

Studies of the Efficiency of Horizontal Belt Pulp Washers

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ABSTRACT:-- *The horizontal belt pulp washer has developed an excellent reputation in the pulp and paper industry. The inherent capability to include a large number of stages, in a single unit, allows for high chemical recovery with low water use.*

There are currently fifty (50) Black Clawson Chemi-Washer horizontal belt washers in operation world-wide. There are five (5) more scheduled to start up over the next twelve (12) months. Several machines across North America were evaluated in detail for this study. The results show COD removal efficiencies between 98.3% and 99.9% at dilution factors between 0.2 and 1.3.

INTRODUCTION

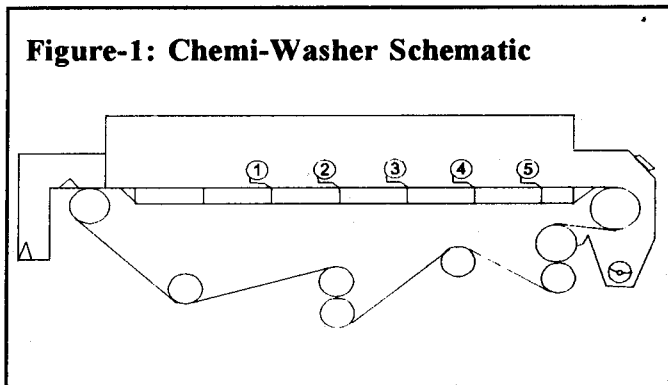
The Chemi-Washer is Black Clawson's horizontal belt washer. The units operate by flowing pulp through an open headbox onto a moving, woven, fabric. The fabric is connected into a continuous loop with a pin seam. The pulp is conveyed down the washer on the fabric. (Figure-1)

Initially the liquor is drained from the pulp to form a washable mat. This mat is about 10-11% consistency for displacement washing. The pulp mat travels under a series of wash showers. The wash liquor is pulled through the mat by vacuum. The clean wash water enters the washer at the discharge

end. The filtrate from the last stage is passed to the previous stage to create the counter-current washing system.

The vacuum, used to pull the liquor through the mat, is supplied by a fan mounted above the Chemi-Washer. Once through the mat, the liquor drops into a suction box where the liquor and gas are separated. The liquor travels through a pipe to a pump and is pumped up to the previous stage shower. The gas travels through an integral mist eliminator to the fan. The gas is pulled through the fan and sent back into the washer hood.

Since the liquor travels directly to the pumps, there are no inter-stage filtrate tanks, Also the gas re-circulation and machine sealing prevent air entry into the system. This means low flow from the vent on the one filtrate tank that is required.



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OVERALL WASHING EFFICIENCY

Several washers across North America were studied for overall washing efficiency and stage-wise washing efficiency. The furnishes ranged from high yield, semi-chemical, hardwood, to bleachable grade softwood. The machines were sampled at the feed, discharge, wash water supply and at each filtrate leg. The filtrate information was used for GEMS balances. This is shown in a later example. (1,2,3).

The overall efficiencies are high for all the components studied. The number of stages varied from two (2) to seven (7) with the majority of washers operating five (5) washer stages. The dilution factor also varied. The two (2) stage Flex-S Washer was running an exceptionally low dilution factor and still achieving excellent results. (Table-I)

Table-I

Overall Component Displacement Ratios					
Stages	Dilution Factor	COD	Soda	TDS	
Mill A	2	-1.74	n/a	n/a	0.900
Mill B	5	0.6	0.993	0.999	0.991
Mill C	5	0.2	0.988	0.998	0.986
Mill D	5	1.2	0.997	0.998	n/a
Mill E	5	1.3	0.994	0.997	n/a
Mill F	7	0.4	0.999	0.999	0.999
Mill G	5	0.5	0.989	0.989	0.988

STUDIES OF THE EFFICIENCIES OF HORIZONTAL BELT WASHERS

All the dilution factors were low when compared to those of drum washers. The highest dilution factor reported in the study is 1.3. This is lower

than the 2.0 to 3.0 that is standard for drum washers. The lower dilution factor results in considerable savings in steam costs in the evaporation plant. This could allow the mill to expand production with out major evaporator modifications.

DETAILED WASHER STUDY EXAMPLE

The example study is the one performed at Simpson Tacoma Kraft. The results have been published in detail elsewhere. This explanation will deal with the methodology.

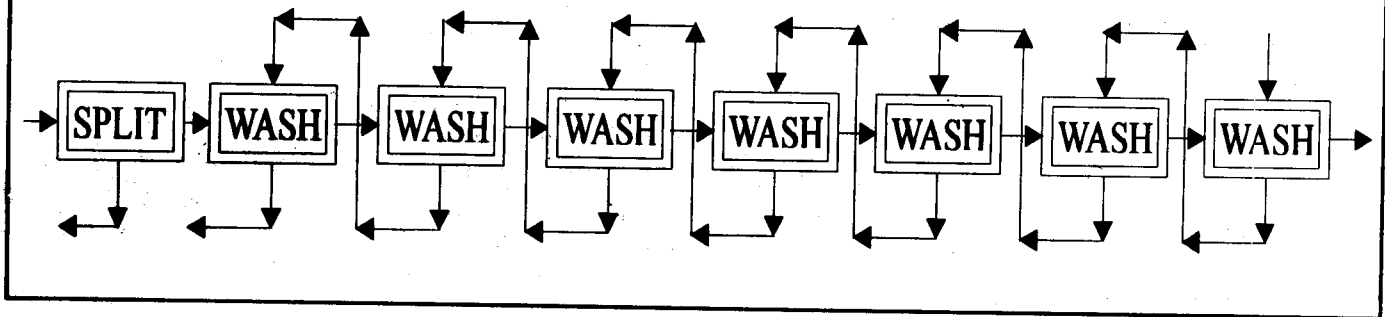
The liquors from all samples were analyzed for Total Dissolved Solids, (TDS), Soda, Chemical Oxygen Demand, (COD), and Residual Alkali. The feed and discharge pulps were tested for consistency. The methods are listed in Appendix-II.

A series of samples were collected over a five (5) day period. The Distributed Control System (DCS) supplied flow information around the Chemi-Washer. Trends from the DCS were studied to ensure the washer was operating in a stable manner to ensure reproducibility between sample sets.

The data was input into a GEMS model to produce information on the stage-wise operation of the washer. GEMS stands for General Energy and Material balance System. This is a modular program based on operation blocks for each unit operation in the pulp mill. The balances are constructed based on block and stream flow diagrams (Figure-2).

The feed data, discharge consistency, and wash water flow are input into the program. The inter-stage consistencies and displacement ratios are varied until the filtrate flows and component concentrations match the sampled values. This yields

Figure-2: GEMS Flow Diagram for Simpson Tacoma Kraft



information on the internal operation of the washer, especially stagewise efficiencies. The stage by stage displacement ratios are given in Table-II.

Table-II

Stage-Wise Displacement Ratios

Wash Stage	Soda	COD	TDS	Residual Alkali
1	0.812	0.925	0.808	0.635
2	0.815	0.945	0.865	0.700
3	0.835	0.930	0.815	0.630
4	0.828	0.935	0.870	0.650
5	0.835	0.940	0.850	0.540
6	0.870	0.935	0.850	0.535
7	0.963	0.920	0.612	0.878

The use of GEMS modeling allows the prediction of performance of future installations. The method can also be used to trouble shoot existing systems.

CONCLUSIONS

1. Horizontal belt washers are very efficient, especially at low dilution factors.
2. COD removal is excellent on the five (5) and seven (7) stage units.
3. GEMS is an excellent tool for modeling washing systems.

REFERENCES

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Appendix I : Definitions

1. Dilution Factor:

The mass of water per unit mass of pulp that enters the black liquor system from the washers.

$$D.F. = \frac{W}{P} = \frac{100-C}{C}$$

Where:

- W = mass flow of water per unit time
- P = mass flow of pulp per same unit time as W
- C = discharge consistency

2. Displacement Ratio:

The ratio of the change in component concentration, across a wash stage, to the maximum achievable change.

$$D.R. = \frac{C_F - C_D}{C_F - C_S}$$

Where:

- C_F = Feed Concentrations (g/l)
- C_D = Discharge Concentration (g/l)
- C_S = Shower Concentration (g/l)

Appendix-II: Test Methods

1. Consistency: TAPPI T 240 om 93.
2. Total Dissolved Solids: TAPPI T650 om 89.
3. Soda Content of Pulp: TAPPI um 255.
4. Soda Content of Liquors: By Flame Photometry.
5. COD: HACH: Disposable vial method with Spectrophotometer.