Removal of residual stickies at Haindl Paper using new flotation technology

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REMOVAL OF STICKIES

ABSTRACT

Processing 1900 a. d. metric tons per day of recovered paper makes Haindl Paper in Schongau, Germany, a very large paper deinking mill. The mill started to use an innovative, dual approach to improve removal of residual stickies in their recycling process. Instead of the traditional approach focusing on pressure screening technology, new injector (aeration element) technology upgraded the existing two-stage post flotation module. Removal efficiency of residual stickies increased from 45% to 60%. After performing additional mill trials with a pilot flotation cell, Haindl Paper found merits in a new flotation process application—floating residual stickies from the fine slotted tailing-screen accepts. Stickies removal efficiency was then 70%.

Application:

Monitoring residual stickies in a large deinking mill proved that new flotation injector technology applied in post flotation after a dispersion module increased removal of residual stickies. It also removes residual stickies in the fine slotted tailing screen(s). This is an innovative application for a flotation module whose traditional role has only involved removal of printing inks and toners.

THE USE OF RECOVERED PAPER by U. S. mills has increased almost 70% since 1990 (1). Between 1992 and 2000, more than US$ 10 billion will go to develop processes that produce recycled paper used in place of virgin fiber paper. The building of ten new deinking mills in the United States in 1994–1996 supports this (2). Most of these new mills are processing wood-free recovered paper for printing, writing, and tissue grades. The challenge for the future will not be recovery of paper or increasing recycled pulp capacity. Quality of paper recovered will be the challenge. This will increase collection and recovered paper separation costs in the three countries that comprise the North American Free Trade Association (NAFTA).

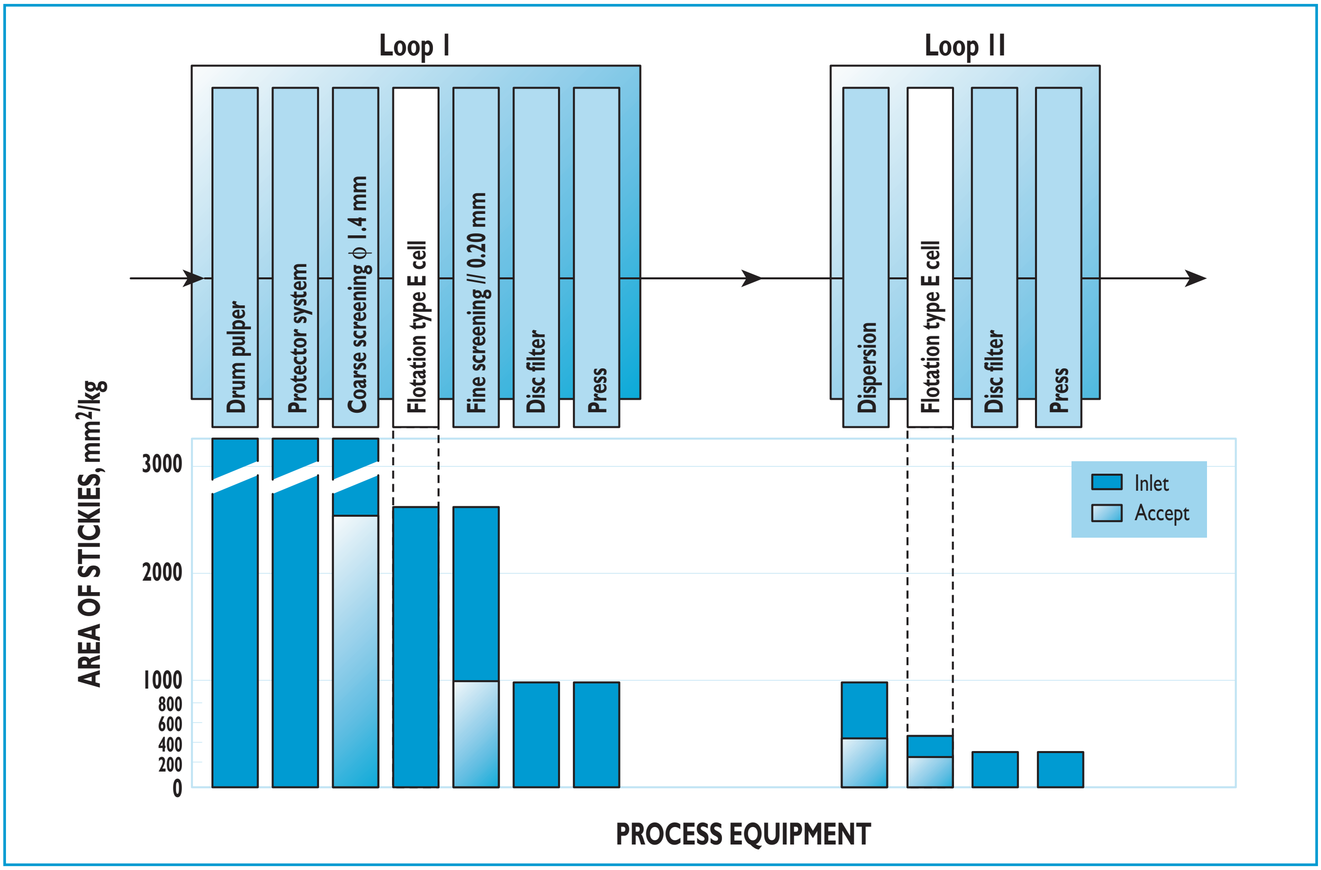
Effective use of capital is a major problem in the North American paper industry *(3)*. Shareholders and investment houses are now aware that the paper industry as a whole has not covered its cost of capital over the last decade *(4)*.

Upgrading existing recycling processes rather than adding recycled pulp capacity or investing in new sorting facilities will be the driving force of investment capital in the next decade. This approach will not only improve final pulp quality but also expand North American industry resources by allowing recycling of lower quality paper grades. These benefits are possible with a moderate capital investment. This economical approach will give most companies an opportunity to meet the challenge of competing with virgin hardwood pulp cost effectively. In Europe, the economical and technical efforts focus on using recovered paper in value-added mechanical grades like supercalendered (SC) and lightweight coated (LWC) publication papers *(5, 6)*.

Most North American recycling processes achieve pulp quality specifications for target brightness and cleanliness. The paper industry perceives stickies as the primary culprit in recycled pulp. Stickies negatively influence paper machine runnability and increase downtime. They also create problems in a converting operation and decrease the appearance and performance quality of a finished paper or paperboard. Stickies cost the U.S. paper industry US$ 650 million per year *(7)*. The paper recycling industry in the United States is therefore endorsing the current efforts of the U.S. Postal Service to unite adhesive companies, machine manufactures, and recycling mills to promote the design of recyclable, benign pressure sensitive adhesives for postal applications *(8)*. Elaborate recycling systems can achieve more than 99% removal of macrostickies *(9)*. Macrostickies remain on an atmospheric 0.10 or 0.15 mm slotted laboratory screening device (unpressurized). Microstickies pass through the slots with the filtrate. Haindl Paper designates the microstickies and remaining macrostickies in the accepts of a fine slotted pressurized screening system as residual stickies. In simplified terms, residual stickies are those stickies that have passed through the fine slots of a pressure screen basket.

Experience at the Haindl Paper mill suggests some new economical solutions for removing residual stickies. This process of upgrading machinery in flotation definitely improves residual stickies removal within the recycle process.

When investigating avenues to combat stickies, fine slotted pressure screening first comes to mind. The development of the fine slotted pres-



1. 1966 reduction in stickies area—Schongau Mill

sure screening technology during the last fifteen years has received considerable attention. For example, basket slot sizes have decreased from 0.35 mm (0.014 in.) to 0.10 mm (0.004 in.), and new basket, rotor, and housing designs have appeared in the equipment market *(10)*. The need to remove macrostickies in processing recovered paper drove all these technological advances.

Low consistency fine slotted screens can remove macrostickies within a 70%–95% efficiency range. Using improved flotation deinking technology in certain process locations can partially remove residual stickies. The most recent research work by the Centre Technique du Papier (CTP) in Grenoble, France, revealed that flotation of stickies depends strongly on size, shape, surface properties, and hydrodynamic flotation parameters of the stickies *(11)*.

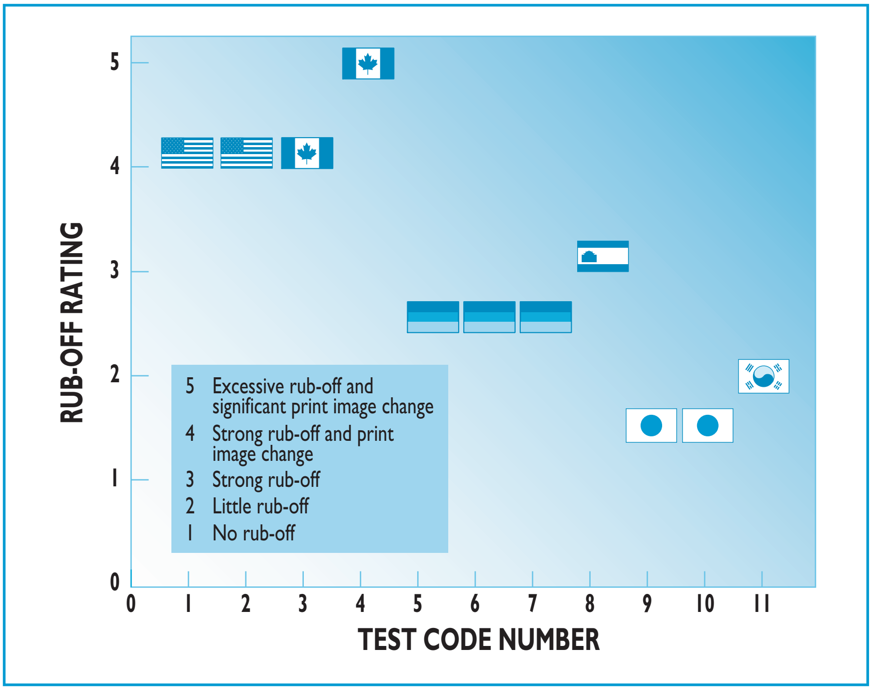
One flotation deinking technology advance during the last two years was the introduction of a new flotation aeration element. Using this new technology expands ink and toner removal size range and improves the efficiency of selectively removing ash and stickies *(12)*. Application of this flotation aeration element to remove residual stickies hinges on selecting the correct process placement for this piece of equipment.

DEINKING PROCESS AT HAINDL PAPER

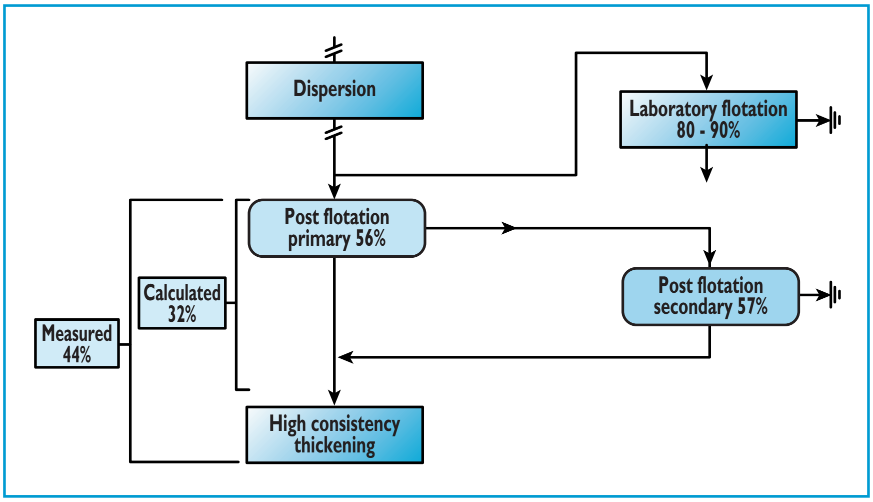
Haindl Paper in Germany is Europe's largest privately owned pulp and paper company *(13)*. A description of this European company and their recycle process is available elsewhere *(5)*. A brief process description is necessary here to visualize the integration of the pre and post flotation in the complete recycle process. Discussing processed recovered paper and final paper products have interest to the North American audience.

The recovered paper they process contains 60% old newsprint (ONP) and 40% old magazines (OMG). In Germany, newspapers have a higher filler content compared with North American newspapers. For example, German newspaper having a filler content exceeding 10% is common.

Traditional fatty acid deinking chemistry is applied to a drum pulper. The drum pulper accepts are pre-screened with the three-stage, holed pressurized screening system of **Fig. 1**. The remaining process modules are a two-stage pre flotation, three- stage fine screening, high consistency hot dispersion, two-stage post flotation, and thickening for water circuit separation. Note that no additional deinking chemistry occurs before post flotation.



2. Rating of rub-off inks



3. 1996 post flotation macrostickies removal

All screening and flotation stages follow the "feed-forward" concept meaning the second and third stage accepts do not cascade back. The final pulp used on three paper machines have a 20% thermomechanical pulp (TMP) content. The annual production of the three machines is 560,000 tons. Examples of final products are newsprint, telephone directories, upgraded newsprint, and on-line manufactured supercalendered category B (SC-B) grades for rotogravure printing *(14)*.

MILL TRIALS AND EQUIPMENT UPGRADES

Focusing on the potential of removal of stickies by upgrading flotation equipment required a systematic approach of applying pilot flotation and other equipment in various process locations. Haindl Paper`s systematic approach covered the following flotation applications:

- Pre flotation: Upgrading secondary cells for brightness and cleanliness improvement
- Post flotation after dispersion to upgrade the following:
  - Secondary cells for removal of stickies and brightness improvement
  - Primary cells for removal of stickies and brightness improvement
- Pre flotation loop: slotted tailing screen accepts (S3).

MILL EXPERIENCES WITH PRE FLOTATION: NO SIGNIFICANT REMOVAL OF STICKIES UNDER CURRENT PROCESS CONDITIONS

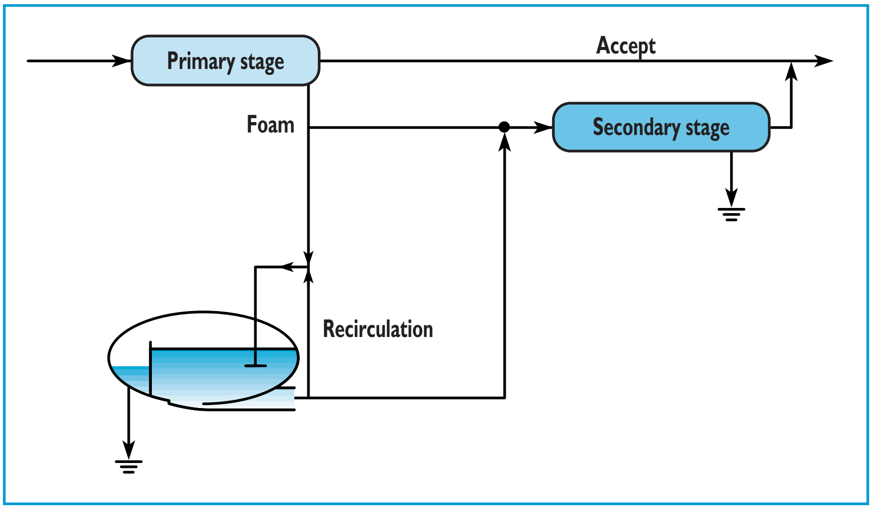
Using the process in Fig. 1, Haindl Paper did not remove macrostickies in the pre flotation module with the current size distribution of stickies, water circuit design, and applied deinking chemistry. The disc filter clear filtrate has use as dilution water before flotation, and the cloudy leg filtrate returns to the drum pulper.

The flotation system at Haindl's Schongau mill has flotation cells with an elliptical design. Stacking the units minimizes space requirements. The testing program for Haindl Paper's stickies around the post flotation module revealed that this module was already providing macrostickies removal. A logical step therefore involved investigating the possibility of enhancing removal efficiency by upgrading post flotation equipment. The company adopted this approach rather than invest in changing water circuits and deinking chemistry in the pre flotation loop.

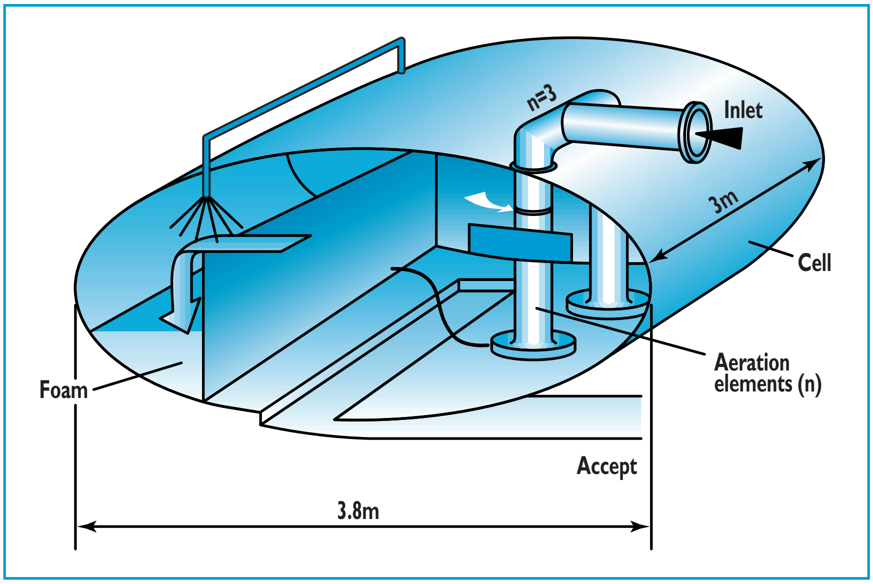
POST FLOTATION UPGRADE: IMPROVED REMOVAL OF STICKIES

Dispersion and post flotation are very common process modules in European newsprint and magazine deinking systems. North American ONP/OMG deinking systems usually have a single stage flotation and soft wash loop due to the different offset printing ink composition in North America.

Selder *et al.* showed in their research that North American black offset ink contained a higher mineral oil and a lower vegetable oil content compared with European inks. In



4. Post flotation location of pilot cell



5. Schematic of pilot cell

addition, Europeans are using low rub-off inks as **Fig. 2** shows. This requires a dispersion step to separate these inks from the fiber mechanically *(15)*.

The existing post flotation module of Haindl Paper's recycled paper process in **Fig. 3** was removing 32% of stickies. The primary stage removed 56% of stickies, and the secondary stage removed 57%. Since the stickies concentrate in primary rejects and secondary accepts are sent forward, the total module efficiency is lower *(14)*.

Tests with a model flotation lab cell showed much higher potential removal of stickies at 80%–90% for the primary and secondary post flotation stages. These tests used the following conditions:

- Pulp as received from post flotation feed
- No additional surfactant
- Laboratory flotation time of 20 min (hyper flotation)
- Reject loss 20% by mass.

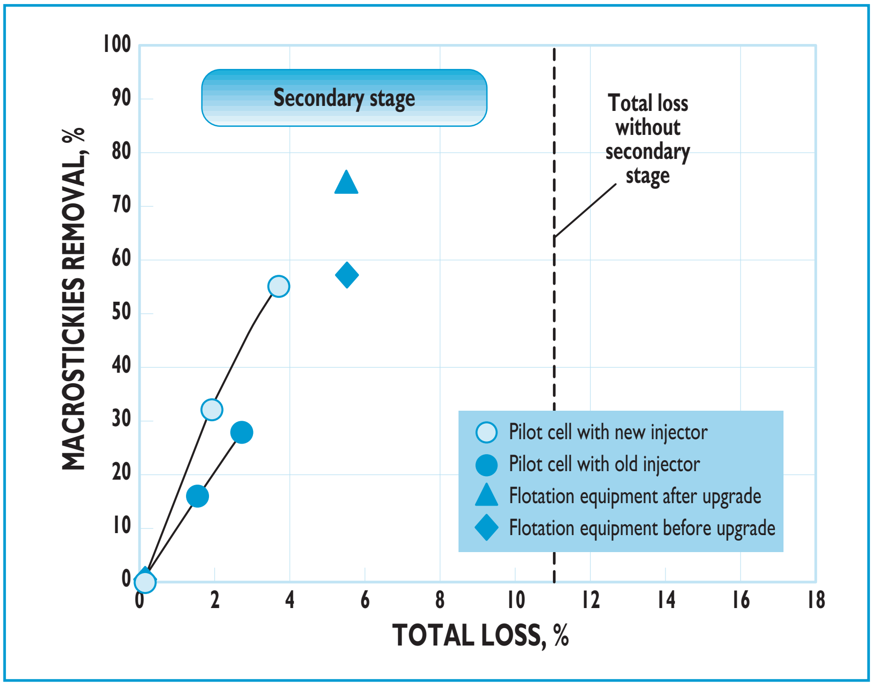
Using these promising laboratory results, a pilot cell model was first installed in parallel with the secondary stage feed flow as **Fig. 4** shows. This pilot cell had the newly designed injector. **Figure 5** Illustrates the pilot cell with three aeration elements and a horizontal ellipse diameter of 3.8 m. **Figure 6** summarizes the results from the trials and the rebuild. The macrostickies removal efficiencies are lower compared with the bench type flotation results because the flotation reject rate and retention time are lower in the pilot cell and in the rebuilt mill equipment. Test runs also involved feeding this pilot unit with post flotation feed pulp. Varying the feed pressure, hydraulic pulp flow, and injector designs helped to optimize removal of macrostickies and ink.

After the successful trials, Haindl Paper upgraded the existing post flotation cells with new injectors. The secondary unit underwent upgrading in 1997 followed by the primary stage in 1998. **Figure 7** gives the average historical data for 1996–1998 showing a consistent improvement of removal efficiency for macrostickies after each upgrade.

TAILING SCREEN ACCEPTS FLOTATION: ADDITIONAL REMOVAL OF STICKIES

After the successful upgrade in the post flotation module, Haindl Paper refocused on the pre flotation loop. As previously noted in the process description, the Haindl process is a "feed-forward" method compared with the traditional "cascade-back" process. For example, the third stage 0.20 mm (0.008 in.) fine slotted screen accepts are sent forward and combined with first and second stage accepts.

Laboratory flotation trials of the tailing screen accepts showed more than 80% removal of stickies. This 80% value refers to the lab flotation feed. Laboratory flotation conditions were identical to those described in the previous section covering the post flotation upgrade. After these promising results, the company installed the pilot flotation cell as **Fig. 8** shows. **Figure 9** shows that the installation achieved a 70% removal efficiency at a 15% reject rate. Using these findings *(16, 17)*, Haindl Paper installed this new process concept in their Schwedt mill location. The Schongau mill will install new flotation equipment when the data from the Schwedt installation is available and the unit proves the concept.



6. Trial results

DISCUSSION OF RESULTS

Because deinking chemistry and water circuits were not variables during the trials and upgrading, the results from the Schongau mill experience require analysis considering only the process location and machine design. The following questions arose:

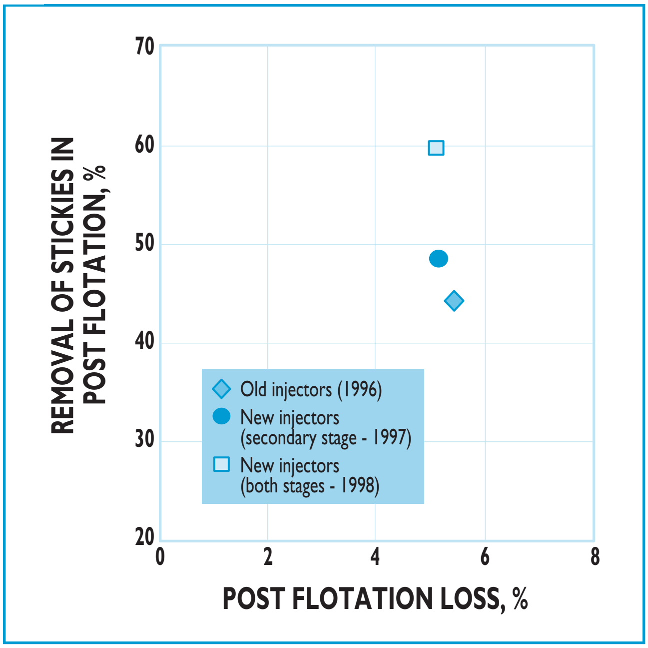
- Why did the macrostickies not float in pre flotation?
- Why did most macrostickies float in post flotation?
- Why did macrostickies float in the tailing screen accepts?

Three differences existed between pre and post flotation:

- Higher surfactant and ink concentration with larger stickies in pre flotation
- Lower surfactant and ink concentration with smaller stickies in post flotation
- Hot dispersion module between pre and post flotation.

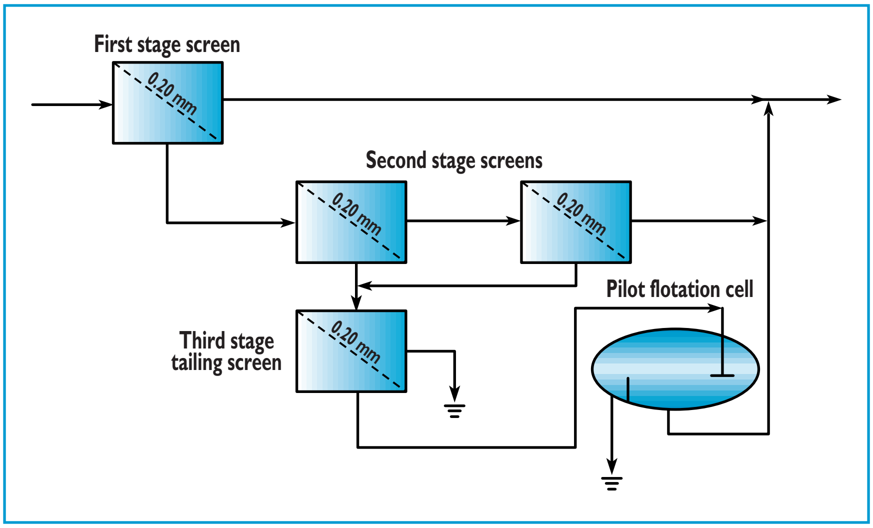
After heat setting the stickies, the average area of macrostickies was 0.95 mm^2 in the pre flotation feed and an average area of stickies of only 0.29 mm^2 in the post flotation feed.

The lower surfactant and ink concentration with smaller stickies is also true for the tailing screen flotation application. The reason is that the residual surfactant and ink after the pre flotation module are washed through the first and second stage pressure screen accepts following the hydraulic water splits as Fig. 8 shows. Dilution water is also added in the second and third screening stage to lower the surfactant and ink concentration more. Using this mill experience, one can conclude that deinking chemistry concentration, ink concentration, or both and size of stickies have impact on the floating ability of macrostickies.

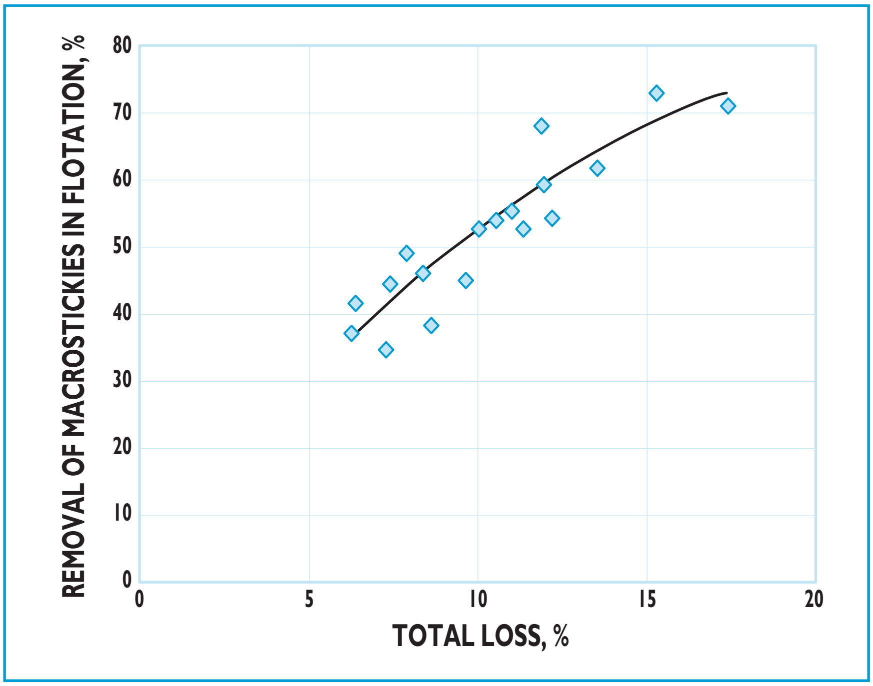


7. Historical data

The newly designed aeration injectors remove more than 90% of the ink particles from 10–150 µm. Haindl Paper personnel think that the new injectors remove not only macrostickies but also microstickies *(18)*. As a result, runnability of the paper machine increases. This belief is synonymous with the sub-visible and near-visible ink removal efficiency data. Unfortunately, the paper industry does not have a convincing method to quantify microstickies *(19)* to prove this hypothesis of an ample reduction of microstickies.



8. Process location of pilot flotation cell



9. Flotation of tailing screen accepts

Supporting the removal of macrostickies in flotation is the installation of a hot disperser module between pre and post flotation. The high shear disk disperser reduces the total number of macrostickies and the specific area of stickies per kg o.d. pulp. Research work by Mannes testing an OMG/ONP furnish has verified the reduction of the number and the total area of macrostickies. Measurement of the stickies used a slotted laboratory screening device. Depending on disperser power input and temperature, reductions of stickies area decreased 60%–95% *(20)*. A reduction in the number of macrostickies can only mean that the form and size of the macrostickies have changed to allow them to pass the slots of the laboratory screening device. After changing the shape and downsizing the macrostickies, CTP research findings clearly demonstrate that applying flotation at that point outperformed screening or cleaning technologies *(11)*. The Schongau installation of the new aeration elements in the post flotation module proved these findings.

CONCLUSIONS

New flotation injector technology applied in post flotation shows promising results in removing residual stickies when a dispersion module is between pre and post flotation. After successful mill trials with pilot equipment, the first commercial installation will prove a new application of flotation removing residual stickies in fine slotted tailing screen accepts.

By focusing on an equipment upgrade approach and adding minimal additional equipment, Haindl Paper improved recycled pulp quality and runnability of paper machines. Flotation can also complement fine slotted pressurized screening technology in the unending battle of economically removing residual stickies from a recycle process. We believe North American recycling mills have an untapped potential to improve their processes by upgrading flotation equipment and finding new applications. **TJ**

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