

VALVE SELECTION IN PULP AND PAPER OPERATIONS

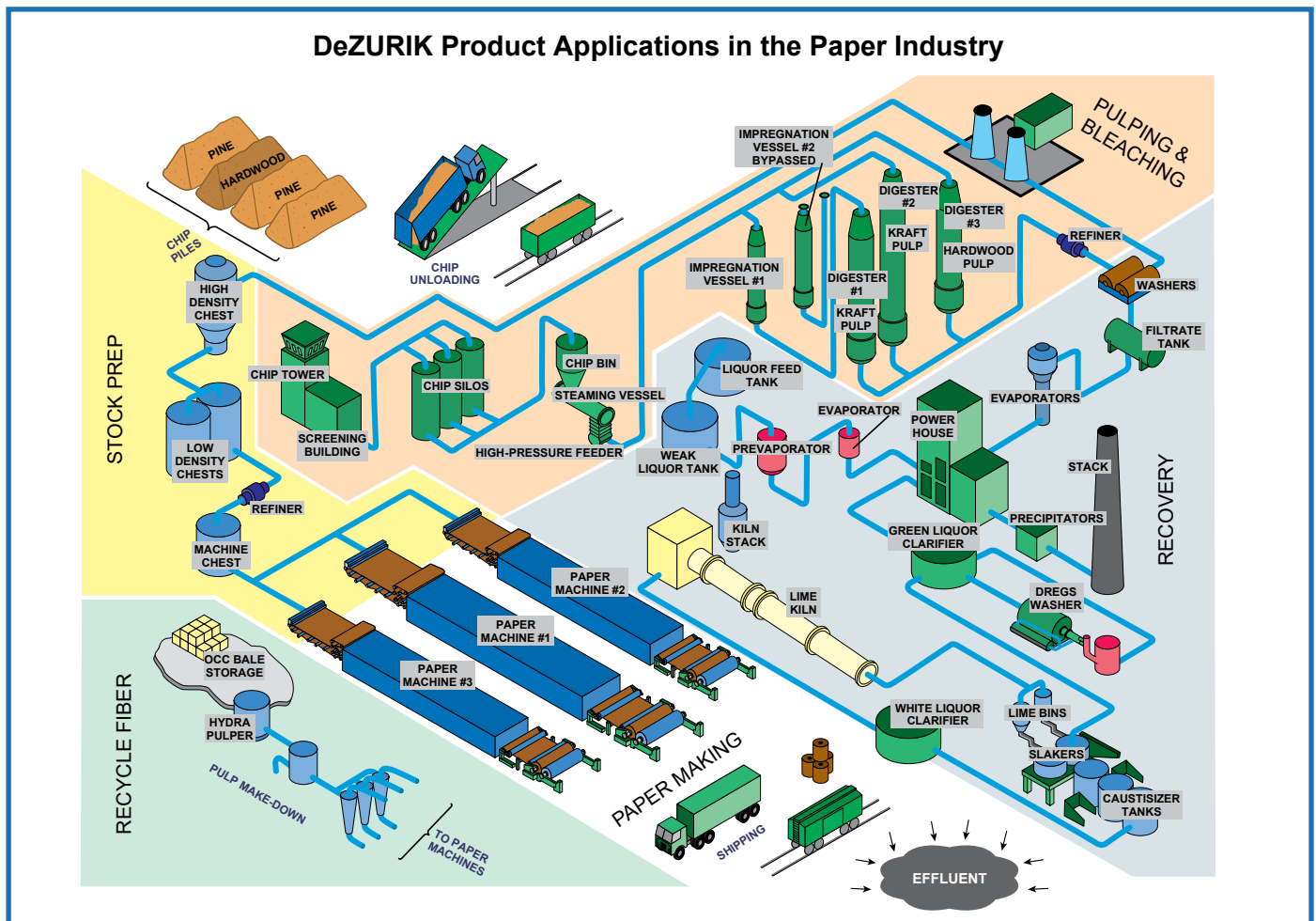
Evolution of the Industry

The pulp and paper industry has evolved from its origins around 100 AD in China, where rag stock was used as a fiber source, to today's modern manufacturing processes. The shift to wood pulp in the 1840s revolutionized production, enhancing efficiency and scalability.

While demand for newsprint and coated paper has declined due to electronic communication, growth in packaging, boxboard, tissue, toweling, and personal hygiene products has surged, driven by global

population growth and economic development. Traditional pulp mills have adapted by producing fluff pulp for hygiene products, alpha crystalline cellulose for rayon fibers, and repurposing machines for tissue, toweling, and boxboard—often using recycled fiber to meet sustainability goals.

This industry transformation underscores the need for precise valve selection to optimize performance, support process adaptability, and enhance profitability in evolving applications.



Optimizing Control Valve Performance for Process Reliability

Continuous improvement in industrial processes relies on reducing variability and enhancing reliability, both of which drive profitability. In the early 1990s, EnTech Control Engineering identified control valves as a key source of process variability due to inadequate response speed, precision, and predictability to controller outputs. This deficiency was a major contributor to poor control loop efficiency and process instability.

In response, valve manufacturers have advanced valve/actuator/positioner designs, validated through rigorous quality testing. High-accuracy, mechanically robust control valves help maintain operations closer to setpoints, improving efficiency and reducing costs.

Key operations in pulp and paper manufacturing—pulping, bleaching, stock preparation, papermaking, recycling, and chemical recovery—require precise valve selection based on process conditions (pressure, temperature, flow rate, and chemical compatibility). Additional factors include material compatibility, service life, maintenance demands, and system integration. A comprehensive evaluation of these criteria ensures optimal valve performance, reliability, and cost-effectiveness across the application lifecycle.

Key Operations

Pulping

Pulping is a critical process that involves the treatment of wood chips to convert them into pulp. This is achieved through either mechanical grinding or chemical dissolution. The process begins with steaming the wood chips to soften them, facilitating subsequent breakdown in chemical environments.

For controlling steam and chemicals in pulping operations, quarter-turn valves—such as v-port ball valves and rotary control valves—offer superior performance. Equipped with hardened trim, these valves provide reliable operation and durability under high-pressure steam and corrosive chemical conditions, ensuring efficient regulation in demanding process environments.

Valve Applications for Pulping	
Purpose	Valve Selections
Steam Impregnation	V-port ball valve with hardened trim, rotary control valve
Steam Venting	V-port ball valve with hardened trim, rotary control valve
Flow & Pressure Control	V-port ball valve, rotary control valve
Dilution Water for Consistency Control	Eccentric plug valve, v-port ball valve, rotary control valve

Bleaching

Cellulose fiber is naturally white, while lignin, also known as wood pitch, imparts the brown color to unbleached pulp. To produce high-quality, stable paper pulps, various chemical bleaching methods are employed, including chlorination, alkaline extraction using sodium hydroxide, chlorine dioxide, oxygen, hypochlorite bleach, peroxide, and ozone. Bleaching is typically carried out in multiple sequential stages, each requiring specific considerations regarding fiber treatment and chemical compatibility for the proper selection of valves. Many of these processes demand valves made from higher-alloy metals or those featuring resilient liners to withstand the harsh conditions. Valve manufacturers commonly provide elastomer and metallurgical compatibility charts to support proper material selection for corrosive applications.

Stock Preparation

Stock preparation bridges the pulp mill and paper machine. In integrated mills, it starts with high-consistency stock from high-density storage and ends at the machine chest with blended papermaking pulp. Non-integrated mills begin with repulping bales. Knife gate valves are most common in this area.

Key Valve Selection Criteria:

- **Stock Consistency:** Fiber concentration in pulp slurry.
- **Freeness:** Dewatering rate, measured in Canadian Standard Freeness (CSF) points.

High-Consistency Stock (6–8%, >500 CSF):

O-port gate valves are ideal. They cut through thick media, preventing dewatering-induced blockages and ensuring reliable seating.

Moderate Consistency Stock (2–6%, <500 CSF):

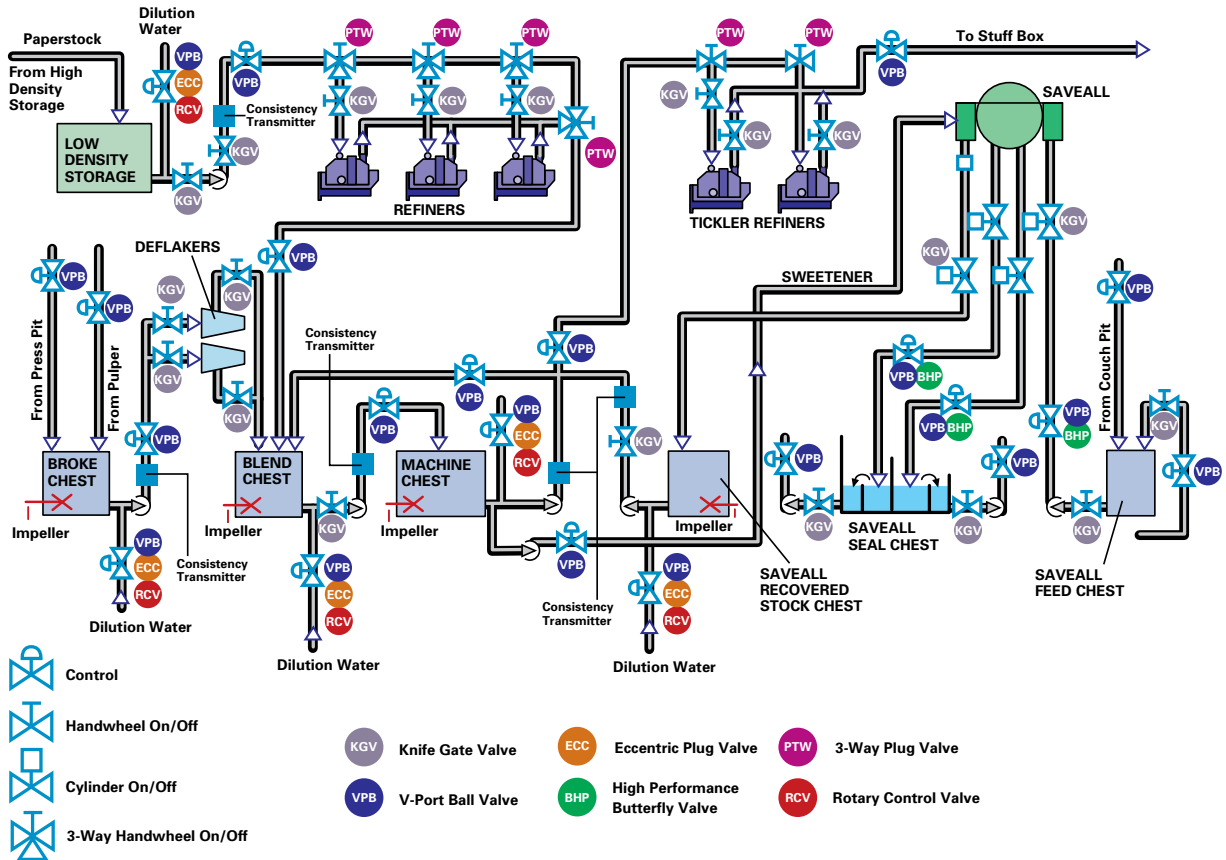
Metal-seated knife gate valves rated for full-reverse pressure are preferred due to durability and resistance to elastomer failure. V-port ball valves with metal seats offer cutting action to minimize fiber buildup and ensure tight sealing.

Low Consistency Stock (<2%) & White Water:

For bubble-tight, bidirectional shutoff, perimeter resilient-seated knife gate valves for on/off service are used. For control applications, resilient-seated V-port ball valve or eccentric plug valves are recommended.

Proper valve selection based on stock consistency and freeness ensures optimal performance, reliability, and longevity.

Stock Preparation and Blending Overview



Valve Applications for Stock Preparation	
Purpose	Valve Selections
Isolation/Shutoff	Knife gate valve, high-performance butterfly valve
Flow Control	V-port ball valve
High Consistency	O-port knife gate valve
Dilution Water Control	Eccentric plug valve, v-port ball valve, rotary control valve
Clarifier & Thickener Effluent	Eccentric plug valve
Abrasive Media (Kaolin)	Rotary control valve
Refiner Stock Control/Mixing/Diverting	3-way or 4-way eccentric plug valve, knife gate valve

Papermaking

Advancements in paper machines—faster speeds, wider webs, and stricter quality standards—underscore the importance of proper valve selection, particularly for the basis weight valve, the most critical valve on the machine. Its failure results in immediate shutdown, directly impacting production uptime, efficiency, and profitability.

Effective basis weight control reduces product variability and minimizes downtime from paper breaks caused by draw fluctuations, retention aid issues, drying inefficiencies, and speed limitations. Key process parameters influencing performance include stock consistency (driven by multiple upstream control loops), pressure control, accurate valve sizing, and precise integration with the distributed control system for optimized loop tuning.

Properly selected and tuned, the basis weight valve ensures stable machine operation, consistent product quality, and cost-efficient production.



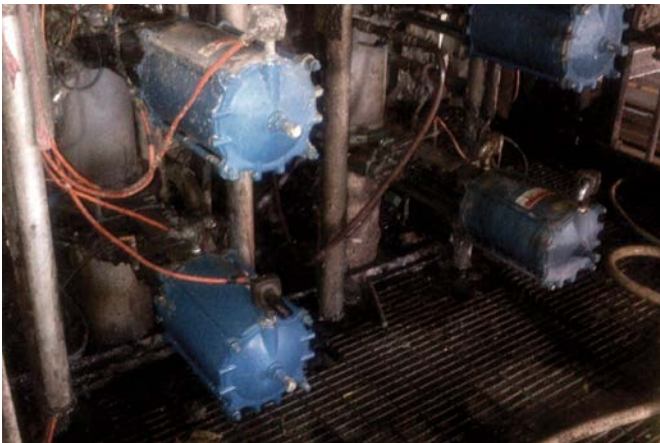
DeZURIK's Precision Electric Basis Weight Control Valve is specifically designed for critical paper stock control and is used for basis weight and head box level control applications.

Valve Applications for Papermaking	
Purpose	Valve Selections
Basis Weight Control	Eccentric plug valve or v-port ball valve with highly precise electric actuation
Cleaner & Pump Isolation	Metal-seated unidirectional and resilient-seated bidirectional knife gate valve
Flow & Level Control	V-port ball valve
Vacuum Control	High-performance butterfly valve, resilient-seated butterfly valve
Tank Level Sensing & Drains	Metal-seated knife gate valve
Steam Service	V-port ball valve, high performance butterfly valve, rotary control valve
Condensate Service	V-port ball valve, high performance butterfly valve, rotary control valve

Recycling

Recycled fiber is a rapidly growing, cost-effective, and eco-friendly material source. Post-consumer recycled paper, the most economical and abundant grade, contains high levels of contaminants, posing unique challenges for valve selection.

In the repulping process, junk trap valves remove abrasives like sand, metal, staples, glass, and rocks via high-density cleaners. These abrasive slurries cause rapid erosion, compromising standard stainless steel valves within days. To ensure durability, valves should feature abrasion-resistant metallurgy such as heat-treated stainless steel for hardened seats, gates, and bodies, or chrome carbide overlays for superior hardness and wear resistance.



DeZURIK KGC Knife Gate Valves are proven performers in Recycle Paper High Density Cyclone Cleaners. The KGC-MC valve is ideally suited for recycle applications that require shearing of media containing heavy trash, solids, nails, wire, staples, plastic or glass.

Chemical Recovery

In the chemical recovery process, pulp fiber is separated from spent cooking liquor in brown stock washers, with chemicals reclaimed through the following steps:

1. **Evaporation** to concentrate black liquor
2. **Incineration** in a recovery boiler
3. **Dissolving** inert chemicals to form green liquor
4. **Causticizing** green liquor with lime to produce white liquor
5. **Burning lime mud** in a kiln to regenerate lime
6. **Recycling white liquor** to the digester for pulping

Valves in severe service—handling pulping liquors, abrasive slurries, and scaling media—require specialized designs emphasizing durable metallurgy, abrasion-resistant trim, and robust sealing.



DeZURIK PEC Eccentric Plug Valve in a pulp mill on a green liquor isolation application.

High-Scaling Applications (e.g., Green Liquor):

Full-ported ball valves are ideal, minimizing scale buildup with self-cleaning seat designs during 90° actuation for tight shutoff. O-port valves are suitable where gate seating surfaces can be cleaned via scrapers.

Control Valves:

Tungsten carbide plating on wetted trim components enhances erosion resistance. Ceramic trim is recommended for abrasive slurry applications, such as calcium carbonate or titanium dioxide, particularly in smaller valves.

Key Considerations for Valve Selection

When evaluating valves for any application, consider the following:

1. **Function:** isolation, control or mixing/diverting
2. **Process conditions:** pressure rating, temperature range, chemical compatibility, consistency, freeness and scale tendency
3. **Valve operation:** leak-free packing, seat leakage class, actuation frequency, fluid velocity, duty cycle, speed of operation, and diagnostic capabilities
4. **Maintenance and installation:** valve dimensions and accessibility

Safety Considerations

Valve selection directly impacts safety, emphasizing proper pressure ratings, temperature limits, and chemical resistance. Additional factors include packing leak potential (fugitive emissions, slip hazards), ease of actuation, ergonomic design for manual valves, and double block-and-bleed lockout valves for confined space requirements.

Material Compatibility

Beyond process media compatibility, consider exposure to boil-out or solvent chemicals used for scale removal, which often differ chemically from process fluids. 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.

Isolation Valves

Seat leakage is critical, especially at low pressures. ANSI/FCI 70.2 defines leakage classes (I–VI). Class IV (0.01% Cv leakage) is common for metal-seated valves, while Class VI provides near bubble-tight performance for resilient seats. Test pressures should be verified, as they are not explicitly defined in the standard.

Control Valves

Designed for throttling, control valves typically don't offer bubble-tight shutoff. To achieve both accurate flow control and tight shutoff, integrate a control valve with an isolation valve. Material selection should address corrosion, erosion, and abrasion risks, which often occur simultaneously, especially at high velocities.

Cavitation

Cavitation, caused by rapid phase changes due to pressure drops, leads to erosion and degraded performance. Proper valve sizing, pressure recovery considerations and system design mitigate cavitation. Valve manufacturers often provide software tools for accurate sizing and cavitation risk assessment.

Optimizing Valve Selection

Collaboration with valve manufacturers enhances selection accuracy. Providing detailed process data, ideally through an International Society of Automation (ISA) Valve Data Sheet (Form S20.50), ensures valves meet specific mill requirements.



DeZURIK High Performance Butterfly Valves are ideally suited for a wide variety of services including water, steam, liquor and other corrosive liquids and gases.

Conclusion

The pulp and paper industry has experienced significant changes over the past decades. Selecting valves that ensure optimal performance and cost efficiency is now a key operational priority. Proper valve selection for each process area within the mill demands a high level of technical expertise and comprehensive process knowledge. While the chosen valve may not offer the lowest initial purchase cost, it should be evaluated based on its total cost of ownership (TCO) over its operational lifespan, ensuring long-term reliability, efficiency, and minimal maintenance requirements.

Article content provided by Todd Greer (Valve Magazine, Winter 2017).

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