To stay competitive in the current business environment it is very important for pulp and paper manufacturers to improve operational efficiency, while reducing operational and capital costs. Equally important are environmental concerns such as reducing water and energy consumption, limiting fresh water intake, plus wastewater and solid waste discharge.

This article discusses two new innovations from Nalco, an Ecolab company, that represent breakthrough application technology for mixing and injection of chemistries in pulp and paper unit operations. PARETO® Mixing Technology is a patented, engineered system that enhances chemical performance by optimising the injection of the chemical additives into industrial process streams. FLOCMASTERTM Technology is a patented method for improving the performance of dewatering applications to provide significant total operating cost (TCO) reduction in plant waste operations.

PARETO MIXING TECHNOLOGY
PARETO Mixing Technology provides a major advancement in chemical injection applications, confirmed through success at many global commercial installations. It is applicable to most chemical injections, specifically to high molecular weight polymers, as are typically encountered in process wet-end and water treatment applications. It has also proven beneficial for additives being fed to the top of a chest (dripped in open tanks) such as defoamers and high-charged, low-molecular weight coagulants (both organic and inorganic).

FLOCMASTERTM Technology is a patented method for improving the performance of dewatering applications to provide significant total operating cost (TCO) reduction in plant waste operations.

CONVENTIONAL INJECTION TECHNOLOGY
In reviewing the fundamentals of injection technology, there are a number of methods utilised for chemical delivery into process pipes. These include direct hose/pipe connection (i.e. T-jet connection) injection stub, drilled quill and several newer, more novel engineered methods. Each of these methods has inherent advantages and disadvantages for the papermaker, and requires certain compromises and technical trade-offs for successful implementation.

The single jet injection system, also known as a “tee mixer”, is commonly used for many chemical applications. Chemical injection performance is evaluated by measuring the uniformity of chemical concentration at different locations downstream from the injection point.

For many single-jet systems, complete mixing does not occur even at 10-30 feet down the length of an approach pipe. This leads to a higher, localised chemical concentration or heavy floc formation, resulting not only in reduced...
The primary purpose of the PARETO Optimiser (Figure 1) is to discharge the mixture of additive and feedwater into the pipe in the desired way by ensuring mixing of chemical with feedwater under controlled hydrodynamic conditions (which prevents deactivation of the chemical).

The PARETO Optimiser is connected through an adapter on the pipe (Figure 2). This specially designed adapter (constructed from stainless steel AISI 316) is used to pre-mix the feed liquid and chemical to ensure consistent penetration of the mixture into the process pipe.

As seen in an actual demonstration (Figure 3), the conventional T-Jet application of an additive at 1.5 metres (5 feet) downstream, a typical distance of post-screen addition points prior to the headbox or clarification unit as dissolved air flotation (DAF), complete mixing has not yet occurred. This will result in a high number of localised chemical concentrations or floc formations along the pipe wall, which can result in reduced chemical efficacy, and also variability in floc formation. This can be detrimental to finished product attributes such as formation, porosity and moisture profiles.

As illustrated at the top of Figure 3, nearly complete mixing occurs within 1.5 metres (5 feet) of injection. This eliminates many of the issues resulting from poor mixing and allows the injection point to be moved closer which further enhances polymer performance.
The optimiser has been designed to be robust, durable, and easy to install and disassemble for inspection and cleaning.

**Programme Design and Installation**

The PARETO Optimiser is able to mix chemical additives and process water prior to introduction into the process pipe, with the engineered system minimising the contact time between the solutions. The injected chemical additives are optimally mixed with the pressurised feed water via a booster pump just prior to process introduction.

PARETO system maintenance is also simple and safe. The optimiser has been designed to be robust, durable, and easy to install and disassemble for inspection and cleaning. The main components of the system, such as the pump, flow meter(s), hoses and valves, are constructed of the highest quality industry materials available. Periodical checking of the PARETO system is required in order to observe any changes from the designed values in pressure and flow. At paper machine shutdowns, the optimisers can also be opened for inspection.

**Programme Components**

- PARETO Optimiser – ensuring proper chemical injection
- Dosing system (water booster pump skid) – mixing power, energy and type
- Chemistry – optimising molecular weight, charge, architecture
- Best practices - replacing fresh water with process water for energy and water conservation

**Papermaking Retention & Drainage Applications**

PARETO Mixing Technology is applicable to many different chemical injection processes. When integrated with Nalco flocculant and microparticle programme, the resulting wet-end programme can deliver enhanced value to customers’ operations, offering a truly unique programme. This is particularly true for existing pre-screen flocculant additions and polymer additions that have insufficient dilution water. In these cases, PARETO Mixing Technology can significantly improve the current chemical injection situation and achieve further improvement by enabling retention aids to be dosed post-screen, achieving the following:

- Retention/drainage aid application points can be moved post-screen closer to the headbox to increase chemical efficiency and minimise negative impacts on formation
- Chemical additives can be diluted by process water instead of fresh water, resulting in significant water and energy savings
- Other wet-end chemicals such as sizing agents, starch, wet and dry strength aids and other process additives can all be fed through use of PARETO Optimisers

**Non-Paper Process Applications**

The use of PARETO Mixing Technology is also applicable to other chemical applications on paper machines, DAFs, pulp mill washers, and other unit operations.

Current installations include:

- Solid/liquid separation (DAFs/clarifiers) improving system stability and obtaining better clarified water for re-use
- Defoamer (pulp mills and paper machines) enhancing treatment by optimising feed points from open chests to closed pipe
Increased cake dryness reduces sludge volume, therefore improving the cake solids content. This benefits waste plant operations by increasing the calorific content of the sludge, or by reducing transportation and disposal costs.

**DEWATERING OPTIMISATION WITH FLOCMASTER TECHNOLOGY**

Significant improvements can be made with respect to reducing operational costs and lowering environmental impact in the area of sludge dewatering. On average, 30-50% of the cost of operating a wastewater plant is directly attributable to the sludge dewatering operation. Sludge is produced at every step of the wastewater treatment process – the primary clarification (or DAF) steps, the biological system, the secondary and tertiary treatment steps.

This sludge is typically thickened and dewatered, after which it is disposed of, either by incineration, or by a disposal company. In both cases, the dryness of the dewatered cake determines the cost of sludge disposal. Increased cake dryness reduces sludge volume, therefore improving the cake solids content. This benefits waste plant operations by increasing the calorific content of the sludge, or by reducing transportation and disposal costs.

**SLUDGE DEWATERING PROGRAMME**

Nalco has developed an innovative and unique programme that delivers quantifiable operational efficiency and sustainability performance improvements in sludge dewatering operations.

The programme combines Nalco flocculants, patented FLOCMASTER Technology and on-site services. This combination results in improved dewatering unit performance, increased cake dryness, and reduced sludge volume for disposal.

The heart of the unique FLOCMASTER Technology is the dynamic inline mixer (Figure 5). The polymer solution is fed into the sludge stream through a hollow shaft opening in the rotating paddle.

Traditional polymer application methods for dewatering operations include simple quill injection or ring injection headers incorporating various static mixer designs. While these methods do offer some mixing, it is often not complete and results in inefficient polymer usage and less than optimal dewatering.

With FLOCMASTER Technology, optimal mixing is achieved via adjustable mixing energy. The rotary speed of the mixer and polymer feed rate can be tied into signals from sludge flow meters, which results in much more efficient and effective dewatering. Dewatering operations incorporating FLOCMASTER Technology have achieved average cake dryness increases of 2-5%, 30% average reduction in filtrate total suspended solids (TSS) and significant improvements in polymer efficiency.

The inline mixer is available in 3 sizes to handle sludge volumes from 10 to 1,760 gpm, ensuring a wide range of applicability. For higher sludge flows, custom solutions are possible. The package of mixer, dosing pump and control panel allows external interface connection from the customer allowing optimal performance of this unique technology.

The ability to use a much higher-strength polymer solution results in an 80-90% decrease in water used in polymer dilution, delivering significant fresh water savings. As a consequence, this also reduces the volume of centrate or filtrate, which has to be sent back to the waste plant for treatment by the same amount. This water reduction leads to lower hydraulic loading of the dewatering unit, improving results and increasing operational capacity.
The result of incorporating these two mixing and injection technologies is increased energy and water efficiency, enhanced finished product quality, reduced solid waste generation and reduced total cost of the operation.

PARETO Mixing Technology improves productivity, wet-end stability and savings

Grade: Board
Background: Board machine retention & drainage application through a PARETO injection system
Situation: Customer sought to improve machine performance and reduce TCO while meeting company sustainability goals
Application: Nalco PARETO Mixing Technology, Nalco Core Shell™ and Nalco POSITEK™ 3G chemistry
Value delivered:
• Increased production by 1.6%
• Reduced chemical usage by 270,000 lbs/year allowing for a VOC reduction of 7,700 lbs/year
• Reduced fresh water usage by 80,000 gallons/day and 42 million BTUs of energy required for water heating

Estimated annual savings:
US$1,145,000 in reduced TCO

PARETO Mixing Technology delivers improved productivity, paper quality and savings

Grade: Graphics
Background: Graphics machine retention & drainage application through a PARETO injection system
Situation: Customer needed to improve machine performance, quality and TCO
Application: Nalco PARETO Mixing Technology, Nalco Anionic Polymer and Microparticle chemistry programme
Value delivered:
• Increased production by 3%
• Increased sheet ash from 16 to 17.3%, reducing fibre usage
• Improved sheet smoothness
• Reduced fresh water usage by 29,000 gallons/day and 4,500 million BTUs of energy required for water heating

Estimated annual savings:
US$2,200,000 in reduced TCO

FLOCMAster Technology reduces disposal costs and water consumption

Grade: Tissue
Background: Sludge dewatering application
Situation: Customer sought to reduce TCO and meet company sustainability goals
Application: Nalco FLOCMAster Technology
Value delivered:
• Increased sludge solids by 6% and reduced sludge generation by 5,500 tons/year
• Reduced fuel used for sludge incineration by 330,000m³ and reduced CO₂ emissions by almost 700,000 tons
• Reduced polymer make-down water usage by 17 million gallons

Estimated annual savings:
US$509,000 in reduced TCO

FLOCMAster Technology has been proven effective for primary, secondary, and blended sludge on all types of dewatering equipment (belt press, filter press, screw press, centrifuges, gravity tables, etc).

The result of incorporating these two mixing and injection technologies is increased energy and water efficiency, enhanced finished product quality, reduced solid waste generation and reduced total cost of the operation.

CONCLUSION
Integrating PARETO Mixing Technology into the papermaking process delivers overall system stability while improving chemical efficiency, and preserving fresh water and energy resources.

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### Nalco Company Operations

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Nalco innovation delivers value

Less is More

PARETO™ mixing technology is a new proprietary feeding solution that increases process stability and saves fresh water and energy, by optimum mixing of chemicals into the process.

- Increasing process stability
- Maximizing chemical efficiency