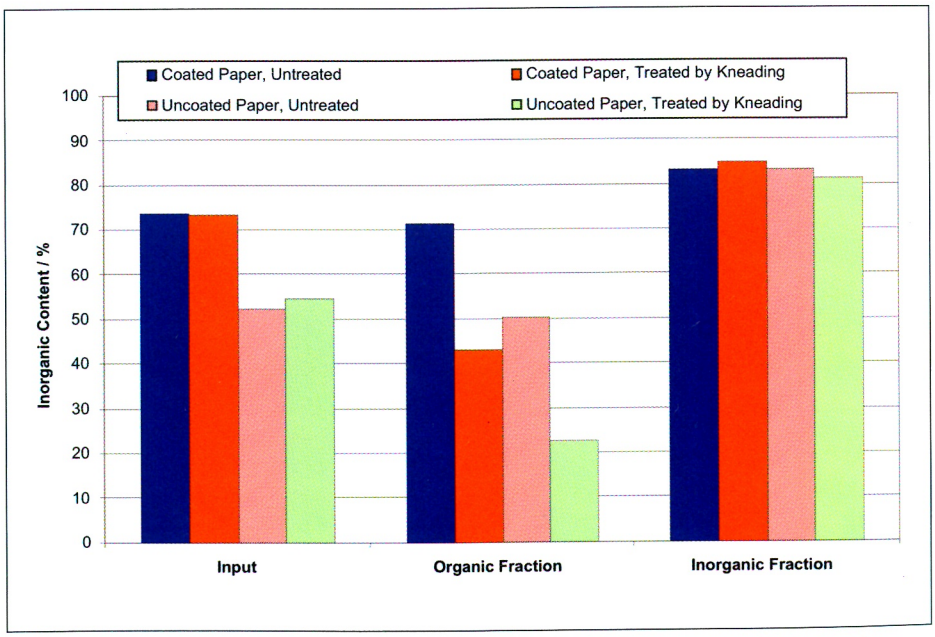

Fig. 1: Inorganic content of coated and uncoated paper before/after separation in the wedge-shaped sedimentation cell with/without thermo-mechanical treatment in the Beken-Kneader

paper of the coated paper also which was coated twice. The first coating layer contained only $CaCO_3$ as pigment and the second contained 50% $CaCO_3$ and 50% clay. Of these two paper grades the fines suspensions were produced for further investigations. One paper grade was pulped in a LC-pulper at a consistency of 4%. After pulping the suspension was screened by a 150 μm hole screen to remove the fibres. The suspension which passed the hole screen was the fines suspension for particle examinations and separation trials. The fines suspension of the uncoated paper had on average a fibre fines content of 45% and an inorganic particle content of 55% and the suspension of the coated paper had a fibre fines content of 24% and an inorganic particle content of 76%. In the continuing course of this article the fines suspensions of the uncoated paper and the coated paper are called coated paper and uncoated paper.

The particle examinations were done with a manometer centrifuge and sedimentation scales. The separation trials were first carried out batchwise in a counter-flow sedimentation cell formed like a wedge and later continuously in a conical counter-flow sedimentation cell. The separation effect was estimated by incineration of the inlet suspension and all produced fractions. Because of the high content of $CaCO_3$ all samples were incinerated at 525°C as is specified in ISO-1762 [2]. As benchmark of the separation effect flotation trials were done in a PTS flotation cell. The flotation

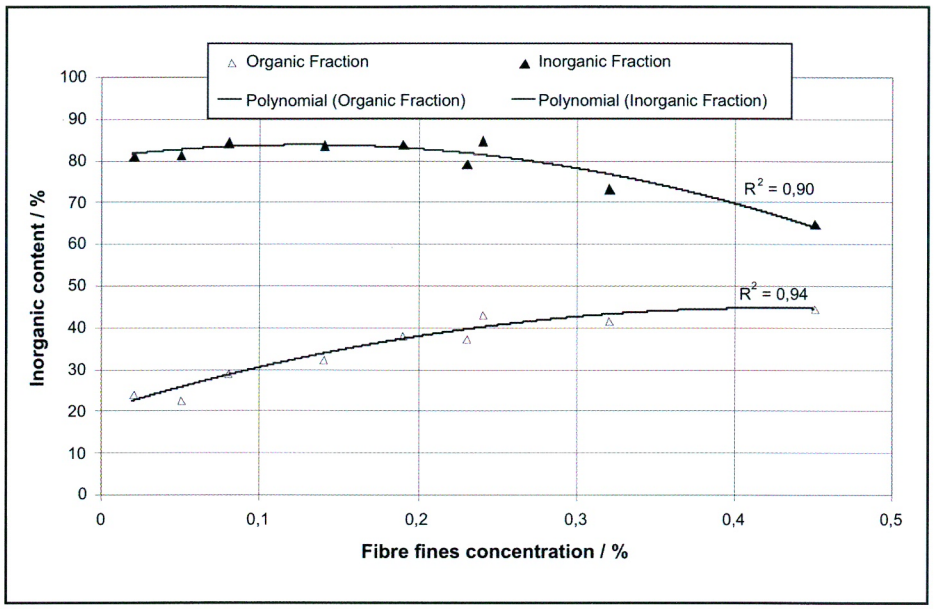

Fig. 2: Inorganic content of the organic and inorganic fraction depending on the fibre fines concentration

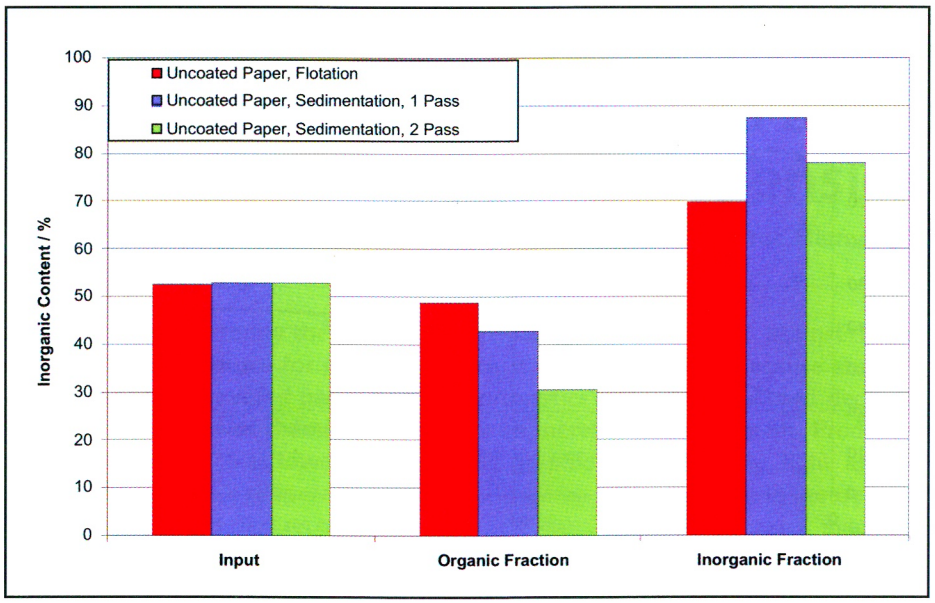

Fig. 3: Inorganic content of the uncoated paper before and after separation in the PTS flotation cell and in the conical sedimentation cell

chemicals were the standard recipe of the Ingede Method 11 [3].

Results and discussion

The first examinations in the wedge-shaped sedimentation cell showed that the fibre fines form flocks which settle faster than inorganic particles. The fibre fines orientate themselves and agglomerate to flocks. But, the flocks grow to a limited size. The more fibre fines are in the suspension, the more flocks form – albeit not of larger size. This phenomenon, that fibres orientate themselves and agglomerate during the sedimentation discovered Kumar and Ramaro [4] as well as Herzhaft and Guazelli [5]. The orientation and agglomeration of fibre fines in recovered paper suspensions describe Feist et al. [6].

Due to their flocculation the fibre fines settle faster than the inorganic particles, although the inorganic particles possess the higher specific gravity. This difference in settling velocity allows solving the separation task by using sedimentation. One requirement for separation is that the fibre fines are not bound with the inorganic particles. However, this requirement is not achieved in recovered paper suspensions. Retention agents and binders adhere to the fibres and fibre fines to the fillers and pigments. This adhesion is not destroyed sufficiently during the pulping process. Consequently, the fibre fines are loaded with inorganic particles. Thereby the fibre fines and inorganic particles show the same settling velocity and cannot be separated from each other. This phenomenon is described by Feist et al. [7] in the particle examinations of the uncoated and the coated paper. Without pretreatment the separation of the fibre fines from the inorganic particles is not possible.

To enable the separation of the fibre fines from the inorganic particles, the coated paper and the uncoated paper were treated thermo-mechanically in a kneader (Beken-Kneader). The effect of the kneading is also investigated by Feist et al. [7] in the manometer centrifuge. The thermo-mechanical pretreatment caused a slowing down of the average sedimentation velocity but also a widening of the sedimentation velocity distribution. This is a clear indication that agglomerates were destroyed. The comparison with the separation results in the wedge-shaped sedimentation cell shows that agglomerates between fibre fines and inorganic particles were destroyed as shown in Fig. 1. After this thermo-mechanical pretreatment the separation between fibre fines and inorganic particles is possible.

After the necessity of the pretreatment had been detected, important parameters which influence the separation were identified. Next to the fluid flow ratio, the most important parameter is the concentration of fibre fines. Insufficient fibre fines generate a decline of the separation effect, because not all fibre fines get into a flock anymore. Too many fibre fines also lead to a decline of the separation effect, because the fibre fines embed more and more inorganic particles in the flocks through the strong flocculation and the flocks disturb themselves more and more in sedimentation. The relationship between fibre fines content and separation effect is shown in Fig. 2. This basic relationship is applied for all counter-flow sedimentation cells. But the

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position of the curve depends also on the cell geometry and on the operational mode.

Because the wedge-shaped sedimentation cell has geometric disadvantages and could only be used batch wise, a conical sedimentation cell was built which could be operated continuously. With this conical cell comparative trials were carried out between the sedimentation process and the flotation process with the uncoated paper. Before the separation process in the sedimentation cell and in the flotation cell, the uncoated paper was pretreated in the Beken-Kneader. The flotation trials were done in the PTS flotation cell with the standard chemicals of Ingede Method 11. The trials showed that the flotation is not very selective. The sedimentation process outclassed the flotation process in the separation effect under these conditions as Fig. 3 shows. Fig. 3 displays the separation results of the uncoated paper in the PTS flotation cell and in the conical sedimentation cell. In the trials with the sedimentation cell the organic fraction was recovered (1 pass) and fed again into the sedimentation cell (2 pass). With the second pass further inorganic particles could be removed which during the first pass embedded in the fibre fines flock.

The counter-flow sedimentation process can solve the separation task, but this sedimentation process only has a low capacity. An economical use is doubtful. If it is possible to transfer the separation in the centrifugal field, the separation might be economically useful. ■

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