A practical view of a microparticle system in supercalendered paper

Anne M. McCourt, Philip A. Ford, Thomas A. Cauley

ABSTRACT: This paper will outline the advantages of running a polymer/bentonite microparticle system on a 400 tons/day twin-wire paper machine making supercalendered printing paper. Prior to running the multi-component microparticle system, a single nonionic polymer system had been run with varying degrees of success. The current microparticle system uses three components comprised of a poly-DADMAC coagulant, a cationic polyacrylamide, and a modified bentonite clay. As a result, considerable improvements in performance, efficiency, and controllability have been obtained. This paper outlines the advantages of the system regarding first-pass retention, drainage, paper machine runnability, and paper quality.

KEYWORDS: Bentonite, microstructure, paper machines, particles, polymers, porosity, retention aids, runnability, supercalendered papers, water removal.

Shortly after the acquisition of our mill from Abitibi-Price in June 1984, the newly formed company, St. Marys Paper Inc., began the first phase of a 23 million improvement project. The plan was to convert production of the three existing paper machines from MF specialties, for which there was a limited future, to kaolin-filled uncoated groundwood specialty papers. At that time, the mill had a capacity of approximately 109,000 tons/year; the newest machine had started up in 1913. Part of the second phase of the improvement project was the installation of two supercalenders and one winder, allowing production of supercalendered papers on PM3 and PM4. A third machine was to continue making MF kaolin-filled paper. In 1985, St. Marys Paper Inc. began producing SCB paper at 82,000 tons/year. The company was probably the first mill in North America to use the SCB designation of SC grades. This SC grade has a 9–15% ash content.

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Paper machine expansion project: the new PM5

In 1987, the mill was running well enough for management to consider further expansion to increase production capacity. After much consideration, St. Marys chose to build a new twin-wire machine, PM5, that trimmed at 4.67 m (184 in.). Two supercalenders and another winder, as well as additional groundwood capacity, would also be installed. The width capability of PM5 was chosen so the existing supercalenders and winder could be retained. St. Marys realized the potential demand for its product within the expanding SC market and wanted a machine fast enough to serve that demand. The mill also wanted a machine capable of producing SCA grades, should they choose to enter that market.

The new PM5 was designed to be the world's fastest SC paper machine, with a design speed of 1200 m/min (4000 ft/min). It was the first machine installed in Canada built specifically to produce SC grades of paper. The machine was designed to run with a furnish consisting of 68% stone groundwood, 20% semi-bleached kraft, and 12% kaolin. The machine operates in the basis weight range of 42 g/m^2 to 60 g/m^2 (28–40 lb/3300 ft^2). Target production on startup was 375 metric tons/day (413 tons/day).

Retention aid system on startup

The incumbent retention aid supplier was involved in the startup and suc-

cessfully used a nonionic polyacrylamide retention aid system; the system is specifically designed for filled and unfilled newsprint-type groundwood stocks. The three existing mill machines were already using this product for MF kaolin-filled papers and SCB paper production.

Retention of filler with the single-component polymer system was adequate for the relatively low sheet ash levels required for the SCB and MF papers. When increased filler levels were used to make a trial order of 20%+ SCA paper, a significant drop in filler retention was experienced. Tray water solids rose to a very high and unacceptable level, in excess of 0.6%.

Stock dewatering characteristics were of some concern on this machine. To enable it to produce acceptable paper, the speed was restricted to 3200 ft/min. The machine also experienced a runnability problem, which was believed to be caused by porosity. Severe sheet blowing in the dryers caused the sheet to move from side to side, producing an uneven reel. Air bubbles would also tend to form on the reel, which would result in wrinkles and edge cracks. The moisture profile after the press section was also somewhat uneven.

After two years of operation, we began investigating alternative types of retention aid systems that would improve filler retention, particularly at the higher levels required for the SCA grades. Other quality and runnability issues were also addressed. Several different systems were considered, and a substantial amount of preliminary work was conducted by several suppliers. In the end, the microparticle system was chosen to provide the desired improvements.

Selection of the new microparticle retention aid system

The present retention aid supplier had run a trial with its polymer/bentonite dual-component microparticle system on one of our other machines and had seen considerable improvements in retention and drainage. However, the system's effect on sheet porosity made it unacceptable for the grade of paper made on that machine. The supplier and a consultant both reported positive effects the polymer/bentonite microparticle system can have on filler retention and runnability, based on similar machines in Scandinavia and Finland making groundwood containing kaolin-filled papers. Similar results were predicted for St. Marys' PM5.

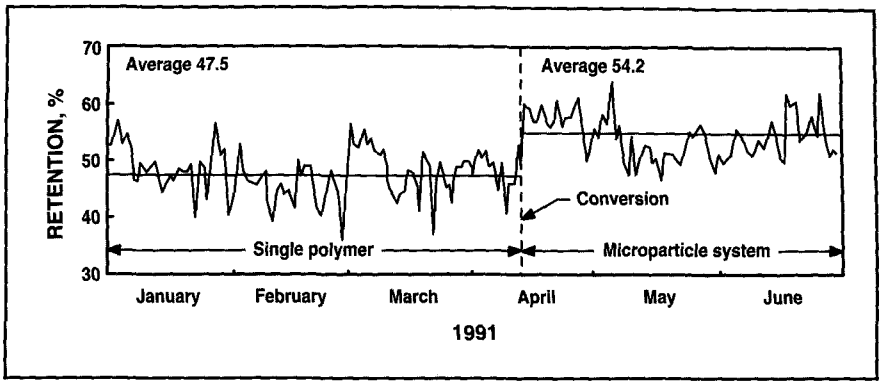
After some discussion, we investigated running a trial with the microparticle system on PM5. A laboratory survey was conducted to select the polymer or polymers most suitable for optimum performance of the system for PM5 and its SCA and SCB furnish characteristics. As a result of this survey, the microparticle system was run in the following manner.

A poly-DADMAC-type cationic coagulant with a higher-than-normal molecular weight was recommended to be added to the inlet of the machine chest. The purpose of this polymer is to shift the charge of the system to make the stock less anionic and therefore bring it closer to the isoelectric point. By doing this, the polymer efficiency of the microparticle system would be significantly improved.

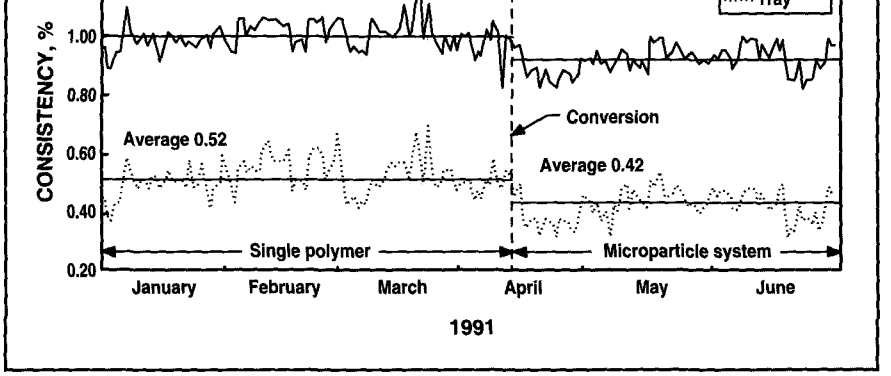
A relatively low cationically charged, high-molecular-weight polyacrylamide was selected as the first component for the microparticle system. This product was added to the thin stock on the inlet side of the primary pressure screen. By adding the polymer in this position, sufficient mixing and shear is available to "deflocculate" the thin stock and condition it to react in a predictable way with the bentonite.

The modified, hydrated bentonite is added as a dilute slurry (0.5%) to the outlet of the primary pressure screen. This microparticle component of the

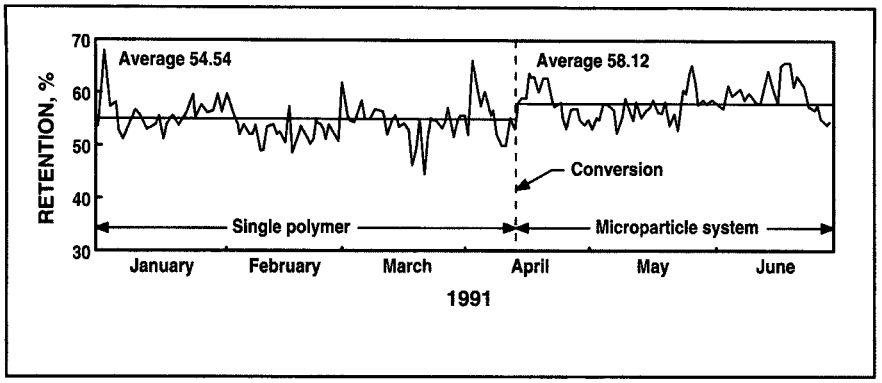
1. First-pass retention, single polymer vs. microparticle system, January–June 1991



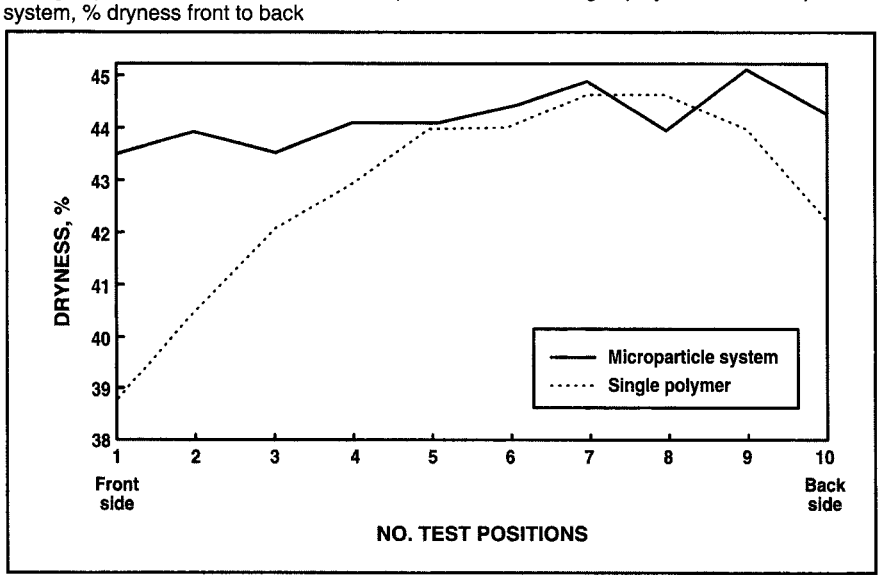
2. Headbox and tray water solids, single polymer vs. microparticle system, January–June 1991



3. First-pass ash retention, single polymer vs. microparticle system, January–June 1991



4. High-speed twin-wire SCA machine press moisture, single polymer vs. microparticle system, % dryness front to back



1. Break frequency before and after installing microparticle system on PM 5 in April 1991

1991 month	*Break frequency, breaks/day*
January	3.0
February	4.6
March	4.0
April	6.2 (Conversion started mid-April 1991)
May	3.7
June	4.1
July	2.0
August	2.4
September	2.5
October	2.0
November	2.1
December	2.4

system reacts with the "coagulated" filler, fines, and fiber surfaces to give the microparticle flocculation characteristic of the process.

Results of using a microparticle system on PM5

Improved retention

Comparing a period of just over three months before converting to the microparticle system, to three months after starting the system, the average first-pass retention increased by approximately 6.7%, i.e., from 47.5% to 54.2% (**Fig. 1**). The standard deviation was reduced from 4.285 to 3.939. This was accomplished by a decrease in headbox solids from 1.0% to 0.91% (a 9.0% reduction) and a corresponding decrease in tray water solids from 0.52% to 0.42% (a 19.2% reduction) (**Fig. 2**).

First-pass ash retention was also increased by approximately 3.6% (i.e., from 54.5% to 58.1%), with a corresponding reduction in standard deviation from 3.605 to 3.245 (**Fig. 3**).

Reduction of the ash in the tray water and the subsequent increase in first-pass ash retention resulted in less loss of filler to the sewer. A reduction in the load to the effluent plant can be beneficial from an environmental as well as economic point of view.

Improved dewatering

The increase in dewatering was caused by a reduction in moisture content after the press section of approximately 1.4%. Not only was the moisture content reduced, but the cross-machine moisture profile was also improved (**Fig. 4**). This was thought to be as a result of the alterations made in addition sequence of the polymers and bentonite required for the microparticle system. The reduction in moisture entering the dryer section was a major factor in allowing the machine speed to be increased from approximately 3200 ft/min (running with the single-polymer system) to 3600ft/min. Other considerations have limited the speed increase, although paper was made successfully at 3700 ft/min with the new system. The reduction in steam pressures in the drying section will also allow future speed increases should circumstances permit.

Improved runnability

It is difficult to determine the exact criteria for runnability improvements; they cover a number of stability or machine-related topics. However, the evidence suggests a reduction in break frequency as shown in **Table I.** Some adjustments were made on the machine at the start of the trial, and its operation improved considerably.

Porosity

Initially, an increase in MF porosity was a concern. However, the more open sheet apparently helped with the de-

watering and drying; it also helped eliminate the sheet blowing problem in the dryer and the air bubbles in the reel. Edge cracks and wrinkles were also greatly reduced.

Initially, the MF porosity increased significantly, rising from 200 to an average of approximately 230, with some results as high as 300 (Parker Printsurf). However, the supercalendered porosity changed only very slightly from a monthly average of 25.3 for March to 26.7 for June 1991. The porosity has since been within specification. Although some early ink smears indicated some increase in show-through, no problems were reported from the press rooms.

It has been reported that papermaking stock treated with the polymer/bentonite microparticle system derives its excellent retention and dewatering characteristics from the "supercoagulation" of colloidal, filler, and fines particles present in the water phase. These are then retained on the long fiber fraction by the action of the bentonite on the charged particles and fiber surfaces. Very little material is left completely free as colloidal or small particles. The interstices in the sheet are left open to aid the easy removal of water during free drainage, vacuum-assisted dewatering, and pressing. There may be some help during the drying process as well. This characteristic may also slightly increase the porosity of the sheet. Adjusting refining and the sheet-forming process can usually return the porosity of the sheet to its normal value.

Conclusion

The polymer/bentonite microparticle retention aid/dewatering system has helped St. Marys Paper Inc. improve its range of SCA and SCB printing grades. Since changing to the microparticle retention aid system, St. Marys has increased the level of filler clay in the sheet and, as a result, significantly increased the gloss and smoothness of its SCA product. Furthermore, the company has the ability to increase machine speed without dryer limitations. TJ

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