

Medium-consistency pulp washer generates superior washing efficiency

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The MCDD washer has successfully been introduced in the oxidative extraction stage of hardwood pulp bleaching, and its efficiency has exceeded the performance values of a vacuum drum filter.

In pulp bleaching plants as well as in brownstock washing, the conventional vacuum drum filter technique is still widely used. The pulp is fed into the washing drum at 1-2% consistency. A large part of the drum area, approximately one-third, is used for pulp thickening and mat formation, and approximately one-quarter is used for displacement washing. The pressure difference required for mat formation and washing liquid flow is developed by the vacuum in the filtrate channel brought about by the drop leg. Fundamental in the operation of the washer is that the pulp mat and filtrate include a great amount of air. The air causes problems with both washer operation and performance. The pulp mat produced is relatively uneven, therefore displacement cannot give the best possible results.

In the new washer versions, pulp inlet consistency is 3-4%, resulting in a mat formation zone that is relatively short. The pulp mat is formed under force in a pressurized inlet space, and the vacuum provided by the drop leg is not required. The actual displacement washing is partly submerged with the aid of excess pressure, which is usually generated with an air blower. The actual washing area of the drum is not much larger than in conventional washers. However, a pulp layer that is more uniform, thicker, and contains less air creates the prerequisites for a higher displacement speed; with the same washing space, a higher capacity per unit is achieved.

Our purpose is to introduce the new medium-consistency pulp washer—the medium-consistency drum displacer (MCDD)—revealing its advantages, our operating experiences, and possible applications.

Operating principle

An article in a recent issue of *Tappi Journal* (1) illustrates the operation of a multistage drum displacement washer. With an inlet consistency of 8-12%, the mat formation zone in the MCDD washer is very short. The thickening

I. Thickening requirement in drum displacer washer at different inlet consistencies

Washer	Consistency, %		Water amount to be removed, m ³ /a.d. metric ton
	Inlet	Washing	
Vacuum washer	1.5	11	52
Pressurized drum washer	3	11	22
MCDD	10	11	1

requirements at various inlet consistencies are presented in Table I.

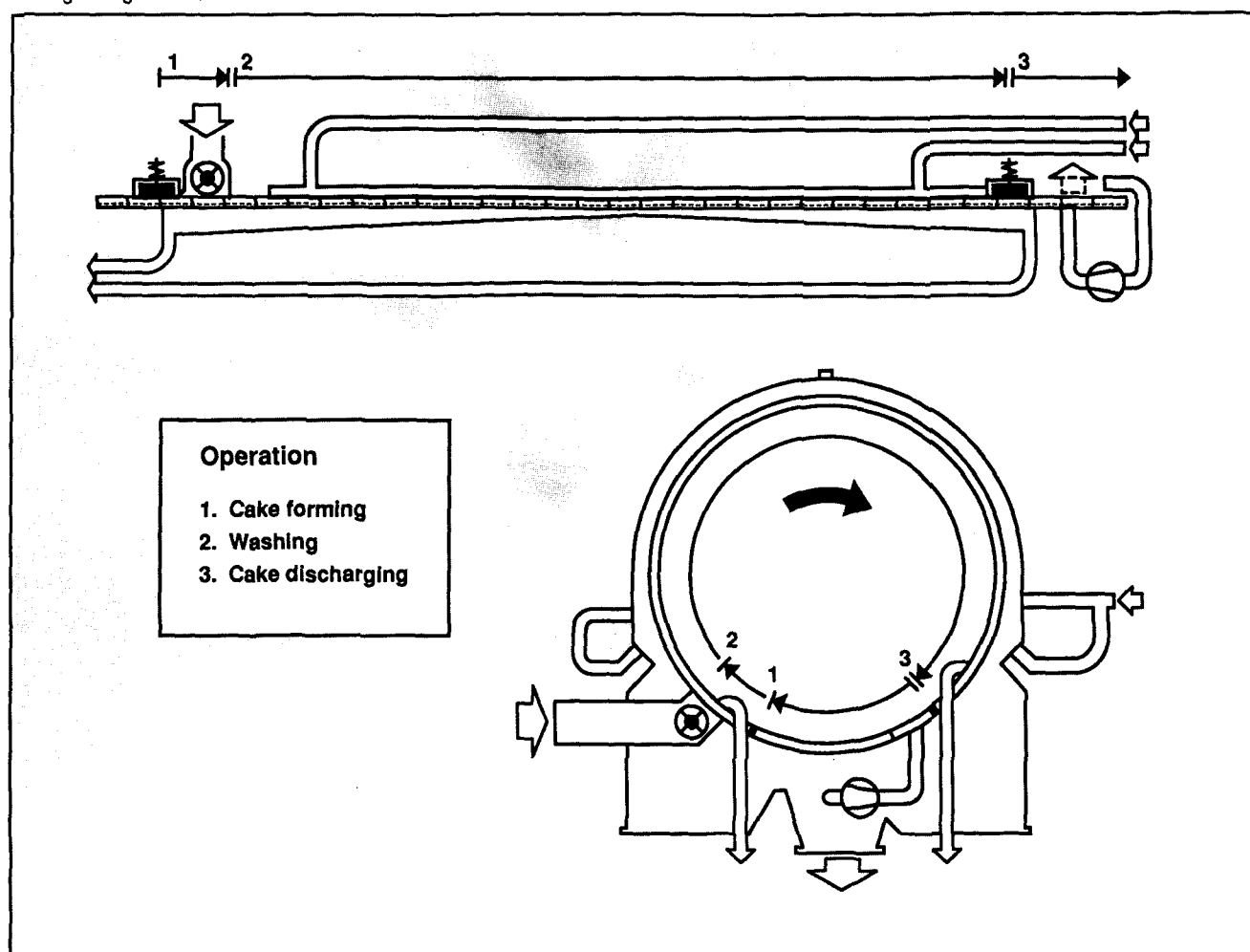
Up to 75% of the washer area is available for displacement. Figure 1 shows a cross-sectional drawing of the MCDD washer.

The washer comprises a drum and a surrounding casing. The drum area is divided into pulp compartments with bars in the long direction of the washer. The bottom of the pulp compartments is made of a perforated plate material. Under the perforated plates are the filtrate compartments, which are connected with the filtrate collecting chamber at the end of the drum. The pulp is fed at 8-12% consistency, with a pressure of 0.5-1.0 bar, to the inlet box, where it is distributed evenly over the drum. The filtrate compartment under the pulp compartment is empty and unpressurized. The pressure difference, which forms and thickens the cake, equals the inlet pressure of 0.5-1.0 bar. The pulp is rapidly thickened to a uniform cake that fills the compartment. The feed box is separated from the washing zone and the pulp discharge space by means of sealing bars. The sealing bar of the washing zone also wipes off the pulp cake so the compartments are always uniformly filled with pulp when progressing to the washing zone. A closed pressurized inlet box, a stable inlet pressure, and the thickness of the pulp layer produce a pulp cake with uniform drainage properties and prerequisites for an efficient washing. The washing consistency of the cake is 10-14%.

The washing liquid is distributed from the washer casing at 0.5-1.0 bar pressure evenly over the washing zone. During the period within the washing zone, the pulp

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1. Single-stage MCDD washer



compartments are submerged. The liquid flows quickly through the cake formed at medium consistency. The amount of washing liquid is controlled by the pressure of the washing liquid. Having penetrated the pulp cake, the washing liquid flows into the filtrate compartments under the pulp compartments and further to a collecting chamber at the end of the drum.

The filtrate compartments, as well as the collecting chamber, are pressurized. The pressure of the washing liquid corresponds to the pressure loss in displacement. From the collecting chamber, the filtrate flows to the filtrate tank.

No drop leg is required, which means that the tank can be located on the same level as the washer. If required, the washing zone can be divided into two to four washing stages (1). Figure 2 presents the operation of a washer with two stages. The pulp cake is released from the drum surface by a pressurized air pulse. The filtrate compartment is simultaneously emptied to prevent post-wetting of the washed pulp.

Washing in the MCDD washer is closed and completely pressurized, and no diluting circulations are required. This offers several advantages for process and mill engineering. The medium-consistency washer is excellent in processes where a consistency level of 8–12% is maintained, e.g., in oxygen delignification and bleaching.

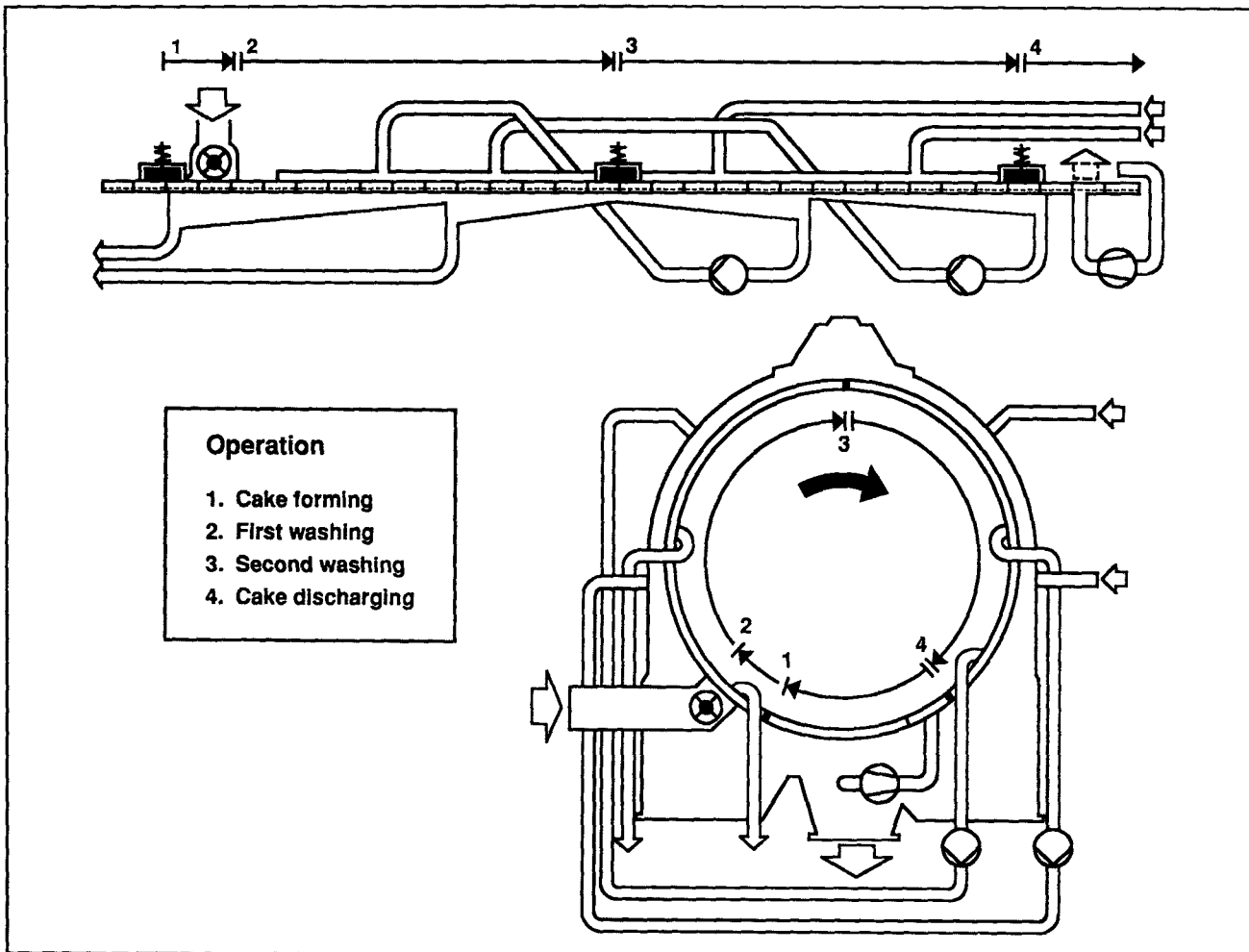
Operating experiences

After successful pilot tests (Fig. 3), an MCDD washer was installed in the oxidative extraction stage of a hardwood sulfate line. Figure 4 shows a schematic of the EO stage prior to installation of the MCDD, and Fig. 5 shows it after the installation. Prior to the modification, the EO stage included an oxygen prereaction tower and a downflow tower. Two vacuum drum filters were connected in parallel after the tower, both with diameters of 3.5 m × 4 m. The production of the line is 450 a.d. metric tons/day. One of the vacuum drum filters was replaced by an MCDD washer, and the prereactor and downflow tower were replaced by a pressurized reactor. Pulp is discharged directly from the top of the pressurized tower to the MCDD 3020 washer (diameter 3 m, length 2 m) without intermediate pumping. Table II shows the EO stage process condition before and after the modifications.

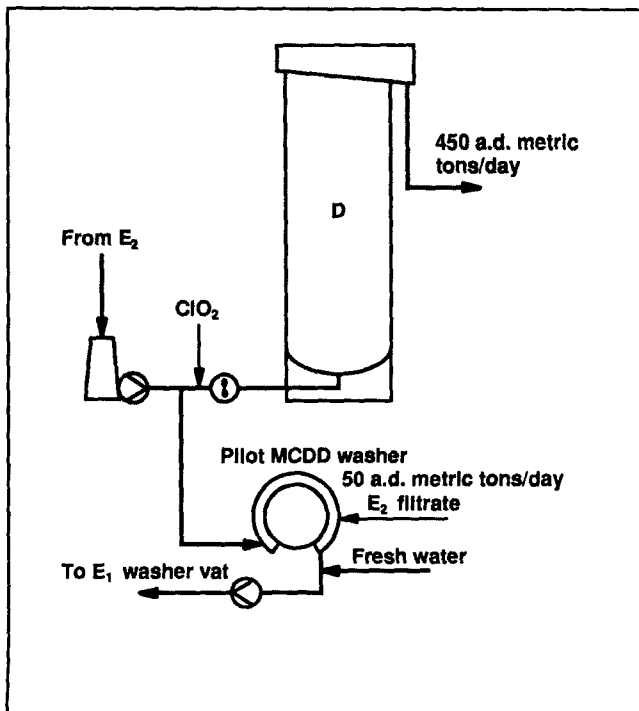
Frequently, little attention is paid to the efficiency of bleach plant washing in spite of the fact that it particularly operates in an overloaded condition with a low washing efficiency. Some papers have shown that by putting more efficiency into washing, substantial savings and environmental advantages have been achieved (2).

Definitions of bleaching efficiency have not been standardized, but the definitions of brownstock washing

2. Two-stage MCDD washer



3. Pilot-scale installation of the DD washer



are also applicable to bleach plant washing. Table III shows the results of mill-scale trials. Washing efficiency is defined based on the definitions of COD_{cr}, dissolved dry solids, and KMnO₄. The table shows the results of an MCDD washer and a vacuum drum filter.

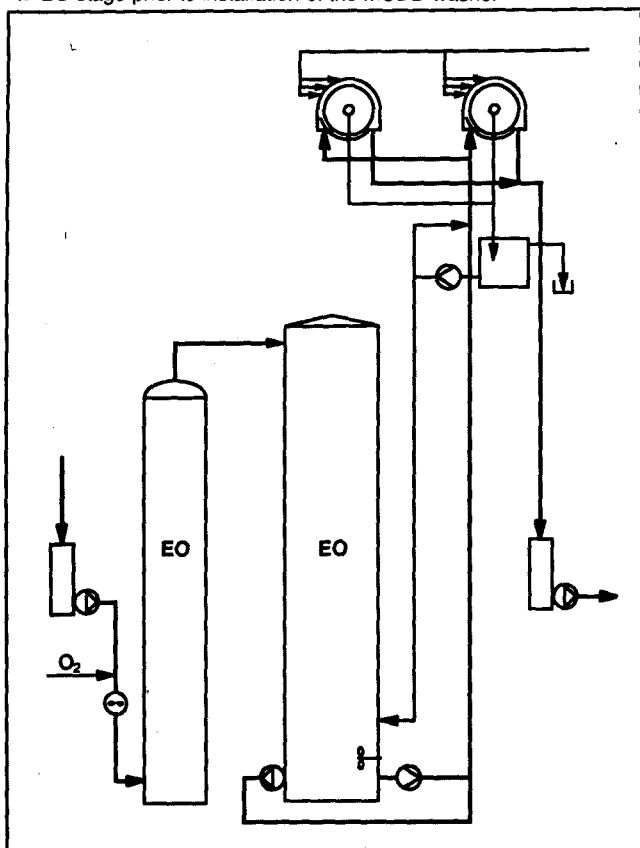
On the basis of several months of operation, we can state that the target figures of the bleach plant have been met or somewhat surpassed using the same process values as before. Excluded from the EO stage was the installed power of 260 kW, and the pressurized reaction stage has enabled a decrease in the use of peroxide. Thanks to its pressurized operation, heat losses of the MCDD are lower and outlet consistency is higher than in a vacuum drum filter. Therefore, heat economy has improved.

The instrumentation of the washer is presented in Fig. 6. Because there are so few control loops and because in fact the washer is a unit included in the pipe line, startups, shutdowns, and the operation of the washer are easy.

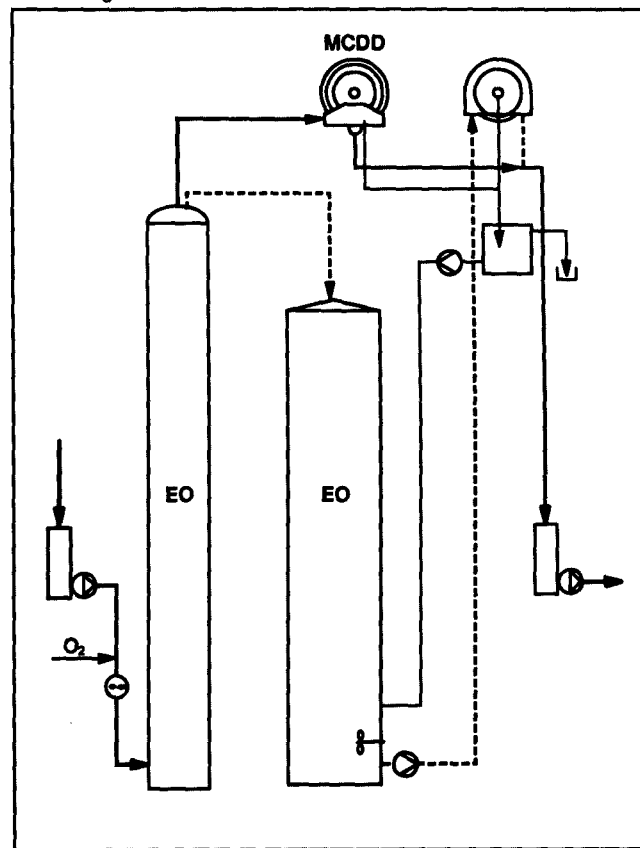
Modelling of MCDD washer

A test unit defining the operational values of the washer has been developed showing the displacement speed in various process conditions. On the basis of the displacement speed, it is possible to numerically simulate the washing stages required for different pulp types. By

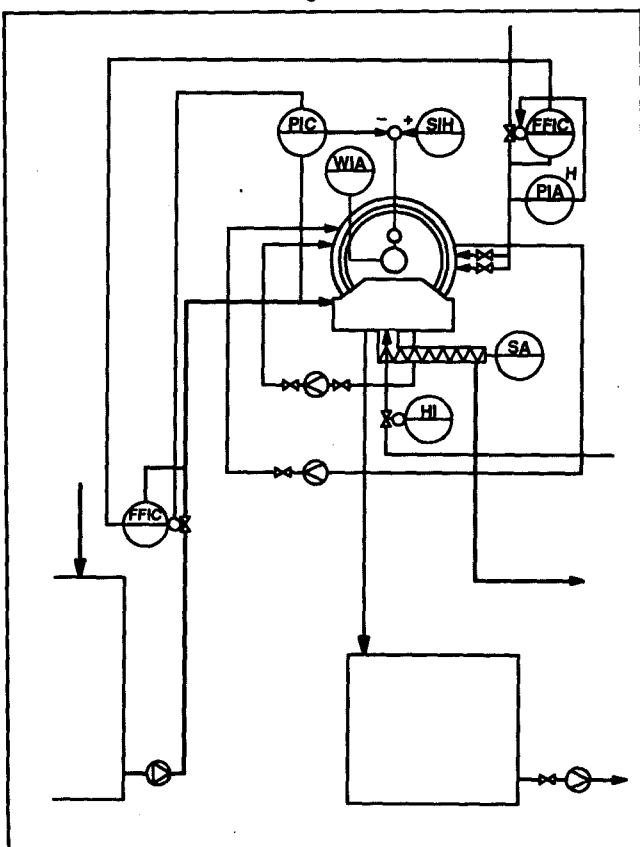
4. EO stage prior to installation of the MCDD washer



5. EO stage after installation of the MCDD washer



6. Instrumentation of the two-stage MCDD washer



defining the fiber constants (compressibility, specific surface, and volume) the cake forming occurrence can be simulated. The effect of inlet consistency on the capacity is calculated in Fig. 7. The measuring points are marked on the graph. The effect of inlet consistency on mat consistency is calculated in Fig. 8. Measuring values have correspondingly been included in the figure.

MCDD applications

The MCDD washer is suitable both for oxygen delignification and bleaching. Figure 9 presents a bleaching scheme with MCDD washers. After oxygen delignification there is a washer with two or three stages. The use of a washer with two stages in bleaching is also advantageous. A recent article (3) reports alkali savings as high as 35% when washing is carried out in two stages after the chlorination stage.

It is possible to reach a high unit capacity with the MCDD washer. Depending on fiber type and the number of washing stages, it varies between 15 a.d. metric tons/day/m² and 30 a.d. metric tons/day/m². With relatively small washer dimensions, high production levels can be handled. The washing process is closed and pressurized so no harmful exhausts or leakages can occur. The washer is filled with liquid and pulp so no corrosive gas-liquid interfaces are formed.

II. EO stage conditions

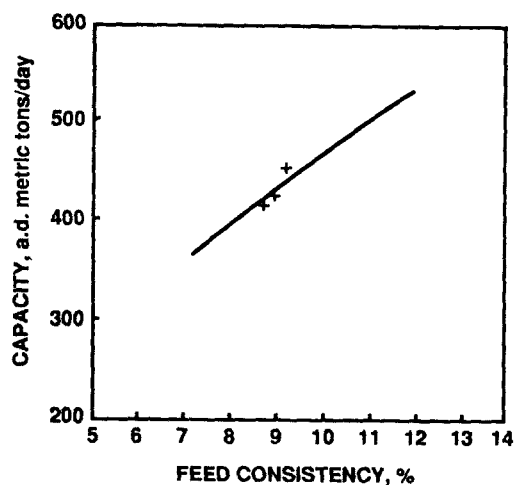
<i>Prereaction tower, min</i>	<i>Tower, min</i>	<i>Temperature, °C</i>	<i>O₂, kg/ a.d. metric ton</i>	<i>NaOH</i>	<i>H₂O₂</i>	<i>Kappa no. after EO</i>	<i>Brightness, % ISO</i>
Prior to modernization	20 Unpres-surized	60 Unpres-surized	6.1	14	2.7	4.4	60
After MCDD	... 45 2 bar pressure	60	4.1	10	1.2	3.8	62

III. Results of mill-scale trials

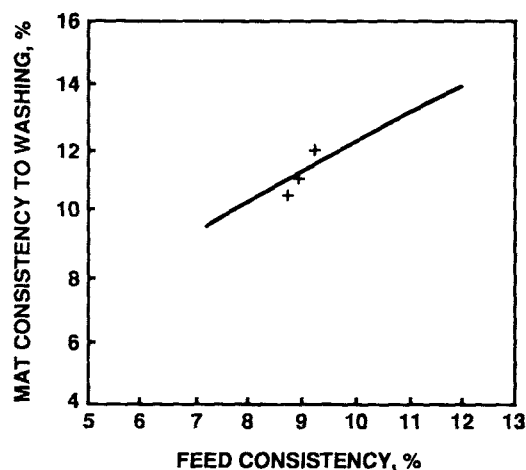
<i>Washer type</i>	<i>Capacity, a.d. metric tons/day</i>	<i>Consistency, %</i>			<i>Washing efficiency E12*</i>		
		<i>Inlet</i>	<i>Outlet</i>	<i>Dilution factor</i>	<i>Dissolved dry solids</i>	<i>KMnO₄</i>	<i>COD_{cr}</i>
MCDD	450	8.6	10.0	0	2.1	2.2	2.4
MCDD	390	9.2	12.0	1.3	2.8	3.3	2.9
Vacuum	400	2.8	9.6	2.9	2.2	1.6	1.7

*The efficiencies are given in Norden's Efficiency Factors when output consistency is 12%.

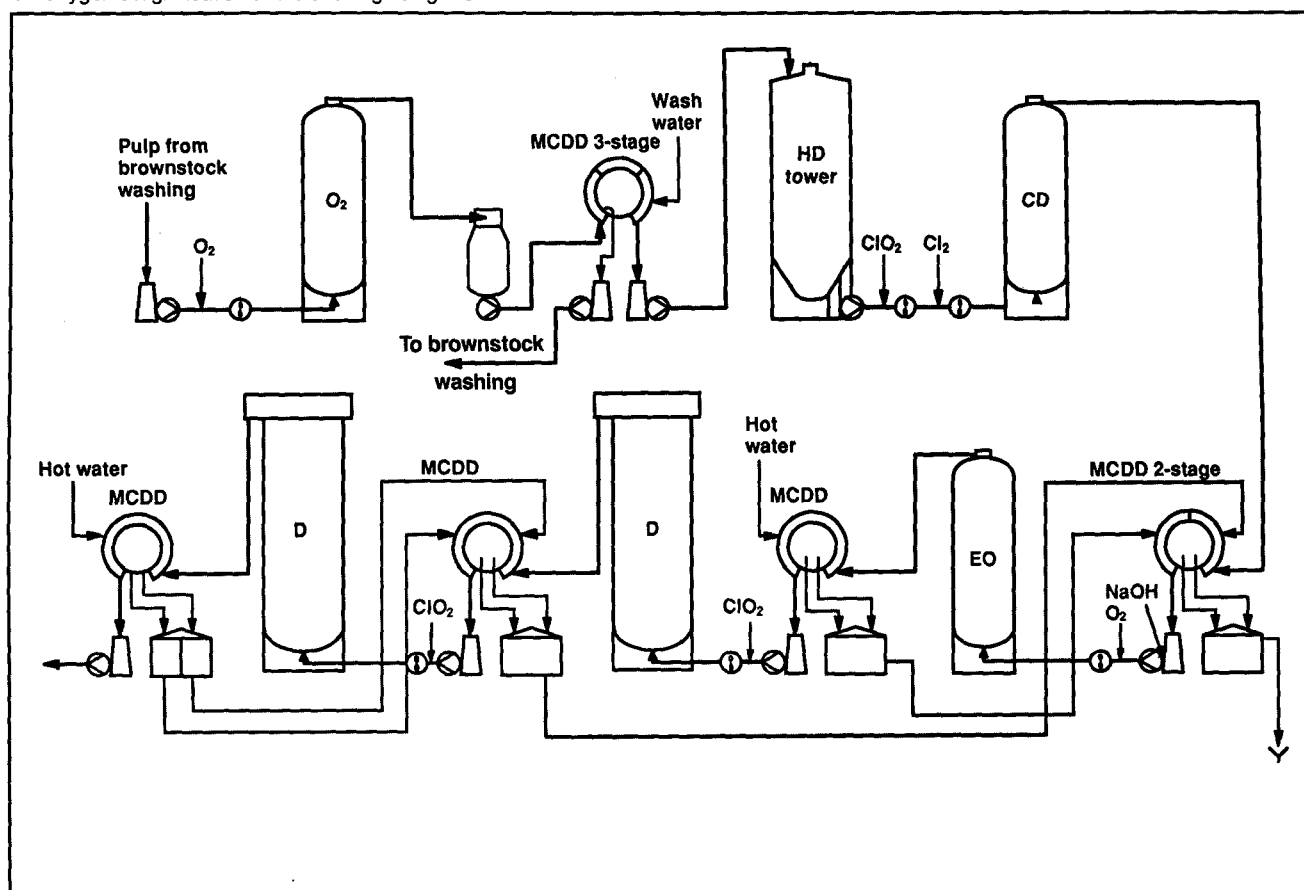
7. Mat formation in MCDD washer feed consistency and capacity DD 3020.1 MC



8. Mat formation in MCDD washer feed and mat consistency DD 3020.1 MC



9. Oxygen delignification and bleaching using MCDD washers



Conclusions

The MCDD pulp washer installed in the oxidative extraction stage in a hardwood bleaching line has given superior results for washing efficiency compared to a vacuum drum filter. Almost three-quarters of the drum area is used for washing, so the specific capacity of the drum is high. The washing process is closed and pressurized, which makes a drop leg unnecessary.

The MCDD washer is applicable in all bleaching stages. The washer can also be multi-staged, in which case it will benefit both oxygen delignification and bleaching. □

Literature cited

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