Executive Summary

Today, the developments in pulp drying follow the trends in fiber line technology and demand larger single lines to reach the best overall economy. The ultimate goal is to design a single pulp drying line that capacity-wise matches the corresponding new Greenfield mega-mills. However, such a goal requires a totally new capacity level and faster drying machine speeds.

Valmet has developed a pulp drying technology concept called DryWay. With its new former and cutter design and other process improvements, you will be able to increase your production speed and capacity dramatically. The DryWay concept features web speeds of 200 to 300 m/min and production rates of 300 to 500 ADT/meter. The new capacity range enables you to reach up to 50% savings in drying machine building volume compared with conventional systems.

This white paper reviews each of the DryWay components: screening, forming, pressing, drying, cutting and baling, as well as threading. An alternative pulp drying plant, FiberFlash™, is also presented. Finally, case studies are presented which further illustrate the results that can be expected by investing in DryWay technology.
During the last 20 years the world has placed a new level of demand on single-line pulp drying capacity. We face a need for good economical solutions of 3,000-3,500 t/d and higher, running at speeds of 200-300 m/min at production rates of 300-500 ADT/meter - with a single line in a greenfield mill.

These features, in turn, place high demands on the development of double wire former technology with double-sided water removal. Valmet has been a pioneer in this field, originally aiming at energy savings and increasing capacity. It is widely recognized that the typical bottlenecks encountered while increasing pulp drying capacity lie in the former and cutter areas. The web speed in present pulp drying machines is approximately 150-180 m/min and production about 200 ADT/meter.

Valmet’s answer to this is the new pulp drying technology concept called DryWay (Figure 1). With its new former and cutter design and other process improvements, you will be able to increase your production speed and capacity dramatically. The new capacity range enables you to reach up to 50% savings in drying machine building volume compared with conventional systems.

The first DryWay was delivered to Stora Enso Kaukopää in 2000. That delivery was followed by the Suzano Mucuri project during 2006/2007. With a dimensioned capacity of 3,340 ADT/d on high pH eucalyptus pulp, Murcuri was the largest single-line drying machine ever built with a trim width of 9,990 mm.

DryWay technology has since been installed at many other locations, including Joutseno, VCP Jacarei, April-SSYMB Rizhao, Arauco Valdivia, ENCE Navia, Nueva Aldea, and Zellstoff Rosenthal and Stendal, with an upcoming installation at Klabin.

DryWay components have also featured in several rebuilds including doubling drying line capacity at Metsä-Botnia Joutseno, adding automated baling equipment at M-real Stockstadt and Nimax™ screens at Lessebo Bruk.

The DryWay concept embraces the entire pulp drying line. Let’s start by reviewing the process in order from wet end to baling.
**Wet end**

Wet end technology is based on the experience gained in deliveries of more than 300 machines worldwide, including the world’s widest pulp drying line with a trim width of 10 meters and a record capacity of 3700 ADMT/d. The latest machine design allows for production rates per width meter of 500 ADMT/d and minimized energy consumption.

**Pulp screening**

In DryWay Screening, medium-consistency pressure screens are used to replace the high consistency screens and the major part of the forward and reverse cleaners that operate at low consistency. This maximizes pulp drying machine runnability and pulp web quality. It minimizes web breaks and MD basis weight variations and protects wires and the headbox. Valmet machine screens are equipped with a new type of Nimax basket for low consistency screening applications, based on patented manufacturing technology. Screening development comes from experience gained in over 500 deliveries worldwide.

Valmet’s solution for screening is to place pressure screens at the short circulation in front of the headbox, between the blend tank and the machine tank, where infeed consistency is typically around 3.5%. This protects the machine from loose particles coming from earlier process and internal circulations, and optimizes investment costs (amount of equipment) and the level of cleanliness achieved after screening. It also provides major energy savings of up to 70% compared with a system based exclusively on cleaners. The two models for slotted pressurized screens are DeltaScreen™ and DeltaCombi™, equipped with slotted wedge-bar type Nimax baskets with fine slots resulting in efficient screening. The Combi model is mainly used as the last stage of pressure screening. (The Mucuri project was based on 4-stage screens with 2-stage cleaners, with reverse cleaners for light impurities.)

The operating consistency of the screens is 1.0-2.5%. Only 0.5-5% of the production is rejected and diluted for later treatment in the reject system, which can process both heavy and lightweight contaminants. Less than 0.1% of the total production is discharged from the process.

DryWay screening system benefits include:

- **Low power consumption**
  - Almost 70% reduction compared with traditional screening and cleaning
  - Almost 85% reduction compared with a conventional cleaner system
  - Energy consumption reduction in entire pulp drying line of 6-8% when compared to traditional screening system
- **Low installation and investment cost**
  - At least 40% reduction compared with a conventional cleaner system
  - Easily controlled operation resulting in even pulp quality

**DeltaScreen - for excellent shive removal efficiency**

The DeltaScreen is a fine screen for pulp concentrations of up to 5% and is equipped with the high performing Nimax screen basket. It is available in a range of sizes to match all capacity requirements. The screen now has an improved housing common with the new DeltaCombi which contributes to increased
capacity and operational reliability. The housing, with pulp introduced at the bottom of the screen, allows for lightweight removal.

The DeltaScreen (Figure 2) is fed from the bottom of the screen and pulp is fed through the rotor into the screening zone. This ensures that harmful heavy particles are kept at the bottom of the screen and will be removed by the junk trap. Accept is taken out from the outer periphery and reject is collected below in the bottom of the screen basket.

A specially designed rotor dilution system has been applied, which allows the most efficient utilization of the whole screening area and washes reject particles from fibers. This enables constant operation of the screen. The precise control of this dilution water also ensures the desired reject consistency out from the screen.

The conical rotor enables better pulp coverage of the whole screening area at an equal speed rate. The tapered feeding concept is reminiscent of the "manifold" principal used for paper machine headbox feeding. This is one of the key features for reaching the highest production per unit of the screening area. This design shortens the retention time of impurities on the screening zone thereby improving the screening efficiency.

Valmet’s DeltaScreen features the Delta rotor for high consistency screening and the Nimax basket for highest possible shive removal efficiency. The screen has been specially designed for ease of maintenance and service. The carefully designed rotor foils and a fair sized gap between the foil and the basket guarantees gentle head pressure and a well extended suction pulse. The basket features a design that creates sufficient micro turbulence to fluidize the stock into separate components i.e. fibers and different types of contaminants.

The screen is equipped with a bearing unit, which has been selected for its ability to provide a long lifetime. The bearing unit is also equipped with a cartridge type mechanical seal that has been standardized within Valmet’s product program. A worn or damaged seal can easily be replaced, without removing the bearing unit, simply by removing the screen cover and rotor and installing a new seal cartridge.
The old cartridge can then be repaired and reused. Cartridge mounted seals have been proven to increase the mean time between failures (MTBF) when implemented in standard centrifugal pumps. The screen is also supplied with insulation for heat protection and noise reduction.

By modularizing parts for the Delta family's various members the long-term maintenance and spare part costs are reduced.

**DeltaCombi - for improved knot and shive removal**

DeltaCombi is a combined knotter and fine screen based on the DeltaScreen and DeltaKnotter™ concept. This machine is intended for efficient separation of knots, uncooked chips, junk (metal, stones etc.), shives and other undesirable debris in the accepted pulp.

The working principle is the same as for a single knotter and a single fine screen ([Figure 3](#)). The pulp is fed tangentially into the bottom part of the screen through the rotating screen basket from the outside to the inside. The pulse generating stationary foils are located on the accept side of the screen basket. The coarse reject is taken out from the bottom part. The accept which has passed the rotating screen basket is led up through the rotor of the fine screen and downwards between the rotor and Nimax screen basket, as in an ordinary DeltaScreen.

**Figure 3. DeltaCombi functionality improves knot and shive removal.**

The DeltaCombi consists of a vertical, cylindrical housing with a top cover, designed as a pressure vessel. Inside the housing, a rotating screen basket with holes, is mounted on a bearing unit, the same type as the one used in DeltaScreen. Additionally, for fine screening, a similar rotor and Nimax basket, as in DeltaScreen, is mounted.

Key benefits of the DeltaCombi include:

- High consistency and high capacity
- Excellent knot and shive removal efficiency
- Possible light weight removal
Nimax screens - for high production and better pulp quality

Screening normally involves tradeoffs between increasing production and improving accept quality. Valmet’s new generation Nimax screen baskets provide both higher production and improved pulp quality. This new basket generation features an increased life span and excellent dynamic strength that will result in reduced screening costs and better pulp quality in all screening applications.

Nimax screen baskets, introduced in 2004, have been further developed for specific applications such as DIP and OCC. During the development work it was discovered that wire shape and profile design affect screening even more than was generally anticipated. As a result, Nimax screen baskets now offer unlimited optimized profiles and slot sizes.

Screening with thin wires and narrow slots is always a challenge. The basket with the highest dynamic strength can also run with the thinnest wires. While the first and second generations of wedge-wire baskets offer sufficient static strength, the forces inside the screen are dynamic (rotor/flow/fibers). Such baskets therefore need to compensate for their lack of dynamic strength with unnecessarily thick wires.

Nimax combines the advantages of welded and groove-supported construction (Figure 4). The superior basket design also incorporates patented shrink-fit support rings. The excellent dynamic strength guarantees the reliability of the Nimax basket while enabling the higher open area. The shape of the new wires and profiles also contribute to the success.

Combining the high open area with the same or lower passing speed gives unique possibilities to increase production capacity, improve accept quality or do both at the same time. While reaching a high removal efficiency of undesired particles, the extremely wear-resistant and durable Nimax screen basket also reduces screening costs as the basket life span is longer and the production capacity of existing screens is increased.

The high capacity laminar design Nimax LD wedge wire saves pumping energy and improves screening efficiency. The lower pressure drop and flow resistance through the slots results in increased capacity and reduction in pumping energy. Nimax LD reduces the backflow vorticity in the accept channel right after the narrow slot, enabling outstanding runnability without fiber blockage or stringing. Nimax also reduces thickening and improves screening efficiency.

Figure 4. Nimax LD laminar design wedge wire (vs. conventional)
Headbox
One of the most important parts of a pulp drying machine is the headbox. The modern wet end features an advanced dilution controlled hydraulic headbox, which ensures an excellent web profile both in machine and cross machine directions.

For special grades, one alternative is a rectifier roll headbox, which can be run either over- or under-pressurized to obtain the correct slice flow. This also provides good formation, small basis weight variation, efficient pulsation dampening within wide flow and consistency ranges.

Valmet headboxes are constructed of solid stainless steel and the frame is very rigid, tolerating high stock temperatures. All the surfaces exposed to stock are polished to the required surface finish. For easy service, the manifold can be turned down for maintenance.

Valmet DryWay headbox benefits include:

- Uniform basis weight
- Good formation
- Large range of stock flows and consistencies
- Solid stainless steel design
- Stable, rigid design allowing high stock temperatures

Forming
To meet specific mill needs, Valmet’s wet end technology comprises both Fourdrinier type solutions and double wire technology with two-sided dewatering and wire pressing.

Fourdrinier
The Fourdrinier type wet end provides extreme flexibility for varying production rates, basis weights, and pulp types, thanks to the adjustable headbox slice. In addition, the Fourdrinier type features long wire lifetime and disturbance-free operation. For maximized dewatering the Fourdrinier can be furnished with a top-former. Alternatively, the top-former can be installed at a later stage when an increase in production becomes necessary.

Double wire
The double wire DryWay former (Figure 5) represents the latest evolution of double wire formers featuring effective, controlled two-sided dewatering. Web formation takes place in a fully controlled, adjustable former section. Due to effective dewatering, Valmet has been able to reduce the former length to less than half of other existing formers.

Traditional pulp drying machines consume significant amounts of energy in their vacuum systems. Vacuum pumps transfer heat to
outside air and cool the web, at the same time the pumps consume a lot of electricity. These heat losses can easily be calculated and account for over 50% of your wet end energy consumption.

The DryWay former utilizes mechanical dewatering methods in all consistency areas and thus avoids practically all such losses. In the low consistency area from headbox to sealing unit, water is removed in an airless, controlled former section. In this way, the consistency rises from 1.0% up to over 20%.

The headbox and the forming section are an integrated single unit, not separate pieces of process equipment. The headbox jet no longer discharges onto an open forming table. Instead, the two fabric forming section and headbox constitute one enclosed space, as in papermaking gap forming applications.

In both wet end alternatives, the first open draw takes place at a dry content exceeding 40%, which guarantees running reliability especially with short fiber pulp. The roll nips are double felted and the rolls rubber or composite covered, ensuring long lifetime for wires and felts. The embedded automation solutions feature wet end web profile control systems for process optimization.

**Web profile control and process automation**

Reliable and optimum operation of the pulp drying line at high-speed levels requires sophisticated automation and control systems. A new concept has been developed for drying process automation that covers process, machine, drive and quality controls, as well as condition monitoring and baling management.

The DryWay intelligent machines feature embedded automation (Figure 6) which ensures the best performance and the most accurate operation. The automation provides efficient operation of the drying process while optimizing pulp drying costs.

The forming section dewatering characteristics are continuously controlled and adjusted to the prevailing operating conditions. Changes in fiber are detected immediately and the optimum dewatering response is adjusted within a couple of seconds.

Valmet’s automation solutions for various headbox types cover manual, remote as well as fully automated web profile control systems. The most advanced automation solutions offer sophisticated methods for both MD and CD profile control. Web profiles are adjusted with automatic dilution control that receives feedback from the profile scanner.

Both machine- and cross machine-directional control are based on making dewatering volumes conform to the dewatering zone geometry on the basis of flow and pressure measurements taken inside and around the former wedges. The above approach allows easy control of the moisture profile of the sheet, which is normally impossible to do with conventional methods without external help, such as a steambox.
The DryWay concept creates a system that is insensitive to fiber changes and pH dewatering factors, and it can maximize output dryness better than conventional systems. Whatever kind of fiber or pH, the dryness output is more or less the same. In traditional Fourdrinier type machines the difference can be as high as 6 to 7%, and with conventional twin-wires about 2 to 3%.

**Pressing**

After delta-pressure based dewatering and after making sure that the rewetting is minimal, press-based dewatering is used. Instead of suction rolls with large and energy consuming vacuum pumps, a DryWay forming section utilizes a shoe press with a felted shoe roll on the top. On the bottom side, there is an open-surfaced counter roll around which the bottom fabric goes. Some 60% of the removed water goes to the counter roll, while the rest is removed by the top felt. Because of the long nip, web dryness exceeds 40% when leaving DryWay press. By avoiding open draws, the process has fewer web breaks and more production hours.

The last dewatering phase is a double-felted SymBelt shoe press with a linear load of 1,000-1,500 kN/m. On the top, there is a rubber covered and deflection compensated SymZL roll. On the bottom side, there is a shoe press roll.

**High dryness - less steam**

With this solution, which is common on paper and board machines, dryness is maximized without compressing the sheet. With two shoe presses, the DryWay wet end is able to give higher dryness values and savings in steam costs for any kind of pulp. Typical inlet dryness varies between 40% and 45% BD and outlet dryness between 50% and 57% BD, depending on fiber quality.

An automatic tail threading device takes the tail to the dryer and secures fast and safe tail threading at high speeds.

**Drying**

**Airborne dryer**

The DryWay airborne dryer (Figure 8) takes care of final drying after the press section - in
this case, evaporating water from the pulp sheet. DryWay dryer features contactless drying and web run with a high drying capacity nozzle design across the whole drying length.

The main challenge in airborne drying is to float and guide the sheet while efficiently evaporating water from it and optimizing all functions - all at the same time. Normally, when evaporation performance is added (i.e. the speed of air flowing from the nozzles against the sheet is increased) the control of the sheet is easily lost. This means varying sheet distance from the nozzles or sideways movement inside the dryer. The heavier the sheet, the more floating force is needed.

**New high efficiency nozzle and fan technology**

The answer to this is the new design of the Valmet nozzle and fan, which can handle higher capacities than before. The new nozzle incorporates knowledge learned from paper coating processes and subsequent paper handling. The nozzle technology is the key element of the dryer, as it determines both the drying capacity and the web runnability.

The main goal for the nozzle technology is to maximize the heat transfer, and thus the evaporation capacity simultaneously ensuring excellent floatation through the drying decks. As a result dust formation and need for cleaning is reduced.

As can be seen in Figure 9, the heat transfer capacity of the new dryer nozzle technology has been significantly improved over time. Model A was used in the first dryer deliveries. The improved model B was launched some years later, and a significant step in increasing drying capacity was taken with the new nozzle generation, model C.

Due to the modern design of circulation air fans, drying nozzles and steam coils, the fan modules feature excellent runnability and enhanced drying. High total energy efficiency combined with low pressure losses of circulation air flow and efficient steam coils improves the drying process performance. These advanced features result in a high output dryer with low energy consumption.

The new generation DryWay dryer nozzles are used to increase evaporation capacity in the end tower areas where previously support nozzles were used. The evaporation capacity of the dryer is increased and therefore a more compact dryer can be designed.

**Inside the airborne dryer**

The web runs straight inside the dryer without any risk of web brakes against the dryer sides. This has been made possible by use of stiff turning rolls - a design originating from paper machines - and torsional rigidity in the roll tower design.
Another important feature is to enable fast and effective cleaning of the pulp dryer during a break. Valmet has developed a new broke cleaning system that minimizes the time needed for broke cleaning.

Benefits of the DryWay dryer include:

- High speed and production rate
- Contactless drying and web run with an improved nozzle design
- Excellent runnability and enhanced drying
- High energy efficiency - energy savings
- Low airflow circulation pressure losses
- Steady web runnability
- Fewer production and maintenance shutdowns

**Cutter layboy**

To fulfill higher and higher capacity demands, the greatest challenge in the cutter layboy area is to increase speed, as there are mechanical limitations on increasing the width.

Rotating knife cutting has been a Valmet standard for years, providing high-speed performance and jam-free operation. Another Valmet standard is a cross-cutting temperature control system to assist in faster start-ups and minimize thermal expansion issues. Knife service life has been increased thanks to new developments in powder metal-based materials.

The pivoting bed knife beam has been a standard for Valmet since the early 90s. This solution is a necessity in cross-cutting to prevent jams at high speeds, such as when a 10 to 20 metric ton roll stops in less than one revolution.

A feltless and tapeless layboy sheet conveyor is provided with a patented double overlapping system where the speed of the cut sheet is reduced to the desired level in two separate steps (Figure 10). This ensures the best possible piling performance and reliability as well as improving bale appearance.

Another standard feature of the DryWay Cutter is the embedded automation with a user-friendly operation interface and sophisticated sound insulation solutions. Since every cutter layboy is completely pre-assembled and tested at our workshop before delivery, erection times are short and start-ups trouble-free.

The DryWay cutter has been developed for a design speed of up to 300 m/min. R&D work was carried out on a 1.2 m wide pilot cutter through a wide range of tests with various pulp qualities.

**Threading**

The cutter is equipped with automatic tail threading and dust removal systems for safer operation.
TailSquirt handles edge trimming and tail cutting at the forming section just before the cutter layboy. TailShooter HW takes the tail over the open draw above the pulper to the cutter layboy.

**TailSquirt - edge trimming and tail cutting**

TailSquirt (Figure 11) cuts the tail and spreads the sheet after threading. Cutting occurs against wire with 20-27 bar pressurized water in forming section and with 600 bar in cutter layboy. The water filtration ratio is 140 microns (100 mesh).

The cutting head (carrier) is moved across the sheet by a speed controlled electric, pneumatic or hydraulic motor. The cutting position is controlled with the help of limit switches (located on the cross beam) or absolute encoder with Profibus connection.

In the advanced version there are two carriers; at the first stage the tail is cut at the tend side and then the tail cutting moves to the center of the machine. Finally the sheet is spread from the center to both sides.

**TailShooter HW - threading from former to cutter layboy**

The TailShooter HW is designed for heavy grades such as pulp, where a relatively heavy tail is carried over an open draw (pulper, etc.). It works at any speed up to 500 m/min, ensuring an automated, safe, fast and reliable tail threading from the press to the cutter layboy. Normally, TailShooter HW is installed on the tending side for safety and to allow manual threading if necessary (Figure 12).

The tail is cut by a pneumatically operated blow unit. After cutting, the tail is transferred by a tail threading belt to the cutter layboy drawpress. The tail is carried by a transfer roll attached to a linear unit.
Baling

The economical packing and protection of the final product is secured in the DryWay baling line, which is based on Robobaling™ technology (Figure 13). With these machines you will be able to reach a capacity of up to 300 bales/hr.

Robobaling technology utilizes Profibus DP technology, where all pieces of equipment are connected by means of a Profibus cable instead of massive field cabling from a central PLC to separate machine I/O. In addition to making installation and subsequent maintenance work easier, the bus technology also makes it quick and easy to pre-install or test mill installations. There is also a clear difference in total installed cost.

The installation time onsite is short because all baling line machines are constructed as complete ready-to-use units. The equipment is test-run at our workshop before delivery. The bale press is tested several times by a special hydraulic operating test bale - after 1000 successfully pressed bales the machine is approved for delivery.

The other main feature of Robobaling technology is the replacement of several hydraulic units and functions with electro-pneumatic actuators. In most cases this provides operational advantages because tuning differences relating to hydraulic oil temperatures are totally missing and the machine operates in the same way regardless of whether the machine has just started (cold) or has been running at a steady state.

The intelligent control systems with user-friendly touch displays ensure that you can easily control, monitor and maintain the production line. For optimal performance of the whole baling line, a PC-based bale control unit, BCU, works as a common master and monitors the overall functions between the various pieces of equipment.

The bale quality system, BQS, is a real-time tracking, identifying and reporting tool for pulp production and quality parameters. Instead of being a last in, first out system (based on production lots), BQS tracks each single bale, its location at any given moment, and where it is being guided. The BQS instantly detects and automatically self-adjusts when a bale is removed from, or added to, the baling line. It also supports
the mill-wide quality system by identifying when each bale was produced and what its quality parameters were at that moment. The BQS (Figure 14) provides a solution to meet ISO quality requirements with the aid of production, quality and other types of reports. A Remote Access Support system enables you to monitor and update programs remotely.

An alternative to the DryWay concept is the FiberFlash process...

**FiberFlash drying**

A Valmet FiberFlash plant is easy to operate and has a high reliability. The dryers are specially designed to suit any client’s process and pulp to be produced. Downtime and maintenance costs are low.

A FiberFlash drying plant (Figures 15 and 16) for mechanical and chemical pulp entails considerably lower investment than conventional drying plants (sheet dryers). Less space and smaller buildings and foundations are required. The greater part of the plant can be built outdoors, even in areas with inclement weather. FiberFlash plants are very flexible and can easily be adapted to existing buildings and machinery.

Modest manpower requirements and automatic, problem-free operation characterize the FiberFlash plant.

Exhaust air from FiberFlash plants is cleaned in a specially designed gas scrubber, preventing the environment from becoming polluted with dust and fibers. What comes out of the scrubber tower is clean vapor, odorless and free from fiber particles.

**Figure 14.** The Bale Quality System (BQS) tracks every bale in real-time, providing all needed quality and production data in an easy-to-use interface for operators.

**Figure 15.** FiberFlash plant at Celulosa y Papel de Durango

**Figure 16.** The capacity range of the FiberFlash system is flexible, and can easily be adjusted from below 50% to above 100% of design capacity, still with good energy economy.
Heating section

The heating source for the drying units can vary, and may be steam/air heat exchangers (Figure 16, 1) alone or combined with direct fired oil or gas burners (Figure 16, 2). The choice of heating energy source depends on the required heating temperature as well as the availability and price of the energy. The heat exchangers are selected depending on the steam quality available, whether it is CTMP steam, white water, hot filtrate or high pressure steam etc. In combination modern highly effective duct mounted gas burners, suitable for either natural or propane gases, can be used.

Coarse shredding and fluffing

Shredding and fluffing are essential factors in the FiberFlash process. The dewatering stage concentrates the pulp to 45-50%. The disintegration is done in two stages: first in a spike roll shredder, and second in a refiner type disc fluffer (Figure 16, 3), which fiberizes and disperses the fibers for the drying system. In the flash drying process, the quality of the pulp and the heat economy of the system depend on efficient pulp disintegration and fluffing. The important feature of this equipment is to maximize the particle surface area of the pulp, which is necessary in order to achieve the best possible heat and water transmission between the hot drying air and the wet pulp.

Disc fluffer

The disc fluffer is a well proven fluffer for the Valmet FiberFlash system. In addition to its application as fluffer in this process it has also proved to be a very efficient mixer in high consistency bleaching.

The pulp particles should be as small as possible in order to obtain the maximum exposed surface and the optimum heat and water transfer conditions. To avoid over-drying the smaller particles, the particle size should be homogeneous. The fluffing process must not cut the fibers or change the properties of the pulp.

The DF-42 disc fluffer (Figure 17) fulfills all the above requirements. Pulp consistency is 45-55% BD, and capacity is up to 450 ADMT/d, depending on pulp type and consistency.

The fluffer/mixer has a vertical driven shaft with a lower rotating disc and a stationary upper disc. The central vertical inlet eliminates any extra feeding device. Radial vanes on the disc periphery blow the pulp out at high velocity.

The fluffer/mixer is supplied with tooth pattern discs. The disc pattern is specially designed to disintegrate up to 55% BD pulp. Stator and rotor tooth-circles are offset enabling the teeth to intermesh for minimum clearance thus achieving maximum fluffing and mixing effect.

The disc clearance can be adjusted from a central control panel during operation by means of an electric gear motor. The fluffer/mixer is also equipped with an automatic load control system, which adjusts the clearance to maintain a preset load regardless of throughput.
Flash drying section
Flash drying is characterized by a very quick, almost instantaneous evaporation. Small particles and single fibers with a large exposed surface area, meet the hot air stream in the drying stages. The fibers are carried by the hot air through the system and they stay in the drying zone for less than half a minute. The fibers will not at any point in the process be heated higher than the wet bulb temperature.

The drying takes place in two or three separate and similar stages, comprising suction duct (Figure 16, 4), primary drying tower (Figure 16, 5), drying fan (Figure 16, 6), secondary drying tower (Figure 16, 7) and cyclone (Figure 16, 8). Directly after discharge from the fluffer, the fiberized pulp enters the first stage suction duct, where the hot air from the heating section is brought into contact with the pulp. The pulp is then carried up and down the primary tower, through the drying fan, through the secondary drying tower to the cyclone where the fibers are separated from the damp drying air. The velocity through both towers is lower than in the ducts causing the bigger fiber bundles containing more water - being heavier - to hover in the air stream longer than the smaller and dryer ones. Thus the towers ensure homogeneous drying of the pulp.

All through the drying process there is very good turbulence. This gives a high heat transmission coefficient and ensures a high degree of drying efficiency. The drying fans are located after the primary tower in each drying stage. In this location the drying air has cooled down considerably, has a lower specific volume and requires less fan capacity. Stage 2 is similar to stage 1. The temperature in each stage is controlled individually, but fine tuning of the final pulp dryness is normally done by adjusting the temperature set point in the last drying stage. The normal target dryness is 87% BD, but different plants are drying their products to drynesses ranging from 83 to 90% BD, depending on pulp type, storage conditions/properties or drying cost versus freight cost considerations. The pulp is cooled in the cooling stage (Figure 16, 9), which is a combined cooling and transport stage bringing the pulp to the bale forming slab press.

Important factors, such as temperature and pressure in the different parts of the dryer are closely controlled from a central instrument panel, ensuring constant and homogeneous dryness of the pulp. Fine tuning of the final pulp dryness is normally done by adjusting the temperature set point in the last drying stage.

Scrubber
The exhaust gases from all cyclones are cleaned in a gas washing scrubber tower (Figure 16, 10) before being released into the atmosphere. The exhaust gases pass through a number of water curtains. Impurities are picked up by the water and carried to the circulation tank.

Optional pre-drying and hot air supply
When a very high dryness of the pulp is desired or when producing pulp qualities that are especially hard to dry, it is possible to add a pre-drying stage to the FiberFlash dryer. In such cases the second drying stage will be operated with higher than normal temperature, and the still rather dry and hot air from the cyclone is recirculated to a pre-drying fan.
situated by the fluffer. The fluffed pulp is blown by the fluffer into the recirculated air and carried by the airstream to the pre-drying cyclone where it is separated from the moist air. From the pre-drying cyclone the pulp drops into the first drying stage suction duct. In this way the full drying potential of the drying air is utilized.

At plants located in areas with cold climate and low outdoor temperatures it is possible to add a hot air supply to be mixed into the cooling system. This is in order to avoid too low pulp temperatures and subsequent springy pulp of less than optimal baling properties.

**Case Studies: new lines**

**The highest design capacity in the world for Suzano Bahia Sul in Brazil**

Suzano Papel e Celulose S.A. in Brazil, is the world’s first producer of eucalyptus-derived pulp and currently the second-largest producer in the world. Pulp is produced at two locations: the Suzano mill in the state of São Paulo and the Mucuri mill in the southern part of the state of Bahia. The company now also owns the pulp and paper producer Conpacel in Limeira, state of São Paulo.

**The world’s second largest pulping line**

The Mucuri mill comprises two pulping lines. Line 1, modernized by Kvaerner Pulping (today Valmet) in 2004, has a production capacity of 680,000 tons per year. Line 2, started in August 2007, is the second largest single pulp production line in the world with a nominal capacity of 1,000,000 tons per year.

Valmet (then Metso) supplied the complete recovery island, including the evaporation plant, the recovery boiler and the white liquor plant, as well as the pulp digesting, drying and baling systems for Line 2. The delivery scope also comprised over 900 process and on-off valves for the entire mill, together with a number of analyzers and transmitters for process control.

The drying line was a part of Suzano’s expansion project at the Mucuri mill and was the largest pulp dryer ever built for the highest production ever made on a pulp dryer (Figure 19). The scope of delivery included bleached stock screening, wet end, dryer, high-speed cutter and three baling lines. This was the first delivery made completely according to the DryWay concept. The advantage with the selected DryWay technology was high specific capacity and low specific power consumption.

The trim width of the drying line was 9,990 mm and the

Figure 19. The Mucuri mill is Suzano Group’s largest integrated paper and pulp production unit.
production capacity 3,340 ADT/d of eucalyptus pulp. Start-up occurred in the second half of 2007. A large part of the delivery was manufactured in Brazil and pre-assembled at Valmet's large facilities in Sorocaba.

**New pulping line at VCP Jacarei, Brazil**

Votorantim Celulose e Papel (VCP), an integrated pulp and paper manufacturer in Brazil, started up a new fiber line at their Jacarei mill in 2002, over one month ahead of schedule. The new pulping system was a part of the company's huge investment program, which included a 770,000 tons/yr pulp expansion project at the Jacarei mill. After the startup the mill was capable of producing a total of 3000 tons/day of fully bleached ECF eucalyptus pulp for printing, writing and coated papers, with 2100 tons coming from the new pulping line supplied by Metso Paper (now Valmet).

Pulping line B, which was in operation at Jacarei before the expansion, produced 350,000 annual tons of eucalyptus pulp. The new line C, with technology supplied by Valmet, encompasses complete fiber and pulp drying lines (Figure 20).

For pulp drying, Valmet's DryWay technology includes the equipment for pressurized bleached pulp screening, a wet end equipped with a SymBelt shoe press, a Valmet airborne dryer, a new high-speed cutter and a complete baling system. The trim width of the drying machine is 7.0 meters, with a speed of 220 m/min.

The final touch to the high quality product for the export market is given with pulp baling. After the cutter, the bales are transferred to three baling lines based on Robobaling technology. The bales are covered with pulp sheets produced by the same drying line. Ready-wrapped 250 kg bales are tied in the unitizers, with eight bales forming 2-ton units. Bales for export are transported to the port of Santos for overseas shipment.
VCP carried out a long term job with a clearly defined focus. The objective was to develop a series of leverages to create a structural base for sustainable growth of their company. With respect to project implementation time and cost - VCP has achieved its goals well.

The world's largest pulp mill in Rizhao

APRIL SSYMB Rizhao mill, the world’s largest pulp mill at the time it had completed one full year of operation and produced over one million ADT bleached pulp, is situated in the heart of Rizhao city. On June 30, 2010, the mill produced its first pulp sheet. The mill has a state of the art ecofriendly and odorless production. Valmet is proud to be APRIL SSYMB's partner in this achievement.

The start-up of the greenfield kraft pulp line and chemical recovery process at the APRIL/SSYMB Rizhao mill in Shandong Province, China, went very quickly as can be seen from production achievement during one full year of operation. Everything is running according to plan, a great accomplishment for this mega-sized kraft pulp mill.

The mill is a joint venture between APRIL (Asia Pacific Resources International) and the local government. Valmet's scope of supply included all main processes for kraft pulp production and chemical recovery. Valmet also provided supervision services for erection and start-up, as well as training of mill staff.

Most advanced technology for lowest environment impact

"We selected Valmet to supply the fiber line from chips to bale, evaporation and recovery boiler because of past good experience in dealing with Valmet equipment and management. The mill has invested in the best available technologies to eliminate smell and reduce the color of effluent, and minimize solid waste. This mill is the new benchmark in size and performance for the pulping industry," says APRIL COO A. J. Devanesan.

Pulp drying is carried out using Valmet's energy-saving DryWay concept (Figure 21). The process at the APRIL SSYMB mill consists of two parallel drying lines. The trim width of the drying machines is eight meters.

The delivery encompasses all necessary process systems from rescreening, drying and cutting through to ready-made bales. The drying machine wet end features Valmet's twin-wire DryWay concept furnished with two shoe presses. This enables high web dryness prior to the airborne dryer and thereby remarkable energy savings.

After pulp drying and cutting, the sheets are baled in three baling lines.
installed for both lines. Valmet's Robobaling technology is used for pulp baling. Both baling systems share two unitizers from where the bale units are transported to storage.

**Case Studies: rebuilds**

There are several ways of boosting the capacity of old dryers. One example of a major airborne dryer rebuild is Metsä-Botnia Joutseno, where the drying length was increased by roughly 40% by increasing the number of drying decks.

Beside the extension of the old dryer a major increase in the drying length can be made also by installing a booster dryer above the cutter.

Another way of boosting dryer capacity is by increasing circulation airflow in the airborne dryer, which was done at the Metsä-Botnia Kaskinen mill and VCP. In Metsä-Botnia Kemi all the steam coils were changed to new ones to increase the drying temperature.

**Rebuild of the Joutseno dryer and air systems**

The 6.7 m pulp drying line PD7 was originally designed for 1100 ADT/d soft- and hardwood, which started up in 1991 with the Valmet wet end and Fläkt airborne dryer. The line had reached its limits and the customer chose Valmet to rebuild the line including the Fläkt dryer.

In addition to the cutter, the wire and press section was rebuilt but the most labor demanding rebuild was carried out on the airborne dryer. Eight new drying decks were installed on top of the old decks. Since the dryer did not have a cooler, an external vertical cooler was delivered to avoid yellowing of the web and support the cutter operation.

Such a capacity increase necessitated new heat recovery, process exhausts and supply air to the dryer. Therefore the machine room ventilation needed to be improved.

<table>
<thead>
<tr>
<th>Metsä-Botnia Joutseno, Finland</th>
<th>Original</th>
<th>Before rebuild</th>
<th>After rebuild</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>1100 ADT/d</td>
<td>1334 ADT/d</td>
<td>2200 ADT/d</td>
</tr>
<tr>
<td>Pulp grade</td>
<td>Bleached softwood &amp; hardwood</td>
<td>Bleached softwood &amp; hardwood</td>
<td>Bleached softwood</td>
</tr>
<tr>
<td>Trim at cutter</td>
<td>6700 mm</td>
<td>6700 mm</td>
<td>6700 mm</td>
</tr>
<tr>
<td>Dryness before dryer</td>
<td>HW 46%, SW 45%</td>
<td>44.7%</td>
<td>48%</td>
</tr>
<tr>
<td>Dryness after dryer</td>
<td>90%</td>
<td>87.9%</td>
<td>90%</td>
</tr>
<tr>
<td>Basis weight</td>
<td>850 g/m²</td>
<td>759 g/m²</td>
<td>930 g/m² BD</td>
</tr>
<tr>
<td>Steam pressure</td>
<td>0.35 MPa(g)</td>
<td>0.44 MPa(g)</td>
<td>0.65 MPa(g)</td>
</tr>
<tr>
<td>Startup year</td>
<td>1991</td>
<td>1999</td>
<td>2001</td>
</tr>
<tr>
<td># of drying decks</td>
<td>19</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td># of cooling decks</td>
<td>0</td>
<td>0</td>
<td>Vertical cooler</td>
</tr>
<tr>
<td># of fan towers</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td># of fans per tower</td>
<td>7</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Total # of fans</td>
<td>190</td>
<td>190</td>
<td>246</td>
</tr>
</tbody>
</table>

*Table 1. Metsä-Botnia Joutseno rebuild*
All the modifications were completed in three weeks shutdown time. The new drying decks on top of the old dryer were lifted in place through the roof of the machine room. Very careful surveys and designs were carried out to make all the new parts fit in place at once so as not to exceed the given shutdown time.

**Rebuild of the airborne dryer at the Kaskinen mill**

The pulp drying line PD1 at Kaskinen was started in 1977 and optimized to top production level. There was still an opportunity for higher production by facilitating a simple rebuild of the dryer. The capacity of the dryer was increased by raising the airflow to blow boxes with extra fan modules.

There was enough space between the old fan modules for the same size of new fan modules with a higher airflow capacity. Thirty-one new fan modules of 13 m³/s were installed underneath the top row of the old fan modules to get the best benefit out of the rebuild.

This way the drying nozzles in the top part of the dryer are fed with higher airflow and speed, where the web has a higher moisture content than in the lower part of the dryer. In the same connection the old air to air heat exchangers of the dryer heat recovery were replaced by stainless steel construction, because the original aluminum heat exchangers were leaking badly due to corrosion damage.

**Rebuild of the airborne dryer at Kemi mill**

The PD6 at Kemi was started up in 1959 and had copper tube steam coils leaking to such an extent that the mill determined that they should be replaced in three steps. The first two steps were carried out during scheduled regular shutdowns of five days per year at Finnish Midsummer in 1997 and 1998 with hot dip galvanized steel coils. The final bigger rebuild was carried out in 1999 in a ten-day shutdown due to an extension of the work.

The steel tube coils allow welding joints compared to copper tubes, which are fused. The welding joints give higher security for leak proof construction than fused joints.

In addition, the dryer internal steam and condensate piping was modified to fit into the new steam coil design. A 10% increase in production and evaporation capacity was achieved as a result of these rebuilds.

**Rebuild of an airborne dryer at Ripasa mill**

The delivery of Ripasa was originally agreed to in 2004. The customer planned to replace their wet lap drying machines with one modern drying machine. However, during the project the situation changed so that the customer decided to increase the production target of the new drying line. The dryer equipment was ready for erection or under manufacturing at the time of the new decision. So Valmet needed to design an extension of the dryer for this new capacity target. The extension consisted of the following changes in the dryer and ventilation equipment:
New drying decks (6 pcs)
New circulation air fans (16 pcs)
Additional heat recovery (1 pc)
Adaptation of machine room ventilation

The rebuild delivery was executed during the erection phase of the drying line. When the drying line was started up in 2005, the extension of the dryer was ready on site. The final dimensioning values were successfully achieved soon after the start-up.

Rebuild of an airborne dryer at JE2 drying line at VCP Jacarei mill

In 2004 VCP decided to increase the capacity of the Jacarei mill. The capacity increase consisted of rebuilds of both drying lines, JE2 and JE3. Both the rebuilds were made by Valmet. The airborne dryer at line JE3, originally delivered by Valmet in 2002, proved to outperform the new capacity level and so it needed no rebuild. JE2 drying line was originally started in 1996. This line was delivered by Sunds (today Valmet) with an airborne dryer from Fläkt. The starting point for the rebuild was the following:

- The new capacity target was set up to be 10%.
- This capacity target we could reach by replacing the existing fan modules by new ones with a higher air flow rate.
- At the same time we managed to solve fan problems the customer had faced for years.

The extension consisted of the following changes in the dryer and ventilation equipment:

- New circulation air fans (86 pcs)
- Rebuild of steam and condensate systems
- New pulper exhaust air and dust removal systems for the cutter
- Modernization of the guide roll system

The rebuild was executed during a short shutdown in mid-2006.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.

Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet’s pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.

We are committed to moving our customers’ performance forward.