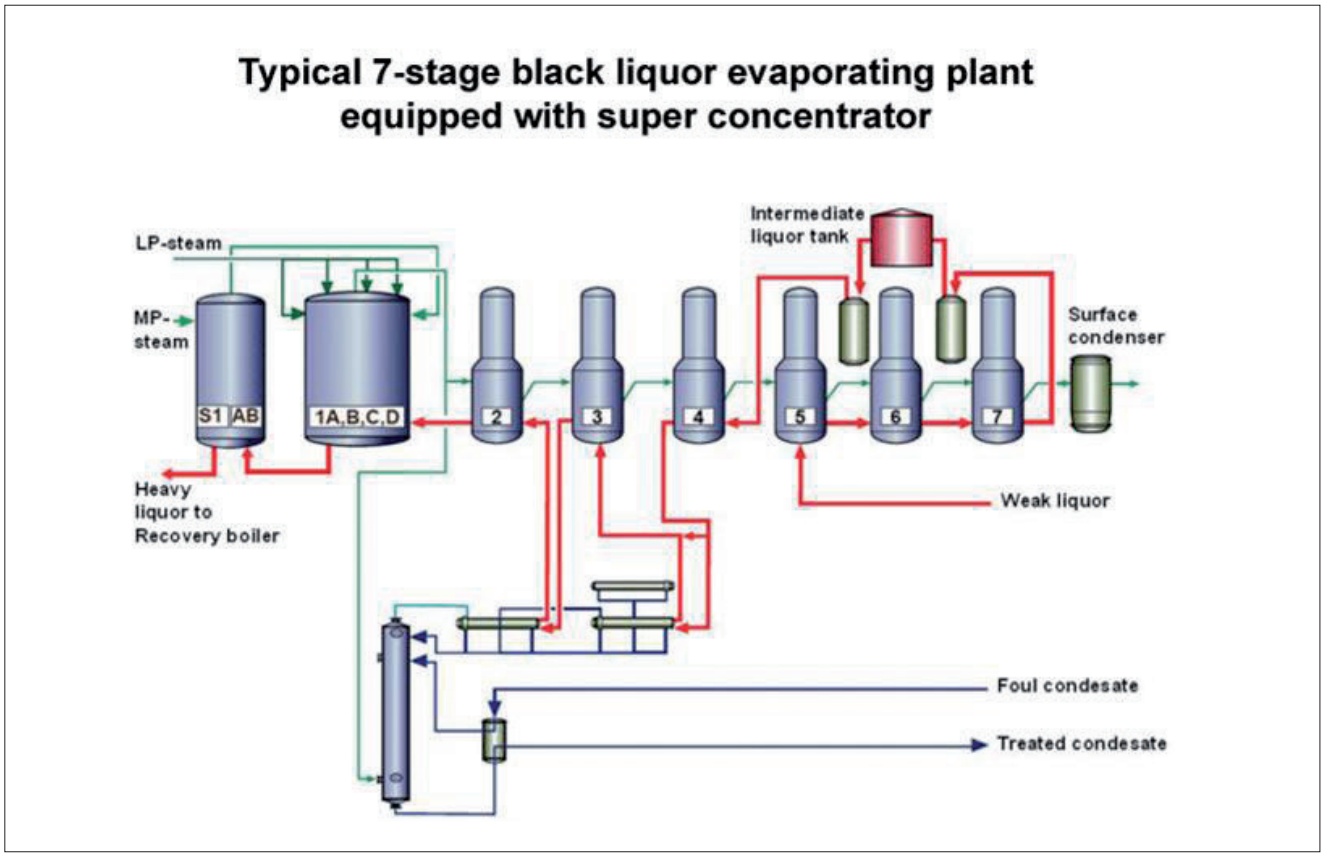
Valves in black liquor evaporation



Overview of the process

When processing wood chips into pulp in the cooking plant, organic materials dissolve in the cooking liquor. Black liquor contains both organic materials and also inorganic components of the cooking liquor.

The black liquor is separated from the pulp during the pulp washing. This weak black liquor (dry solids content of 14 % - 18 %) contains too much water for direct use as fuel in the recovery boiler.

The main purpose of the evaporation plant is to increase the dry solids content of the black liquor by evaporating water until reaching a concentration that allows burning in the recovery boiler. Since there is the potential danger of smelt explosions, the dry solids content of concentrated liquor should be a minimum of 58%.

Today a dry solids content of 72 ... 75 % is the minimum, and 80 ... 85% the target value for the dry solids content.

The process

An evaporation plant usually consists of several heat transfer units connected in series. A serie of evaporators is operated at different pressures to gain high steam economy.

Water removal is done by multiple effect evaporation in almost all pulp mills operating with the sulfate process. The number of effects is usually 5-7. The optimum number of effects depends on the steam balance of the mill.

Requirements for valves

Black liquor is a thick media, which gets viscous when the dry solids content increases. Black liquor can cause scaling problems in the valve. Valves must be able to perform in both control and shut-off applications. Careful valve type selection is recommended for the last part of the evaporation plant and in pipes feeding the subsequent processes. When used in shut-off the valves must provide tight closure.

A flow diagram of six-stage evaporation plant is shown in the Figure 1. As the evaporation process moves from effect 6 toward effect 1, the solids content increases. Between effect 3 and effect 2 the solids content is above 50 %.

Our valve recommendations can be seen in the Tables 1 and 2. The values mentioned in the Table 1 are typical average values of the evaporation processs. For control services the primary recommendation is the segment valve as well as the ball valve also. For lower solids content is the butterfly valve preferably used.

The operating conditions in the storage and evaporation of black liquor are moderately corrosive. Temperature rises approx. from 70 °C to 135 °C.

Rising solids content should also take into consideration when making the material selection Based on recent mill experiences Neles recommend to use duplex stainless steel material in the segment valve and ball valves if the solids content of black liquor is above 80 %. Otherwise grade 316 stainless steel in castings is sufficient.

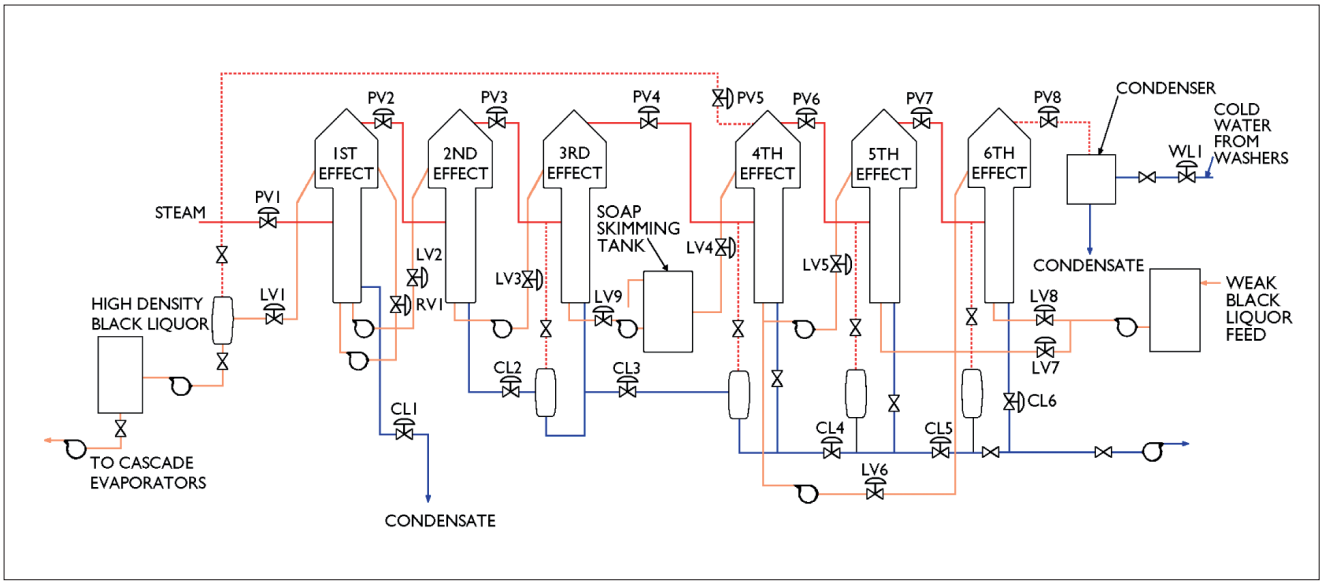


Fig. 1. Flow diagram of a multiple evaporator plant.

Table 1. Process conditions of the evaporation plant and valve recommendations.

Process variable	1st effect	2nd effect	3rd effect	4th effect	5th effect	6th effect
Temperature (°C)	135	100	90		75	65
Specific gravity (kg/m³)	1400	1200	1150	1120	1100	1050
Solids content (%)	> 75					12-18

Values mentioned in the table are typical average values of the evaporation process.

On-off valves						
Ball valve	*					
Triple eccentric disc valve						
Control valves						
V-port segment valve	*					
Ball valve	*					
Triple eccentric disc valve						

* Duplex stainless steel is required if the solids content is above 80 %.

Table 2. Control valve selection of the evaporation plant.

CONTROL VALVE SELECTION				
Tag *	Application	Recommendation	Alternate	Typical size
PV-1 to PV-8	Steam pressure contol	V-port segment valve	Triple eccentric disc valve	DN200 (8”) to DN300 (12”)
LV-1 and LV-2	Liquor level control	V-port segment valve	Ball valve	DN100 (4”) to DN200 (8”)
LV-3 to LV-8	Liquor level control	Triple eccentric disc valve	V-port segment valve	DN150 (6”) to DN200 (8”)
LV-9	Soap skimming tank level	Triple eccentric disc valve V-port segment valve	DN150 (6”) to DN200 (8”)	
RV-1	Liquor recirculating control	V-port segment valve	Ball valve	DN100 (4”) to DN200 (8”)
CL-1 to CL-6	Condensate level control	Triple eccentric disc valve	V-port segment valve	DN100 (4”) to DN200 (8”)
WL-1	Water level control	V-port segment valve	Triple eccentric disc valve	DN80 (3”) to DN150 (6”)

* Tag numbers refer to the Figure 1.

Neldisc triple eccentric disc valve

V-port segment valve, series RA

M-series ball valve

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