Stickies Monitoring at a Newsprint and Packaging Mill

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INTRODUCTION

One of the many challenges facing paper manufacturers both globally and in South Africa is the problem of stickies in recovered paper. Stickies refer to the tacky hydrophobic, pliable organic materials found in recycled paper systems (Putz, 2000; Hoekstra *et al.,* 2001). Although there are no figures available in South Africa, it has been estimated that stickies-related problems are costing the United States paper industry several million US dollars per year (Friberg, 1997; Bajpai, 2006). This is mainly due to product quality problems such as holes, dark spots and reduced strength of the finished product (Putz, 2000; Sitholé & Filion, 2008). Runnability problems such as sheet breaks that arise due to deposits on the wire, felts, press rolls, drying cylinders and calenders also result in long periods of downtime for cleaning (Friberg, 1997).

In response to a questionnaire that was developed by the CSIR's Forestry and Forest Products (FFP) Research Centre and distributed within the recycling sector of South Africa, many paper recycling mills highlighted the measurement and removal of stickies as an area of concern for their operations. Stickies are derived mainly from pressure sensitive adhesives (PSA), hot melt adhesives (HMA), or a combination of both. Pressure sensitive adhesives are used in labels and tapes and appear tacky and flexible at room temperature. Hot melts are used in bindings and are usually solid at room temperature. Other main sources of stickies include printing inks and coating binders. Generally, stickies are classified as either *primary* or *secondary* (Sarja *et al.,* 2004). *Primary stickies* remain solid throughout the papermaking process, and are further classified into macrostickies (>100μm in size) or microstickies (<100μm in size) (Doshi & Dyer, 2000). *Secondary stickies* originate from agglomeration of dissolved or colloidal substances as a result of abrupt physico-chemical changes in process conditions (*e.g.* temperature shock, pH shock, addition of cationic poly-electrolytes, *etc.*). *Potential secondary stickies* are the colloidal or dissolved substances that have not yet formed secondary stickies but have the potential to do so (Carré *et al.,* 1998). A schematic description for the size classification of stickies is given in Figure 1. This size classification is important as it influences the strategies for removing each size class, and also influences the approach taken for minimising their effects on papermaking (Doshi & Dyer, 2000).

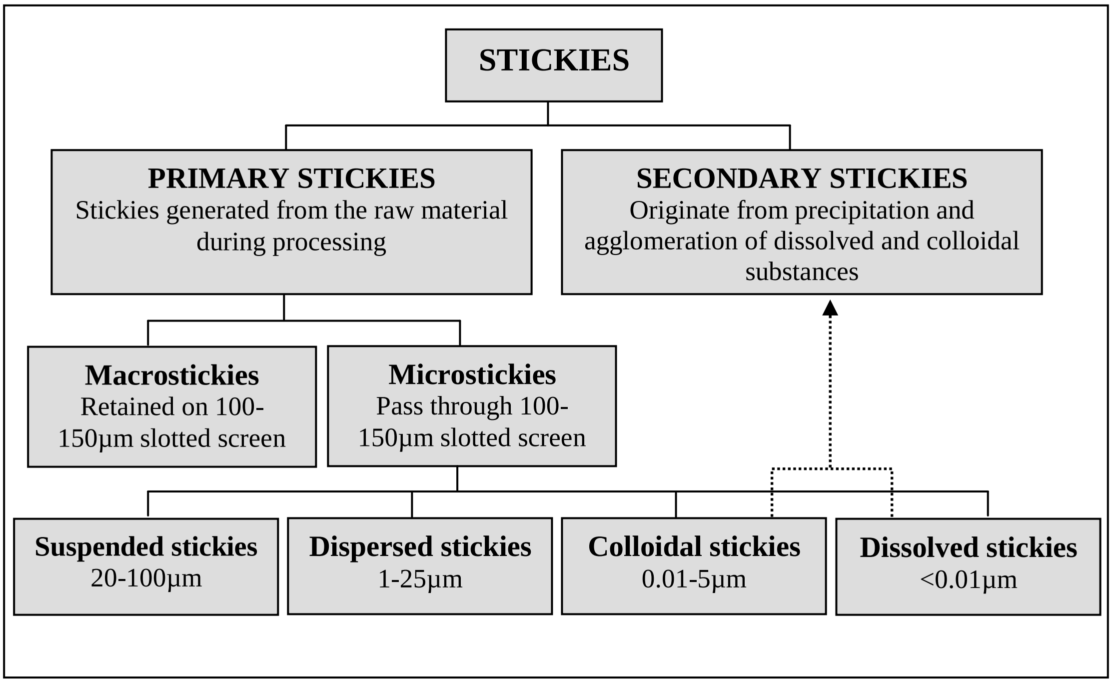

Figure 1. Size classification of stickies (Doshi et al., 2003).

The literature is replete with methods for the measurement of macrostickies and microstickies in recycled pulps. For some examples, see Doshi *et al*. (2003), Sitholé & Filion (2008) and Doshi (2009). In the case of macrostickies, there are three standardised methods available – TAPPI standard method T277, INGEDE (International Association of the Deinking Industry) method 4, and a method by the International Organisation for Standardisation (ISO) that is based on either visual inspection (ISO 15360-1:2000) or image analysis (ISO 15360-2:2001) of the screenate. Most South African mills utilising recovered fibre in papermaking are currently quantifying macrostickies using a screening method that is based, in part, on the TAPPI standard method T277. In this method, the sample is screened to separate/concentrate the macrostickies from the pulp, followed by heat-setting of the macrostickies between a black filter paper and coated paper, and finally the macrostickies are quantified by image analysis. Following the concentration step there are several divergent methods for analysing the macrostickies in the screenate, with most mills following the procedure described by Aquan-Yuen *et al.* (1999). This procedure involves lamination of the filter paper containing the screenate and subsequent quantification of macrostickies by image analysis. In the case of microstickies and potential secondary stickies, there are no standard methods available for measurement, and very few, if any, paper recycling mills in South Africa carry out these measurements on a regular basis. Some of the shortcomings of existing methods for measurement of macrostickies and microstickies that were highlighted by mill personnel during the survey included: (1) poor definition of stickies – depending on the size of the screening device macrostickies can be defined as larger than 75, 100 or 150*µ*m; (2) long turn-around times; (3) the procedures are labour intensive and complicated; (4) in some instances there is need for sophisticated equipment and expertise; and (5) procedures often have poor separation of macrostickies and microstickies. Consequently, measurement of macrostickies and microstickies at some mills is not carried out on a regular basis. This results in lots of missing data, poor monitoring and incomplete understanding of the process with regards to stickies.

As a result of this, mill personnel have expressed their need for methods that are simple and quick and which can be easily implemented in a mill environment. In addition, the methods should not require significant capital investment. In response to this need, the CSIR developed methods that are based on existing methods in the literature but which have been modified to meet the requirements mentioned above. The objective of this study was to demonstrate the applicability of the new methods by undertaking stickies audits in a newsprint and a packaging mill to test the sensitivity of the methods to detect changes in the concentration of stickies at various stages in the process. The efficiency of the new methods was also compared with existing methods that are available in the literature for measurement of stickies.

MATERIALS AND METHODS

Measurement of Macrostickies

The procedures described by Houtman and Tan (2002) and Aquan-Yuen *et al.* (1999) were combined and modified to measure macrostickies. The new method was verified using the TAPPI standard method T277.

Measurement of Microstickies

Methods described by Allen (1997) and Huo *et al.* (2001) were combined and modified and used to measure microstickies. The new method was verified by turbidity readings of the process waters.

Measurement of Potential Secondary Stickies

Dissolved and colloidal substances were precipitated after pH shock and measured using the method described for microstickies. The method was verified using the procedure described by Sarja *et al.* (2004) that was developed for measurement of potential secondary stickies.

Process Description of Packaging Mill

The packaging mill that participated in this study recycles old corrugated cardboard (OCC) to produce fluting and testliner. Waste bales of OCC are fed into the re-pulper where a ragger rope removes long wire, plastics and other elongated materials. On a side stream the detrashers remove shorter wires and smaller plastics. The accepts from the detrashers are re-circulated back to the re-pulper. The re-pulper then pumps the stock to the dump chest via the high density cleaners which removes small heavy particles such as staples. From the dump chest, the stock is pumped to the primary coarse screen (2.2mm holes). Accepts from here enter the first intermediate chest. Rejects are directed to a secondary coarse screen (2.2mm holes) via a supply tank. Accepts from the secondary coarse screen are directed to the first intermediate chest. Rejects are directed to a tertiary coarse screen (2.0mm holes) via a supply tank. Accepts from the tertiary coarse screen go to the first intermediate chest. Rejects go to trammel and are discharged to a skip. The first intermediate chest pumps the stock to the fractionator (0.25mm slots) where the pulp is divided into two streams: short fibre stream (60%) and long fibre stream (40%). After fractionation, the short fibre stream is thickened and stored in the short fibre storage tank. The long fibre stream is further screened in the fine screens (two units in parallel). The accepts from the primary fine screens (0.25mm slots) go to the thickener before going to the long fibre storage tank. The rejects go to the reject tank which pumps the stock to the secondary fine screens (0.25mm slots). The accepts from here go to the thickener before going to long fibre storage tank. The rejects after secondary fine screens go to the tertiary fine screen (0.25mm slots). Rejects from here go to the hydra-screen. Accepts go to light reject cleaners. Accepts from the light reject cleaners go to long fibre intermediate chest (supply tank for the fractionator) and rejects go back to the hydrascreen.

Process Description of Newsprint Mill

The newsprint mill that participated in the study recycles old newspapers (ONP) and sorted books and magazines (SBM). The ratio of the furnish that is fed into the high consistency re-pulper is 65% ONP and 35% SBM. In addition to hydrogen peroxide, sodium silicate and soap, caustic soda is added to the re-pulper to adjust the pH to 9–10. After re-pulping, the stock is diluted and dumped through a poire coarse screen (6mm holes) where large contaminants such as plastics, wire, *etc.* are removed. The accept stock is pumped to a dump tank and rejects are discharged to a skip for disposal. Two-stage high density cleaners are then used to remove larger, heavier contaminants such as staples by centrifugal action. The accept stock goes to a coarse screen feed tank, whilst the light rejects are sent to the secondary high density cleaners for further processing to recover fibre. The heavy rejects go to the heavy separator. During coarse screening, the stock is forced under pressure through primary coarse screens (1.6mm holes) to separate contaminants larger than the hole size from the fibre suspension. The rejects from primary coarse screening are further processed in secondary and tertiary coarse screens to recover fibre. The accepts from coarse screening go to the flotation feed tank. During flotation, ink is removed using soapy air bubbles. The bubbles act as collectors for the ink particles which attach to the bubbles and float to top of the flotation cells where the inky bubbles are removed by overflow. Rejects from the primary flotation cell are then sent to the secondary cell for further processing to recover fibre. The accept stock is sent to the first stage centrifugal cleaners where contaminants such as minerals, sand and grit are separated from the fibre according to density differences. The accepts from here go to the fine screens. The rejects from the first stage centrifugal cleaners are then further processed through three more stages of centrifugal cleaning. Rejects from the fourth stage are sent to the heavy rejects waste separator, and then to the waste skip. The pulp stream enters the fine screens (0.15mm slots) where the velocity decreases to allow the heavy material to settle out and collect at the bottom of the screens. The accepted stock flows to the disc filter to be thickened. During thickening, in addition to the removal of water, other chemical contaminants and some remaining ink particles and stickies are made less troublesome by the addition of talc. The stock is then fed to the double wire press and dewatered to around 27% consistency. The stock from the press is heated in the heating screw using low pressure steam to soften/dissolve stickies. At the heating screw outlet, the stock is fed into the disperser plates where stickies contaminants are finely dispersed throughout the pulp. Hydrosulphide, a reductive bleaching agent, is then added to the stock which is diluted and pumped to a storage tower ready to be fed onto the papermachine.

Sampling

Pulp samples were obtained at several points in the newsprint and packaging mill. For this study, samples were collected over a four-week period and average results were reported for macrostickies, microstickies and potential secondary stickies. Where applicable, samples were taken at the Re-Pulper (RP); Dump Chest (DC); Primary Coarse Screen Feed (PCSF); Primary Coarse Screen Accept (PCSA); Secondary Coarse Screen Feed (SCSF); Secondary Coarse Screen Accept (SCSA); Intermediate Chest (IC); Long Fibre Stream After Fractionation (LFAF); Primary Fine Screen Accept (PFSA); Secondary Fine Screen Accept (SFSA); Long Fibre Storage Tank (LFST); Out of Flotation (OF); Accepts after Centrifugal Cleaners (ACC); Before Wire Press (BWP); After Wire Press (AWP); Medium Consistency Pump (MCP); and Storage Tower (ST).

RESULTS AND DISCUSSION

Packaging Mill

The four-week averages for macrostickies concentrations at various stages in the process are shown in Figure 2A. The CSIR method used for measurement of macrostickies showed elevated levels at the re-pulper and at the secondary coarse screen feed. A decreasing concentration was observed at the dump chest and low levels at the primary and secondary coarse screens. These results are consistent with the expectation and understanding of the process. The re-pulper is the first stage of the process where the recovered waste paper is slushed into a suspension of individual fibres. No screening or cleaning occurred at this point and so the concentration of macrostickies was high. The decreasing concentration of macrostickies for the pulp sample taken at the dump chest may be due to removal of some macrostickies particles at the high density cleaner that preceded this stage. The low values for the accepts after primary and secondary coarse screening indicated good stickies removal efficiency of the coarse screens. The elevated stickies concentration found at the secondary coarse screen feed was expected as this was the reject stream after primary coarse screening.

After each stage of coarse screening, the accept streams were collected in the intermediate chest which then pumped the stock to the fractionator. After fractionation, the pulp stream was split into two, a short fibre (60% split) and a long fibre (40% split) component. Figure 2B shows the average macrostickies concentrations over the four-week period for the short fibre stream taken from the intermediate chest and further downstream to the short fibre storage tank. (Note the change in scale on the y-axis). The short fibre stream after fractionation showed low macrostickies levels which may indicate that the majority of macrostickies was retained in the long fibre stream. Beyond this point, the level of macrostickies remained fairly constant until the storage tank.

The average macrostickies concentrations in the long fibre stream are shown in Figure 2C. High levels of macrostickies in the long fibre stream after fractionation confirmed the low levels of macrostickies obtained for the short fibre stream after fractionation. Primary fine screening was found to remove a significant proportion of macrostickies. Elevated macrostickies in the accept stream after secondary fine screening may indicate some screening inefficiencies at this point. Results obtained from the sample taken at the long fibre storage tank indicated a decrease in macrostickies concentration. This may be due to a diluting effect as the two accepts streams from primary and secondary fine screening merge. In addition, some macrostickies could also have been removed during thickening.

The macrostickies results obtained using the CSIR method were verified against results obtained using the TAPPI standard method. Generally, there was good correlation and similar trends throughout the process were evident using both methods.

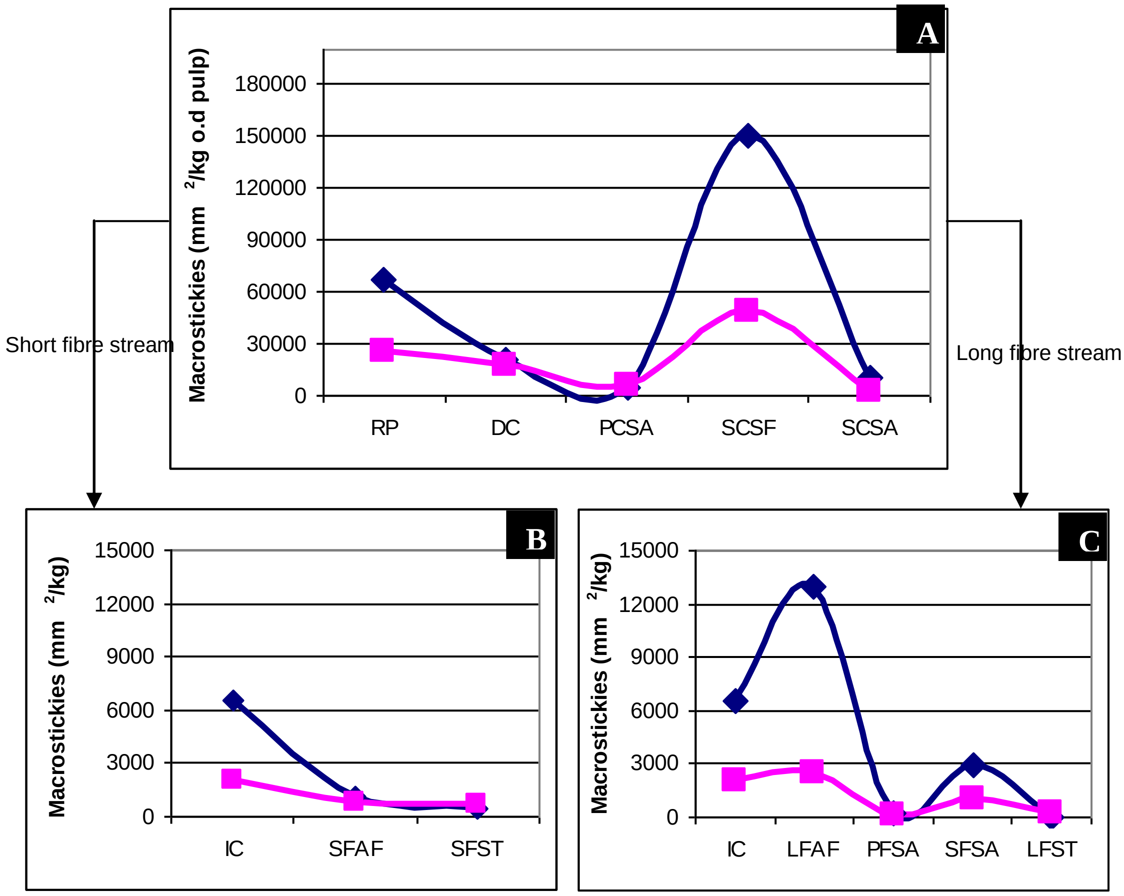

Figure 2. Macrostickies concentrations measured on pulp samples taken at various stages in a packaging mill recycling old corrugated cardboard. Macrostickies were measured using a modified method developed by the CSIR (♦) and the results were compared to that obtained with the TAPPI T277 standard method (■).

The four-week averages for microstickies concentrations at various stages in the process are shown in Figure 3A. The microstickies concentration remained at constant levels throughout the process. There was some removal of microstickies after primary coarse screening. The accept stream showed a decrease in microstickies concentration, whilst the reject stream after primary coarse screening showed an elevation of microstickies. In Figure 3A the secondary coarse screen feed is the primary coarse screen reject stream. The short fibre stream after fractionation (Figure 3B) remained at constant levels until the storage tank, where a slight decrease in microstickies concentration was noted. The long fibre stream (Figure 3C), on the other hand, showed elevated microstickies levels after primary and secondary fine screening which may indicate possible fragmentation of macrostickies into microstickies during fine screening. At the storage tank, microstickies concentration in the long fibre stream returned to the original levels found at the intermediate chest, possibly due to removal during thickening that preceded the storage tank.

Measurement of turbidity of the pulp filtrates show similar trends to microstickies measured directly.

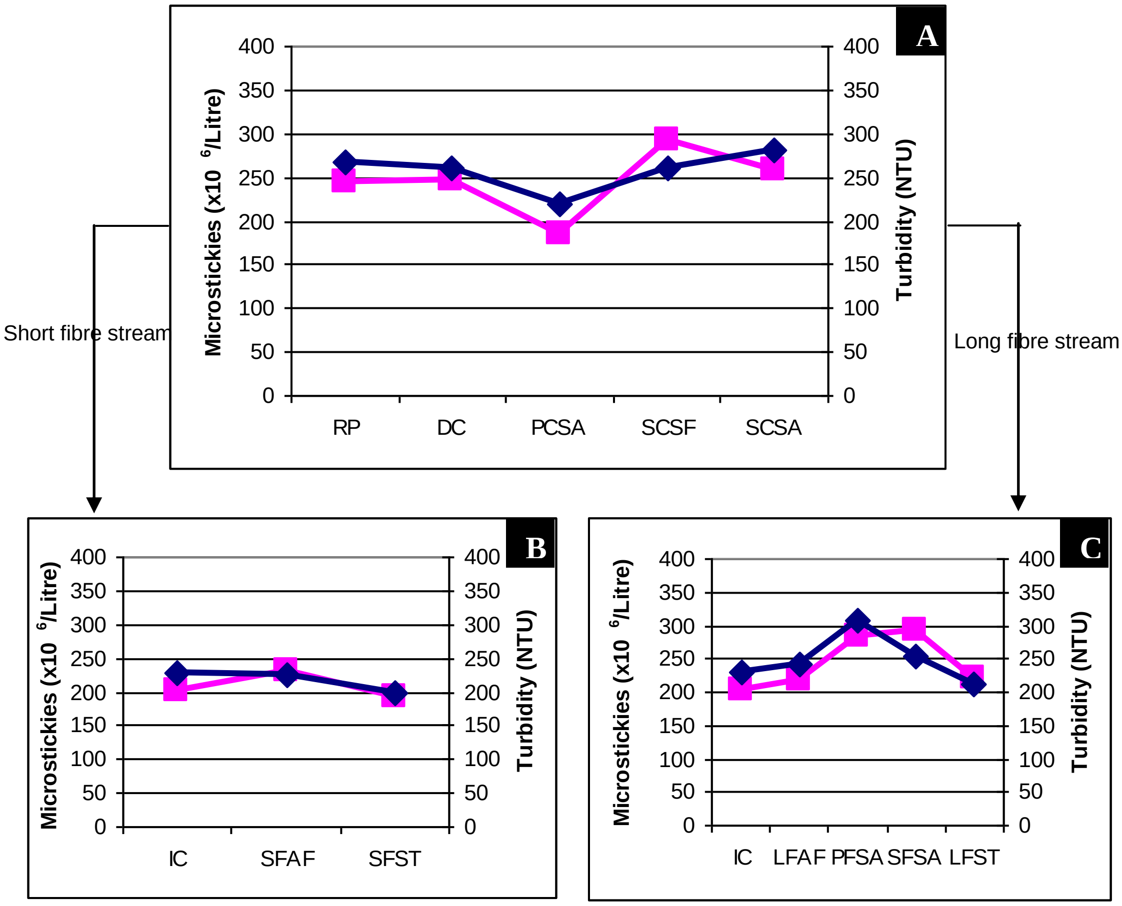

Figure 3. Microstickies concentrations measured on pulp samples taken at various stages in a packaging mill recycling old corrugated cardboard. Microstickies were measured using a modified method developed by the CSIR (♦) and the results were compared to turbidity measurements of the filtrates (■).

The four-week averages for potential secondary stickies concentration at various stages in the process are shown in Figure 4A. The levels remained constant from the re-pulper to after primary coarse screening. Beyond this point, there appeared to be a slight elevation in the concentration of potential secondary stickies which may be related to the increase in microstickies that was seen at this point in Figure 3A. The elevated levels of potential secondary stickies were also observed with the method developed by Sarja *et al.* (2004) to measure potential secondary stickies. Pulp samples of the short and long fibre streams taken after fractionation and further downstream showed that the concentration of potential secondary stickies remained constant. This trend was mirrored by the results obtained using the method developed by Sarja *et al.* (2004). However, the results obtained using the method developed by Sarja *et al.* (2004) did show a drop in the concentration for the sample taken at the long fibre storage tank.

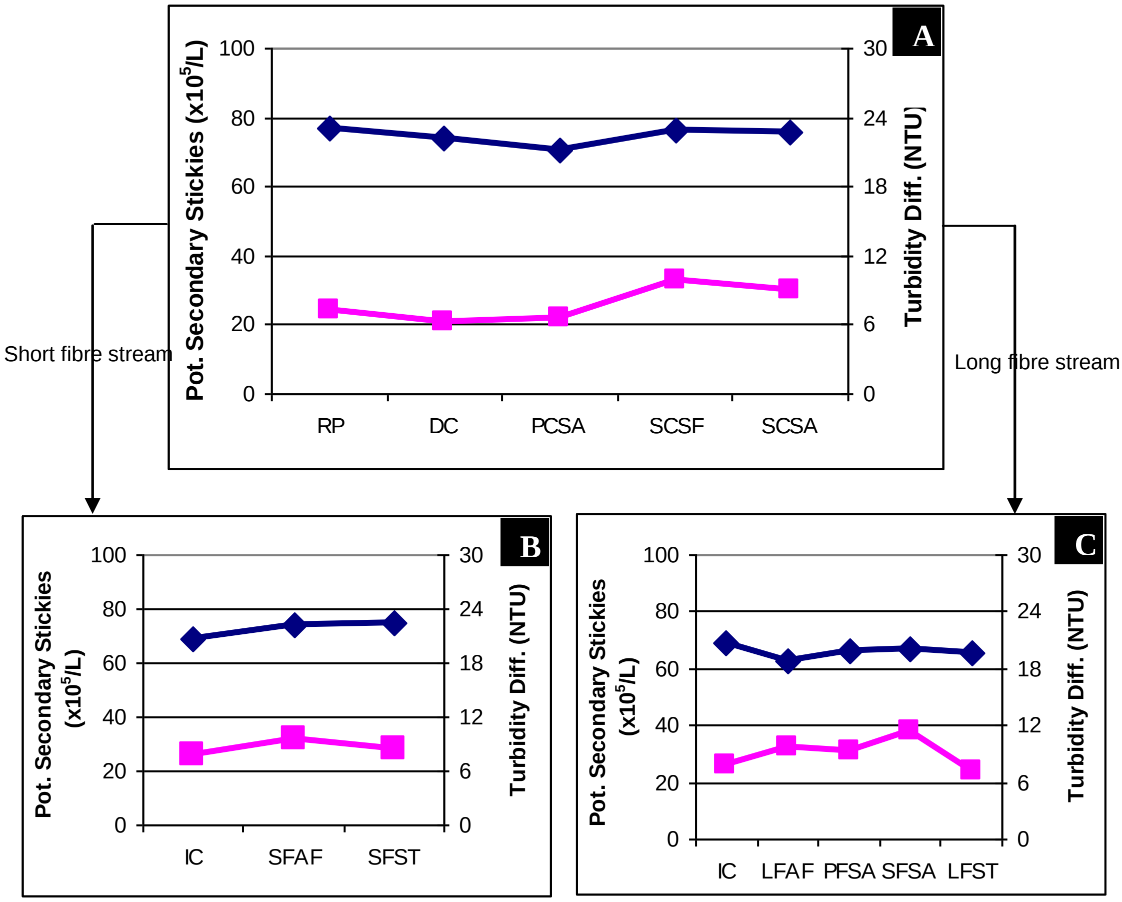

Figure 4. Potential secondary stickies concentrations measured on pulp samples taken at various stages in a packaging mill recycling old corrugated cardboard. Potential secondary stickies were measured using a modified method developed by the CSIR (♦) and the results were compared to another method (■) developed by Sarja et al. (2004) to measure potential secondary stickies.

Newsprint Mill

The four-week averages for macrostickies concentrations of pulp samples collected at various stages in the newsprint mill are shown in Figure 5. The macrostickies were measured using both the method developed by the CSIR and the TAPPI standard method T277. The TAPPI method showed that the concentration of macrostickies in the re-pulper was around 14 000mm^2/kg compared to 1000mm^2/kg obtained with the CSIR method. This large discrepancy between results could be related to the non-uniform distribution of macrostickies in the re-pulper and the high amount of contaminants that could interfere with the measurement. Beyond this point however, both methods showed similar results as the pulp was processed through the poire screens and high density cleaners. Elevated macrostickies levels were measured in the feed to coarse screening. There was a significant reduction in the macrostickies concentration after coarse screening indicating good efficiency of the screens. According to the results obtained with both methods, flotation deinking and centrifugal cleaning had little impact on macrostickies removal. However, as expected, fine screening performed well removing most of the macrostickies. Beyond this point the macrostickies concentrations remained at low and constant levels.

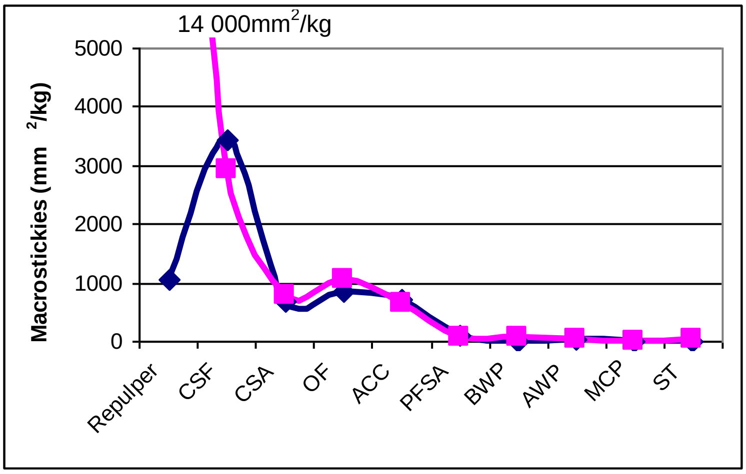

Figure 5. Macrostickies concentrations measured on pulp samples taken at various stages in a newsprint mill recycling old newspapers and sorted books and magazines. Macrostickies were measured using a modified method developed by the CSIR (♦) and the results were compared to that obtained with the TAPPI T277 standard method (■).

The four-week averages for microstickies concentrations of pulp samples taken at various stages in the newsprint mill are shown in Figure 6. A high concentration of microstickies was found in the re-pulper. At the coarse screen feed the concentration dropped significantly. Re-pulping was carried out at high consistency, so the decrease may be attributed to dilution of the pulp exiting the re-pulper prior to the poire screen and the high density cleaners. Beyond coarse screening, microstickies concentration remained at constant levels throughout the process until the wire press. After the wire press a distinctive increase in microstickies concentration was observed. This could be due to retention of microstickies in the pulp during thickening where the consistency of the pulp was increased to 27% prior to dispersion. For the pulp samples taken at the pump and storage tower, the lower concentration of microstickies could be due to dilution of the stock back down to 10-12% before the papermachine. A similar trend was observed with turbidity measurements in which elevated turbidity readings were recorded in the re-pulper and after the wire press.

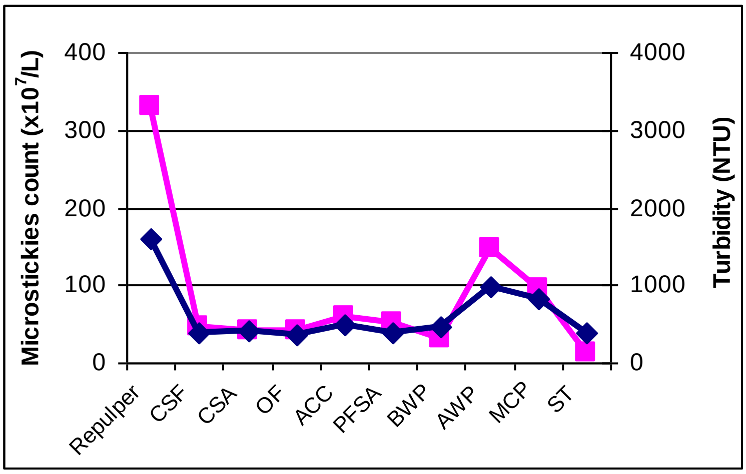

Figure 6. Microstickies concentrations measured on pulp samples taken at various stages in a newsprint mill recycling old newspapers and sorted books and magazines. Microstickies were measured using a modified method developed by the CSIR (♦) and the results were compared to turbidity measurements of the filtrates (■).

The four-week averages for potential secondary stickies concentrations of pulp samples collected at various stages in the newsprint mill are shown in Figure 7. Here again, elevated levels were found at the re-pulper which then dropped significantly for the pulp samples taken from the feed stream to coarse screening. Beyond this point, the levels of potential secondary stickies remained constant, with slightly elevated levels being recorded after the wire press. Similar to the findings for microstickies, this could be related to thickening of the pulp prior to the screw press and dispersion. A similar trend was obtained using the method developed by Sarja *et al.* (2004) for measurement of potential secondary stickies.

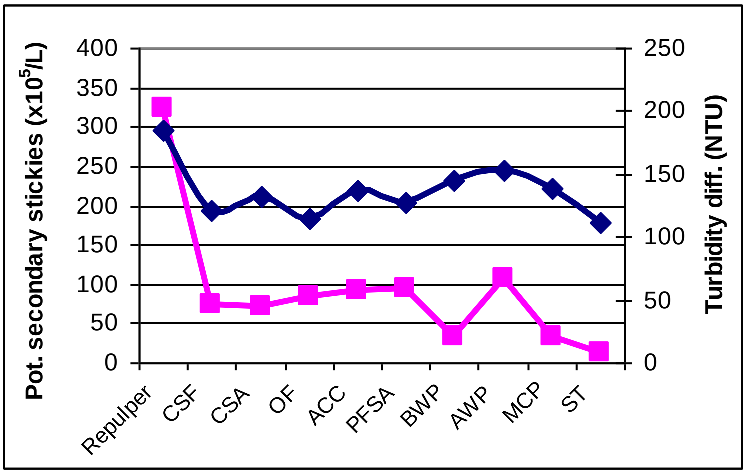

Figure 7. Potential secondary stickies concentrations measured on pulp samples taken at various stages in a newsprint mill recycling old newspapers and sorted books and magazines. Potential secondary stickies were measured using a modified method developed by the CSIR (♦) and the results were compared to another method (■) developed by Sarja et al. (2004) to measure potential secondary stickies.

CONCLUSIONS

Through a survey conducted by the CSIR's Forestry and Forest Products (FFP) research centre, the South African paper recycling industry expressed their need for quick and simple methods to measure macrostickies, microstickies and potential secondary stickies. In addition, the requirement was that the methods be easy to implement in a mill environment without the need for significant capital investment. Based on these requirements, the FFP research centre modified existing methods available in the literature to develop new methods to meet these requirements. In this study, the sensitivity of the new methods to detect changes in the concentration of macrostickies, microstickies and potential secondary stickies were evaluated on pulp samples collected throughout the recycling process of a newsprint and a packaging mill. In order to verify the results, the new methods were compared against existing methods. The results showed that the new methods compared favourably to existing methods. In addition, expected trends were observed and problem areas requiring optimisation were identified using the new methods. It is anticipated that the new methods will be suitable for mill personnel to monitor the levels of stickies throughout the process on a regular basis. It is envisaged that the data derived from regular monitoring will help mill personnel better understand their process in terms of total stickies concentration and aid in implementing measures to control stickies in their process.

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