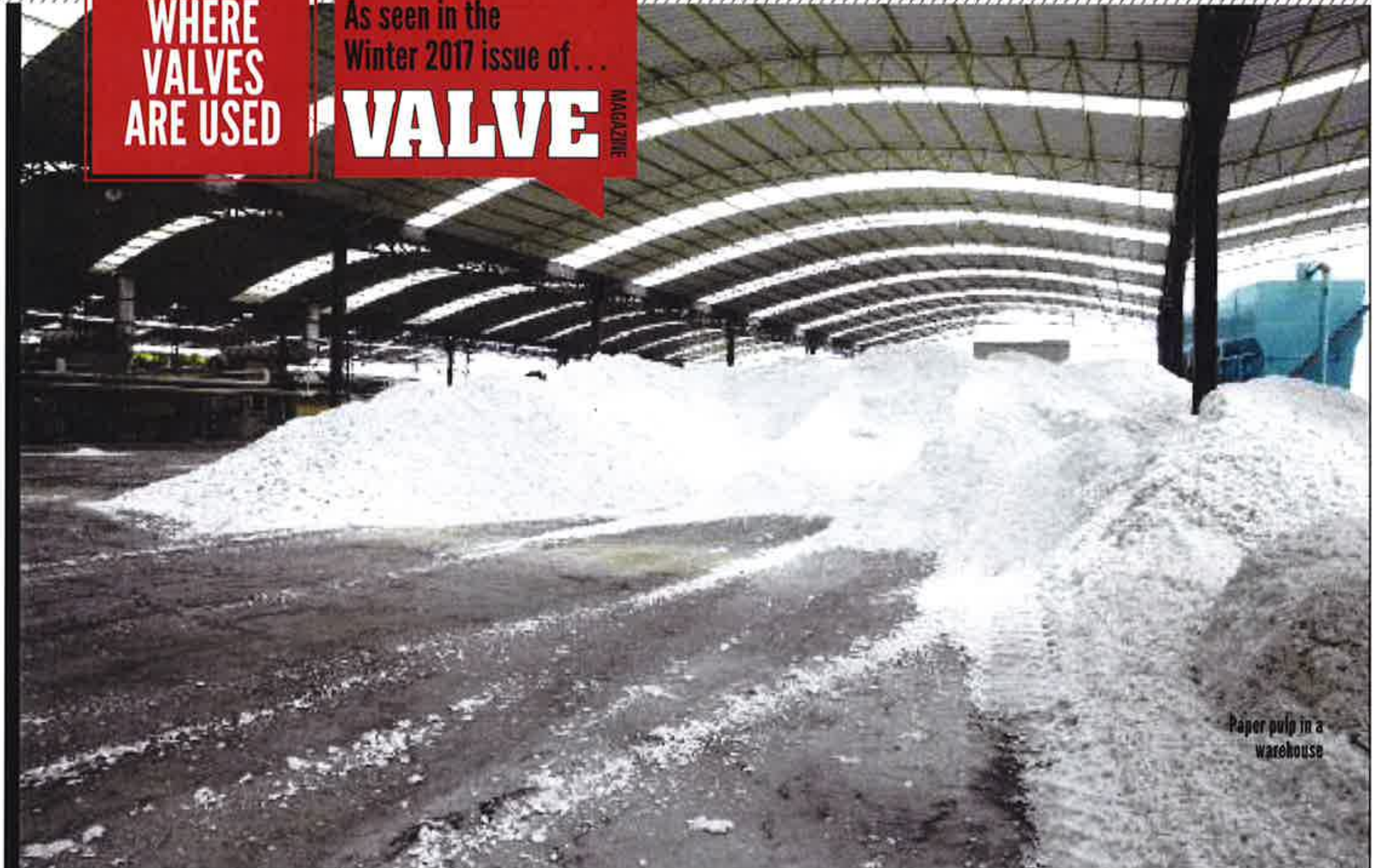
WHERE VALVES ARE USED

As seen in the Winter 2017 issue of... VALVE MAGAZINE



Paper pulp in a warehouse

Valve Selection in Pulp and Paper Operations

BY TODD GREER

Over the centuries, the pulp and paper industry evolved greatly: from the first recorded paper made from rag stock in China (circa 100 AD) to paper derived from wood pulp (the 1840s) to the highly technical manufacturing and chemical processes of today. Paper use historically was for communication, but electronic channels have created significant decreases in newsprint and coated paper. However, other industry sectors emerged, and the world's growing population and modernized economies mean these new sectors, which include packaging and boxboard, tissue, toweling, diaper and personal hygiene products, among others, are flourishing.

In response to this evolution, some traditional pulp mills have converted to produce fluff pulp, which is used for personal hygiene products; others have converted to make alpha crystalline cellulose for the manufacture of rayon fiber in the textile markets. Paper machines also are being repurposed to produce tissue, toweling or boxboard predominantly from recycled fiber.

Executive Summary

SUBJECT: The world's paper use has changed dramatically and so have the mills and machines that produce a widening array of paper and packaging products. Knowing how to choose valves for applications in the growing industry of today can enhance performance and create profit.

KEY ISSUES:

- Cost and application considerations
- The different processes of mills and machines
- What valves make good choices

TAKE-AWAY: The right valves often are not those with lower initial costs, but rather those that provide the lowest cost of ownership over the life of the valve.

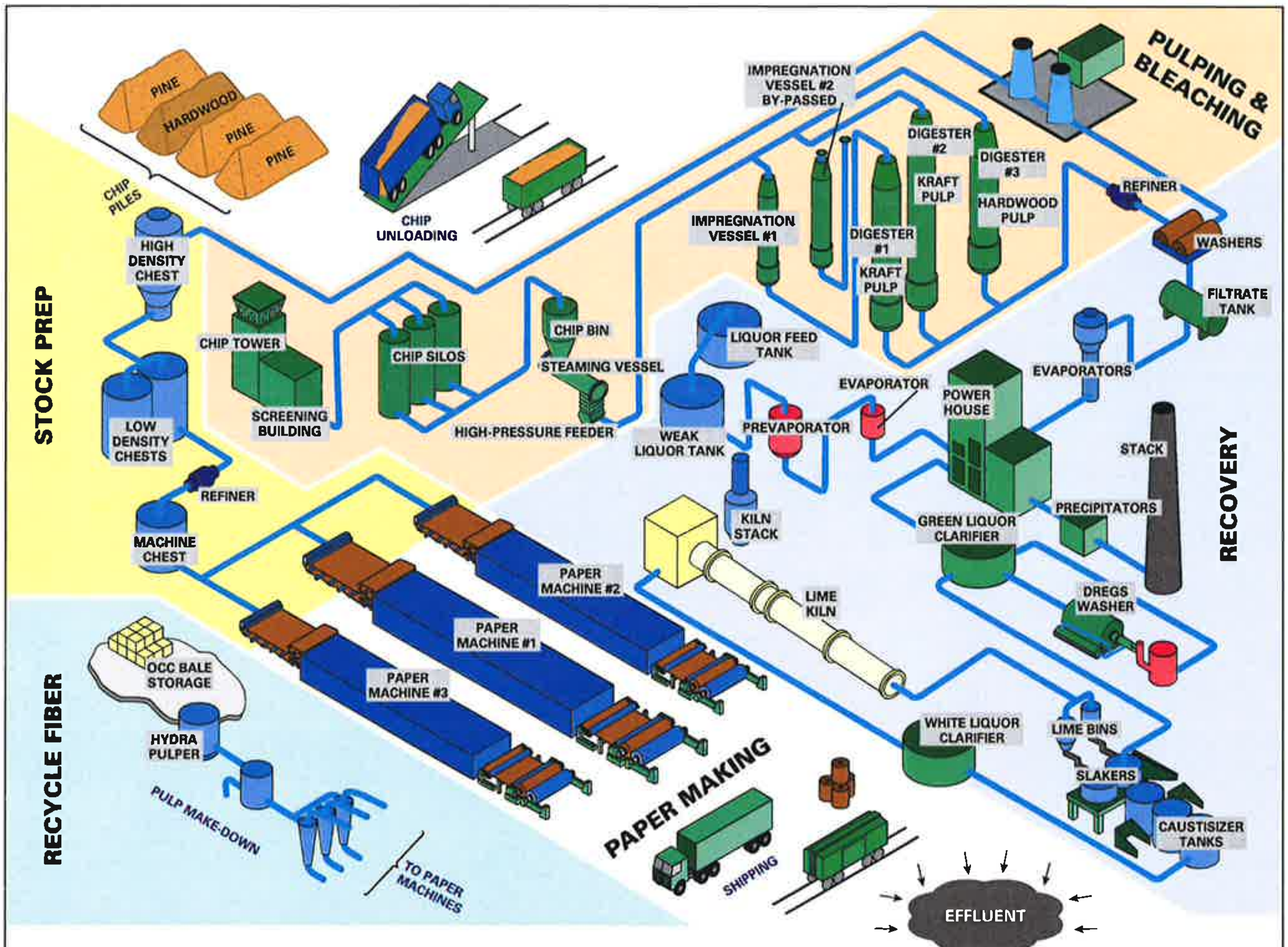


Figure 1. Diagram of a paper mill operation

Correctly selecting valves for applications in this modern and ever-evolving industry can significantly enhance a mill's performance and increase profits (Figure 1).

BETTER OPERATIONS/BETTER MARGINS

Continuous improvement is driven by decreasing process variability while increasing process reliability. This has a positive impact on profit margins. In the early 1990s, EnTech Control Engineering identified the fact that process variability in a control loop was often caused by control valves that were unable to respond to controller output signals quickly, precisely and in a predictable manner. This undesirable behavior was the single biggest contributor to poor control loop performance and destabilization of process operations.

Control valve manufacturers responded to this finding, and the performance of the valve/actuator/positioner package is now demonstrated by exacting quality tests. Selecting control valves with high control accuracy and reliable mechanical performance allows plants to run processes closer to their setpoint—an important factor in increasing plant efficiency and reducing running costs.

APPLICATION CONSIDERATIONS

When evaluating a valve for any application, primary considerations are:

1. *Function:* isolation, control or mixing/diverting
2. *Process conditions:* pressure ratings, temperature range, chemical compatibility, consistency freeness and scale tendency
3. *Valve operation:* leak-free packing, seat leakage, frequency of valve operation, fluid velocity, cycle duty, speed of operation, accuracy and speed of response performance through partial stroke testing or inline diagnostic testing
4. *Maintenance and installation:* dimensions and accessibility for installation or maintenance

Safety is paramount in any mill environment, and valve selection plays a critical role. The importance of having a valve with the proper pressure rating, temperature capability and chemical resistance are obvious. Other safety considerations include the probability of packing leaks that could allow media to create slip hazards in walkways, fugitive emission constraints, ease of actuation and ergonomics associated with actuation of manual valves, and the need for double block-and-bleed associated with lockout and confined space requirements.

Also, a compatibility requirement often forgotten in the pulp and paper process is the boil-out (removal of deposits) or solvent chemistry used to remove scale buildup or biological growth in a pipeline. These chemicals are typically on the opposite end of the pH spectrum from the process media so they dissolve precipitated scale buildup. Valve materials that are compatible with the process media must also be compatible with the solvent chemistry.

For isolation valves, an important criterion is the allowable seat leakage, especially under low-pressure conditions. The specification used most commonly is American National Standards Institute/Fluid Controls Institute (ANSI/FCI) 70.2. The leakage rating ranges from Class I to VI. Class IV is the most common for metal-seated valves at 0.01% of rated valve capacity (C_v). Class VI is common for resilient-seated valves at near-bubble tight. It is imperative that the test pressure be qualified because it is not explicitly specified in this standard.

Control valves are designed to throttle flows and typically are not required to provide bubble-tight shut off. Because seat friction is often the enemy of good control, a clearance seat can be used to reduce friction. Where control and bubble-tight shutoff are both required, a control valve and isolation valve are used in combination.

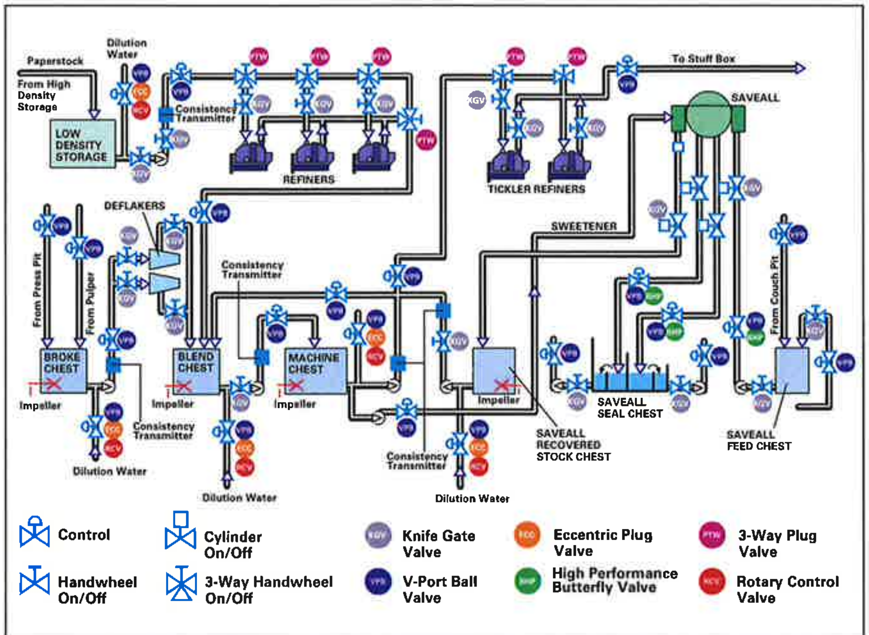


Figure 2. Stock preparation and blending

When selecting control valves, corrosion, erosion and abrasion also need to be considered. Corrosion occurs through deterioration from chemical attack. Erosion is deterioration caused by moving fluids. Abrasion occurs from mechanical contact between two materials. It is common for these three factors to happen in conjunction with each other. The higher the fluid velocity, the more likely such damage will occur. Proper valve style selection, material choices, installation procedures and system design are critical in combatting these potential pitfalls.

High-performance butterfly valves are ideal for many pulp and paper services including those that involve water, steam, liquor and other corrosive liquids and gases.

Cavitation is erosion that commonly affects control valves caused by a phase change of a liquid to a vapor and then back to a liquid as the fluid passes through the vena-contracta of the valve and exits downstream. Cavitation is dependent on the pressure drop ratio of the valve: valve pressure drop divided by the inlet pressure and the valve pressure recovery factor. It is largely controlled by proper valve sizing, selection and system design. Mitigating cavitation improves the life cycle of the valve and control performance. Most control valve suppliers provide free software programs for properly sizing valves for service conditions including the likelihood of cavitation.

Many mills have developed partnerships with valve manufacturers to enhance plant expertise. This requires good technical communication of process conditions between mill personnel and the manufacturer for each area of the mill—information that can be used to select the correct valves for that area. Whenever possible, the mill should provide an International Society of Automation (ISA) Valve Data sheet (Form S20.50) to specify the criteria for selecting the correct valve.

Table 1. Valve Applications for Stock Preparation

Purpose	Valve Selection
Isolation/shutoff	knife gates, high-performance butterfly valves
Flow control	v-port ball
High consistency	o-port
Dilution water control	eccentric plug, v-port ball, rotary control
Clarifier and thickener effluent	eccentric plug
Abrasive media (kaolin)	rotary control
Refiner stock control/ mixing/diverting	3-way or 4-way eccentric plug valves, knife gate

For a quarter-turn control valve in this application, a resilient-seated v-ball or plug valve is the right selection (Table 1).

STOCK PREPARATION

Stock preparation (Figure 2) is the interface between the pulp mill and the paper machine. In an integrated mill, stock preparation begins with high-consistency stock at the discharge of a high-density pulp storage chest and ends with the blended paper-making pulp furnish (the pulp and any ingredients added before it's introduced into the machine) at the machine chest. In a non-integrated mill, stock preparation starts by feeding pulp bales into a repulper system. The most common valves in the stock preparation area are knife gate valves.

For pulp slurries, the percent concentration of fiber is called stock consistency. The rate at which pulp slurry will dewater is defined by a property called freeness and is measured by Canadian Standard Freeness (CSF) points. Both stock consistency and freeness are critical application criteria in valve selection.

High-consistency pulp stock is stock in which fiber exceeds 6-8% and has a high freeness rate of more than 500 CSF points. If high-consistency stock in the pipeline is not flowing, it will dewater and inhibit a valve from closing. For this application, an o-port valve is recommended. When an o-port gate valve closes, it removes a cross section of the media in the pipeline to allow the valve to seat. When the o-port is opened, it replaces the cross section back into the pipeline.

Moderate consistency stock ranging from 2-6% with a freeness rate of less than 500 CSF points is handled best by a metal-seated knife gate valve rated for full-reverse pressure. A metal-seated valve in this service will have a longer lifecycle than an equivalent resilient-seated valve because of the rugged metal construction. Metal-seated valves also offer the advantage of not having an elastomer that can fail and color-contaminate the stock. A quarter-turn valve such as a v-port ball with a metal seat will provide a cutting action that keeps the seat face free of fiber buildup so the valve seals tightly.

For consistencies below 2% or general mill white-water applications that require bubble-tight shutoff and bidirectional service, a perimeter resilient-seated knife gate valve is the right choice for on/off service.

SECONDARY FIBER REPULPING—RECYCLING

Recycled fiber is growing rapidly as an environmentally friendly and economical fiber source. Recycled paper is separated for quality and cleanliness into a multitude of grades and costs. The most economical and highest volume of recovered material is labeled "post-consumer." It contains a high amount of contamination, and the level and variety of that contamination present unique valve selection critera.

The repulping process (Figure 3) begins as bales of recycled paper delivered to the pulper. Junk trap valves remove sand, metal, staples, glass and rocks directly off the pulper using high-density cleaners. Recycle fiber with high levels of contaminants and abrasive slurries are extremely erosive—standard stainless-steel valves can be compromised in the matter of days. As a result, valves used in this service need metallurgy that will hold up to abrasion such as heat-treating stainless steel to increase the hardness of valve seats, gates and bodies. Other choices include using chrome carbide overlays to provide a protective surface with a greatly increased Rockwell C hardness.

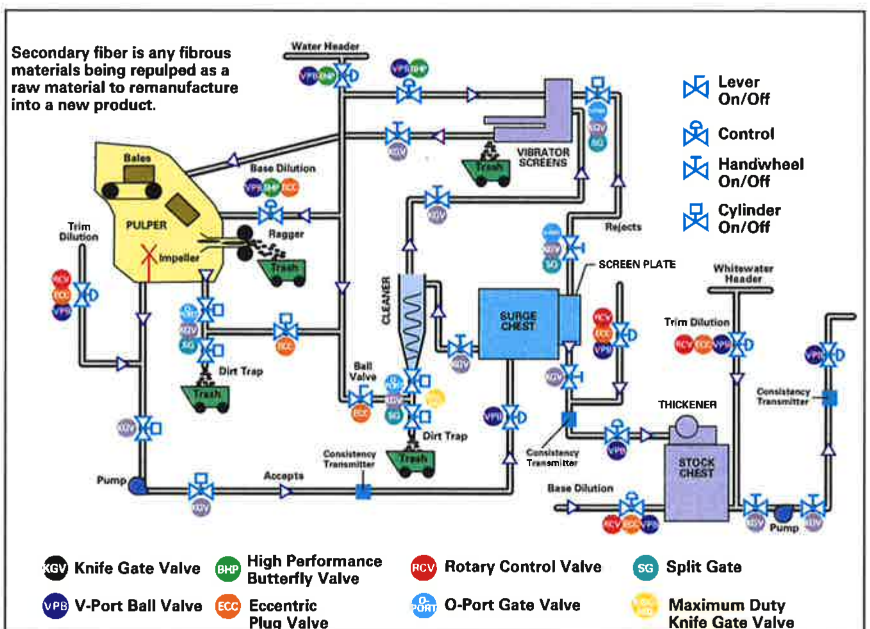


Figure 3. Secondary fiber repulping operation

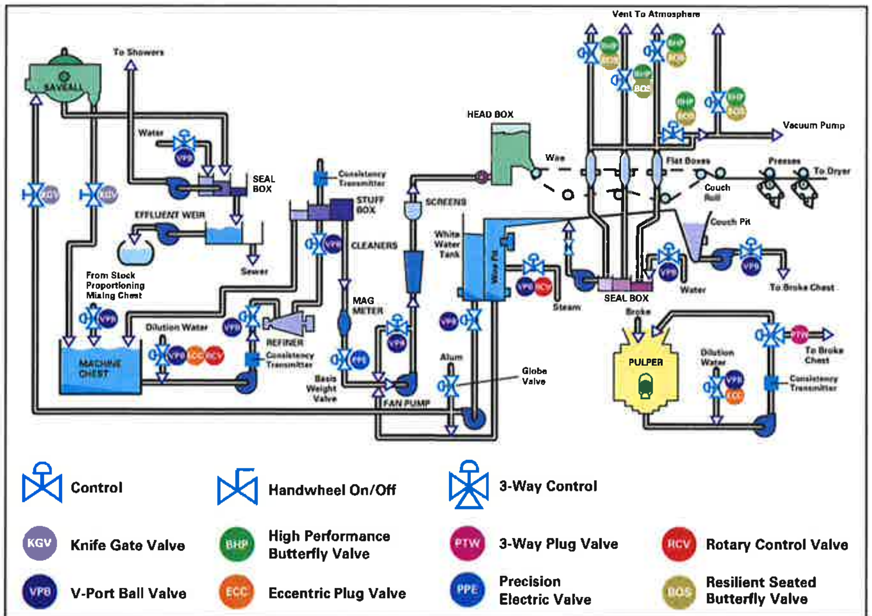


Figure 4. Fourdrinier wet end

PAPER MACHINE

Paper machine (Figure 4) advancements have created ever-increasing speeds, wider webs of paper and more exacting standards of quality. No valve exemplifies the importance of proper valve selection better than the most critical valve on any paper machine: the basis weight valve. If this valve fails, it will immediately shut down the paper machine.

Proper basis weight control is integral to the cost of the finished paper product and its variability. Such control is critical in machine operation uptime and can impact lost time that occurs from paper breaks caused by draw variability, retention aids, drying performance and maximum production speeds. These factors all equate directly to operating efficiency and profit.

Understanding the process parameters that lead up to the basis weight valve is important. One critical parameter is consistency, which is the additive effect of numerous control loops before the basis weight valve. Other parameters include pressure control, valve sizing and the interface into the distributed control system for loop-tuning control, a detail critical to providing exceptional basis weight control (Table 2).

Table 2. Valve Applications for Paper Machines

Purpose	Selections
Basis weight control	plug or v-port ball valve with highly precise electric actuation
Cleaner and pump isolation	metal-seated unidirectional and resilient-seated bidirectional knife gates
Flow and level control	v-port ball
Vacuum control	high-performance butterfly, resilient-seated butterfly
Tank level sensing and drains	metal-seated knife gate
Steam service	v-port ball, high-performance butterfly, rotary control
Condensate service	v-port ball, high-performance butterfly, rotary control

BLEACH PLANT

Cellulose fiber is inherently white. Lignin (also called wood pitch) contributes the brown color of unbleached pulp. To produce high-quality, stable paper pulps, bleaching methods use chemical process such as chlorination, alkaline extraction sodium hydroxide-based, chlorine dioxide, oxygen, hypochlorite bleach, peroxide and ozone. Bleaching is usually perfomed in sequential stages, and each stage has specific fiber and chemical considerations for properly selecting valves. Many of these processes require higher alloy metals or valves with resilient liners. Valve manufacturers offer elastomer and metallurgical chemical compatibility tables for corrosive materials to aid in proper selection.

PULPING

Pulping involves steaming wood chips to soften them and then either physically grinding or chemically dissolving the chips into pulp. Quarter-turn valves such as v-port ball or rotary control valves with hardened trim are well suited for the steam and chemical-handling applications of the pulping operation (Table 3).

DIGESTERS

A batch digester is essentially an industrial pressure cooker filled with wood chips and liquor. Most batch units are now equipped with an automatic capping valve—the most popular are ball valves—but knife gates can be used as well. The bottom of the digester has a blow valve to hold pressure.

Batch digesters can either be sulfate chemistry (referred to as kraft pulping) or sulfite pulping. Valve selection for these processes is affected by the fact that kraft pulping is an alkaline process (high pH), and sulfite pulping is an acidic process (low pH).

Continuous digesters use a heated, pressurized chamber that retains wood chips at sufficient temperatures and time for the chemical reaction to dissolve the lignin bonding the fibers. The predominant valve used around the digester is a rotary dual metal-seated valve for both continuous and batch digesting.

Table 3. Valve Applications for Pulping

Purpose	Selections
Steam impregnation	v-port ball with hardened trim, rotary control
Steam venting	v-port ball with hardened trim, rotary control
Flow & pressure control	v-port ball, rotary control
Dilution water for consistency control	eccentric plug, v-port ball, rotary control

CHEMICAL RECOVERY

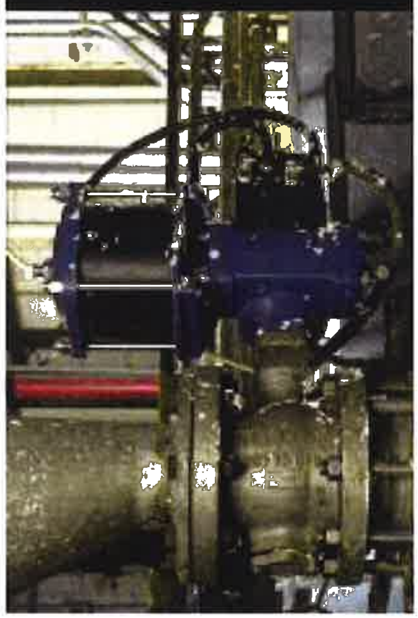
From the blow tank, pulp fiber is separated from spent cooking liquor in brown stock washers and sent to the bleach plant. Recovery of chemicals from the spent cooking liquor and incineration of the organic residuals (lignin) starts with weak black liquor from the brown stock washers and follows this process:

1. Evaporation to concentrate black liquor
2. Incineration of black liquor in a recovery boiler
3. Dissolving inert chemicals to form green liquor
4. Causticizing green liquor with lime to form white liquor
5. Burning lime mud in a kiln to reconstitute the lime for the causticizing process
6. Returning white liquor to the digester for chip pulping

Valves operating in severe service conditions such as pulping liquors, abrasive slurries and scaling media require special design criteria to perform reliably and handle the challenges. Valve selection should include consideration of design features as well as metallurgy, wetted trim requirements and abrasion resistance.

In high-scaling applications such as green liquor, full-ported ball valves are preferable. Ball valves limit the surface area available for scale buildup, and the seat designs will scrape the ball clean through the 90-degree actuation rotation before seating, which provides tight shutoff. O-port valves are an alternative when the seating surface of the gate can be cleaned by using a scraper.

V-port valves can provide highly accurate control of paper stock.



For control valves, plating wetted trim components with tungsten carbide provides a barrier surface. Ceramic trim is an option, especially for smaller control valve applications on abrasive slurry service such as calcium carbonate or titanium dioxide.

CONCLUSION

The pulp and paper industry has experienced significant changes in the last 20 years that have made selecting valves providing maximum performance and lowest cost an important strategy. Selecting the proper valve for each area of the mill requires technical capability and in-depth process knowledge. Although that selection may not have the lowest initial cost, it should be the valve that has the lowest total cost of ownership over the valve's life. VM

EDITOR'S NOTE: Pulp and paper plants use many types of valves. This article provides an overview of some common valve styles and where they are used. It is not meant to be all-inclusive.

Todd Greer is pulp & paper industry manager for DeZURIK, Inc. (www.dezurik.com). He also was production manager of International Paper's Sartell, MN paper mill for over 20 years. Reach him at todd.greer@dezurik.com.