Modern paper machines such as gap formers and hybrid-formers that are used in the production of graphic grades and operate at over 1,000 m/min (3,280 fpm) typically expose papermaking furnish to very high levels of hydrodynamic shear forces, making retention more difficult where traditional single or dual polymer programs cannot achieve acceptable results.

The need for increased drainage at higher retention levels in paper grades with higher ash content has led to the development of microparticle-based retention programs. However, the trade-offs between retention, drainage and sheet properties are further accentuated in gap former machines. For optimal performance, gap formers need to have a comprehensive retention system able to provide the highest retention possible with a lower flocculation (small flocs), while improving drainage in a controllable manner, as the amount of water drained is crucial to achieve enhanced sheet quality.

In gap former machines, the fiber suspension is directly injected into the wedge of two forming wires (Figure 1), with the subsequent formation of the paper web between two forming rolls. Strong and abrupt drainage is created on both sides of the paper web due to the centrifugal forces and the application of vacuum. Subsequently, the web travels through a series of pressure static blades that promote drainage in both sides of the paper web forming the sheet. In this section of the gap former, the high shear forces that promote drainage place a lot of strain or demand in the retention system performance, as retention can be limited by formation. The correct ratio between drainage at the forming rolls and drainage at the blades is essential for the quality of the sheet, as too much drainage in the forming rolls negatively impacts formation, z-filler distribution and z-directional strength.

It is this balance between two drainage areas and retention that has lead many mills over the years to modify their microparticle retention programs to cope with the high shear forces of gap formers.

This article will focus on the implementation of Nalco’s ELLIPSIS™ Cationic Micropolymer Technology as a viable solution for papermakers operating high speed machines to have at their disposal in order to achieve more drainage in a controllable manner, while increasing filler and fines retention without detrimental effects on formation and other sheet properties.

Fig. 1. Schematics of a gap former.
MICROPOLYMER-BASED RETENTION SYSTEM

Paper producers are under pressure to improve the cost-competitiveness of their operations by improving On-Machine Efficiency (OME) and paper quality. Requirements for porosity, surface roughness, ink receptivity and formation for good printability necessitate higher filler loadings and controllable drainage. Papermakers’ desire for higher filler retention and controllable drainage without adversely affecting sheet properties created the need for developing a new retention system based on micropolymer technology.

Functionality has been verified with laboratory tests, pilot machine trials, mill scale tests and commercial applications. A micropolymer trial was run on the EuroFEX Experimental Paper Machine at the Swedish Pulp and Paper Research Institute (STFI) in Stockholm, Sweden to evaluate the performance of the retention capabilities of the ELLIPSIS retention-based program relative to existing retention single flocculant and microparticle-based systems.

Figure 2 shows a schematic diagram of the short circulation of the EuroFEX Pilot Paper Machine. The machine conditions that were used during the trial are detailed in Table 1. The forming unit was a roll-blade gap former.

After the initial roll dewatering, the papermaking furnish is dewatered over a blade section with blades on both sides so that drainage is symmetrical. The pilot paper machine demonstrated improved formation at higher retention levels, when compared to the traditional single flocculant and dual bentonite based programs (Figure 3).

CASE STUDY 1

A mill was seeking to improve OME on a newsprint machine by increasing the machine’s speed through more uniform drainage. The mill was also looking to improve runnability by strengthening the RDF program. The machine was a standard newsprint hybrid former producing 170,000 tons per year, with an operating speed of 1,200 m/min (3,937 fpm) using TMP and RNP pulp as furnish. The program in place at the time was single component—cationic flocculant.

A comprehensive system survey was conducted by Nalco to better understand the mill’s productivity issues. The mill’s current retention and drainage program was evaluated in the laboratory beside several Nalco programs in order to identify the optimal choice. As a result of these evaluations (verified in conjunction with the mill), Nalco’s proposal was to implement a program using ELLIPSIS. This program was designed based on a modified retention and drainage platform. This is a dual-component program utilizing cationic micropolymer and high molecular weight flocculant.

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**EUROFEX OPERATING CONDITIONS**

| Grade: | Graphic grades |
| Type of Machine: | Roll former |
| Furnish: | TMP (57%), SWD (28%) and Filler (15%) |
| Speed (m/min): | 1,100 |
| Jet-wire ration (m/min): | 40 |
| Slice Opening (mm): | 9 |
| Basis Weight (g/m²): | 50 |
| Press Loads (kN/m): | 60, 500, 700 |

Table 1.

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Fig. 2. Schematic diagram of the short circulation of the EuroFEX Pilot Paper Machine indicating some of the chemical addition points during the trial.

Fig. 3. EuroFEX summary results showing the effect of improved beta-formation at higher retention levels when using ELLIPSIS.
The application of Nalco’s comprehension RDF program resulted in the following benefits that resulted in improved OME:

- 6-m/min (19.7 fpm) draw reduction
- 7% increase on First Pass Retention (FPR) from 50 to 53.5% on average
- 14% tray solids reduction and a 9% head-box consistency reduction
- 2 tons per day less fiber loss from the uhle boxes
- 8% production increase on average (Figure 4)

CASE STUDY 2

The second case study involved a gap former paper machine producing 200,000 tons per year of graphic grades running in acid conditions at 1,300 m/min (4,265 fpm) using 100% TMP. The machine was suffering from some sheet quality issues as MD TEA, leading to decreased paper machine speed and production losses.

Nalco performed an in-depth wet end survey on the paper machine, which included the laboratory evaluation of the incumbent program, and determined that a co-feeding of ELLIPSIS with a high molecular flocculant would achieve the results the mill was looking for.

During the trial with the new program, the machine was able to increase efficiency in a number of ways, including an increase in average production by 12.6%—from 517 to 581.9 tons per day (Figure 5). The following are additional results:

- The average production rate during the trial for a 45 grams sheet was 25 tons/hour, which comes to an additional production of 38 tons per day (assuming no downtime).
- The average production rate during the trial for a 48.8 grams sheet was 25.8 tons per hour, which comes to an additional production of 16.8 tons per day (assuming no downtime).
- There were no reported quality issues during the trial. The former and press section were cleaner and the machine was running faster. Rather than reduce steam usage, the new program was able to reduce draws and increase machine speed.

CONCLUSION

In high speed machines operating at 1,000 m/min (3,280 fpm), an improper combination of chemical forces mixed with fibers and fines create large porous stable flocs, which are very difficult to drain in the forming section, resulting in papers with irregular z-filler distribution, poor formation, low strength and poor printability. Moreover, this is further accentuated by the use of high doses of high molecular weight flocculants in combination with microparticles to achieve higher filler retention and increased drainage.

The implementation of ELLIPSIS retention program based on the combination of a high molecular weight flocculant and a micropolymer on high-speed machines machines provides papermakers with viable solution to selectively retain fines and filler while providing increased drainage in a controllable way. By incorporating ELLIPSIS into a machine’s retention program, papermakers can mechanically optimize their gap and hybrid former to achieve new levels of retention without sacrificing z-filler filler distribution, formation, roughness and strength.

Casimiro da Silva Santos is Global Program Manager, Expertise Center RDF & Functionals, Paper Services Division at Nalco.