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Energy checklist: pulp mill

Scope

This Technical Information Paper provides an energy checklist for the pulp mill: from digesters through the washers, refining, defibering, screening, and bleaching, plus evaporators, recovery boilers, caustic area, and lime calciners for the liquor. This comprehensive list contains concise statements without detailed explanation for brevity. Checklist items are non-prioritized areas of focus where energy related improvements can be realized.

Safety precautions

All mill safety protocols and precautions must be followed at all times.

Checklist

1. General items

1.1. Chilled water (1)

- 1.1.1. If practical, raise chilled water temperature and reduce condenser water temperature.
- 1.1.2. Reduce scaling or fouling.
- 1.1.3. Purge trapped air in condenser.
- 1.1.4. Maintain adequate condenser water flow.
- 1.1.5. Replace absorption chillers with electric drive centrifugal chillers.
- 1.1.6. Use the [Chilled Water System Analysis Tool](#) available from the Department of Energy – Advanced Manufacturing Office.

1.2. Compressed air systems (2)

- 1.2.1. Use outside air for air compressor intake.
- 1.2.2. Reduce compressor air pressure.
- 1.2.3. Repair compressed air leaks.
- 1.2.4. Use synthetic lubricant in compressors.
- 1.2.5. Recover waste heat from air compressor and use it to heat the plant in the winter.
- 1.2.6. Use vortex nozzle for cleaning.

- 1.2.7. Use tools, calculators and tip sheets to benchmark and evaluate systems, available from the Department of Energy - Advanced Manufacturing Office: [Compressed Air Systems](#) .
- 1.3. Insulation and packing
 - 1.3.1. Properly insulate all pipes and tanks in accordance with the [Mechanical Insulation Design Guide](#) (3)..
 - 1.3.2. Use state of the art packing to increase equipment reliability while minimizing water use.
- 1.4. Pumps (4)
 - 1.4.1. Select all pumps for specific use. Maximum efficiency is obtained by matching the pump and motor for present requirements, not future use.
 - 1.4.2. Use mechanical seals.
 - 1.4.3. Use VFD's on pumps to minimize energy where appropriate.
 - 1.4.4. Use tools, calculators and tip sheets to benchmark and evaluate systems, available from the Department of Energy -- [Pump Systems](#) .
- 1.5. Refiners (5)
 - 1.5.1. Operate fewest refiners possible.
 - 1.5.2. Optimize plate design to allow minimum specific energy at optimum shive levels.
 - 1.5.3. Use Specific Energy Control to allow optimum shive levels (prevent over-refining).
 - 1.5.4. Eliminate reject refining by recirculating screen rejects back to the blow tank if system has sufficient capacity.
- 1.6. Steam Systems (6)
 - 1.6.1. Find and repair steam leaks.
 - 1.6.2. Implement a steam trap management program.
 - 1.6.3. Investigate potential areas for condensate return.
 - 1.6.4. Evaluate insulation condition.
 - 1.6.5. Investigate opportunities to reintroduce flash steam.
 - 1.6.6. Use tools, calculators and tip sheets to benchmark and evaluate systems, available from the Department of Energy - [Steam Systems](#) .

2. Digester Area

- 2.1. Conveyors
 - 2.1.1. Belt conveyors are preferred over pneumatic conveyors.
- 2.2. Batch digesters
 - 2.2.1. Two level steaming may be advantageous.
 - 2.2.2. Direct steaming may be advantageous at many mills; check the overall steam power balance to determine if indirect steaming should be used.
 - 2.2.3. Percent yield affects steam-power balance more than any other single item.
 - 2.2.4. Recover blow heat efficiently.
 - 2.2.5. Control gas-off.
 - 2.2.6. Computer controlled digester should level steam demand and increase pulp uniformity.
 - 2.2.7. Optimize cooking conditions: chip loading, liquor charge, and temperature-pressure-time relationship.
- 2.3. Continuous digesters
 - 2.3.1. Excess fines and pin chips adversely affect operation. Digester screen design will dictate the system tolerance; diagonal slotted screens are most forgiving.
 - 2.3.2. Excess water from chip washing adversely affects operation.
 - 2.3.3. Poor white liquor quality (clarity) will result in plugging and scaling of digester screens and heaters.
 - 2.3.4. Good steaming is important, particularly for SW. Optimize chip bin level control if steaming in bin, utilize bottom steaming in SV and optimize SV relief.
 - 2.3.5. High wash zone loading results in channeling & poor operation; converting to downflow will decrease cooking temperatures, lower energy consumption and possibly improve washing.
 - 2.3.6. Top separator basket slot size needs to match chip furnish.
 - 2.3.7. Always rebuild equipment to OEM specifications.
 - 2.3.8. Flash Liquor Pump in particular; speed should be as slow as possible.
 - 2.3.9. Safety relief valves should be checked annually and should relieve to a safe location.
 - 2.3.10. Energy recovery: consider opportunities for additional heat recovery via heat exchangers.

3. Brown stock washing

Washing of unbleached pulp is central to all chemical pulping processes. Its primary purpose of is to wash dissolved material from the pulp fibers, using an optimum amount of water in order to a) recover black liquor (organic and inorganic) solids for energy and chemical regeneration, and b) reduce chemical use in downstream processes such as oxygen delignification, bleach plant and paper machine. Good control of inlet stock consistency and dilution factor, and maintaining appropriate process temperatures (showers and filtrates) are critical to efficient washing, enabling high recovery of process chemicals while limiting the energy required in evaporation and concentration of weak black liquor. Modern equipment for brown stock washing has been designed to accomplish this. The following checklist is specific to vacuum washer technology, based on the assumption that the process temperature and production rate are fixed by other mill parameters (7)

3.1. Minimize horsepower consumption.

3.1.1. Use separate pumps for inlet pulp dilution and shower water as they have different head requirements.

3.1.2. Eliminate or minimize the use of face wire cleaning showers.

3.2. Maximize weak black liquor solids concentration sent to the evaporation plant by making the best use of wash water and reducing intrusion/infiltration water in the system.

3.2.1. Maintain and control an optimum target for total system shower ratio across different rates of production.

3.2.2. Eliminate the bypass of filtrate around individual washing stages.

3.2.3. Eliminate or minimize any tramp water entering the system, such as water lances or clean-up water.

3.2.4. Use airlift take-offs rather than air/water/steam doctors. Airlifts use 8-10" w.c. air pressure.

3.2.5. Use modern showers that are placed at the proper timing, that distribute wash water evenly, and that minimize plugging.

3.2.6. Use mechanical seals on filtrate pumps.

3.2.7. Use level transmitter configurations that do not require purge water.

3.2.8. Minimize shower velocity that disrupts the pulp mat and encourages air entry.

3.2.9. Displacement washing is more efficient than vat dilution; avoid water runoff into the vat.

3.3. Maximize black liquor solids concentration to the evaporators by maximizing washing efficiency of each individual stage.

3.3.1. Control washer inlet and vat consistency to ensure even distribution of the pulp over the face of the washer (target 1.5% with low variability).

3.3.2. Use modern showers that are placed at the proper timing, that distribute wash water evenly, and that minimize plugging.

3.3.3. Minimize fresh water utilization in shower water and maintain as high a shower temperature while avoiding drop leg flashing.

3.3.4. Increase discharge consistency with the use of a light weight roll near the discharge.

3.3.5. Minimize air being drawn in to the filtrate system by utilizing a corrugated deck design rather than an open channel backing wire deck.

3.3.6. Increase drop leg vacuum by removing air from the drop leg with appropriate gas-free valve technology.

3.3.7. Increase drop leg vacuum by insuring that the drop leg velocity is 10-12 ft/sec for open channel washers and 12-16 ft/sec for corrugated deck washers. Ignore air content when calculating velocity.

3.3.8. Increase drop leg vacuum by having a straight drop from the valve elbow to the filtrate tank of no less than 30 ft. If a drop leg contains a horizontal component, placement at the bottom is preferred for vacuum creation.

3.3.9. Remove air from the system with an optimized design of the filtrate tank and inlet separator.

3.4. Process monitoring, control, and optimization

3.4.1. Maintain well calibrated consistency meters for brown stock flow to knotters, wash plant and screens.

3.4.2. Implement automatic control of brown stock consistency and washer shower flow rates.

3.4.3. Maintain data for washer mat consistencies and soda loss and tune dilution factors and shower ratio to meet mill needs relative chemical make-up and evaporation costs.

3.4.4. Complete temperature surveys of brown stock area shower water, filtrates and stock to identify