Improved Washers For Low Effluent Bleach Plants

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INTRODUCTION

More stringent environmental regulations and customers' awareness in preferring products which are manufactured with a minimum impact on the environment make it necessary to reduce the amount of effluent from pulping and bleach plants. This, in combination with the trend to use less or no chlorine-containing bleaching agents, has changed the features and functionings required of an efficient washer.

The "new " stages, e.g. Z or PO, are much more sensitive to COD impurities and heavy metals, and the temperature and pH-swings are usually more pronounced than with chlorine-based sequences. Thus, we are facing a situation where two driving forces are compressing the operational window: Better washing efficiencies should be obtained with a lower water consumption. In addition, the closing of water loops leads to a build up of calcium ions. During the pH-swings an increased amount of oxolates are formed which may cause severe scaling problems in the washing equipment.

Thus the washers of the new generation

- o need improved washing efficiencies,
- o have to be able to handle temperatures above 90°C,
- o have to be insensitive to scaling and
- o have to achieve high specific throughputs.

There was no washer on the market that fulfilled all requirements. Some that claimed to obtain better washing efficiencies are quite sensitive to scaling. The avoidance of chlorine containing bleaching technology made it possible to use washers based on the double wire press principle, offering the possibilities to fulfill all the above mentioned requirement.

BASIS FOR CALCULATIONS

In order to simplify the comparison of the different washe.'s a system as shown in fig.1 was used. A pulp stream enters the system coming from a bleach tower for example at 10 % consistency. The level of impurities (e.g. COD) was set at 100% at this point.

The pulp is diluted to the desired inlet consistency by using filtrate from the washer or press. For pure dilution/extraction washing, the wash water, which for reasons of simplicity contains no impurities, is added to the dilution chest. The pulp is then predewatered, washed and further dewatered to the desired outlet consistency. If the washer allows separate collection of different filtrate qualities, the one with the lower concentration of impurities is predominately used for dilution ahead of the washer.

All calculations were made for a DF= 1.5. The results are reported as percent carry over into the

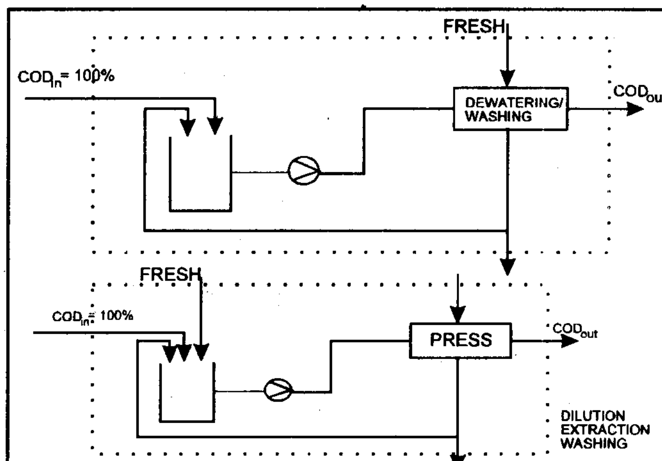

Fig. 1: System used for mass balance calculations

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next stage or as washing efficiency of the system, according to the equation

Washing efficiency (%)=100%- carry over (%)

For the calculations, the following typical DR values have been used (Tab.1). They are usually only obtained if the washer is not overloaded and if it is in an "early" washing position with a lot of impurities present. The DR values are typically lower at a later stage in the bleach plant.

Table-1

Displacement ratio values after a dilution factor of 1.5

	DR
Vacuum washers	0.80
Pressurized washer	0.78
Twin roll press	0.35 - 0.40

The DR value for the twin roll press was increased slightly for the lower outlet consistencies because more m^3/t of wash water are then available at a constant dilution factor. For vacuum and pressurized washers, the DR was kept constant regardless of the outlet consistency.

CONVENTIONAL WASHERS

As is well known, there are two basic principles for washing chemical pulps, i.e. displacement and dilution/extraction washing. It seems to be obvious to combine these two washing principles in an optimum manner, which means having very efficient displacement washing first, even a press with good dilution/extraction washing efficiency. This sounds simple, but it is difficult to achieve both effects because they are contradictory, as demonstrated in fig.2. Displacement washing of the fiber mat can only be achieved at medium consistency. At higher drynesses the mat becomes impermeable. If the outlet consistency is now increased by using an efficient press, the amount of water available for displacement washing is reduced when the washer is operated at a constant dilution factor DF. This means that the actual DF in the washing zone is decreased and can have a negative value. Thus, even under ideal conditions, the maximum obtainable displacement ratio (DR) is low. Deviations from these ideal conditions in industrial processes further reduce the actual DR values compared to those shown in fig.2.

These facts lead to the effect that all conventional washers obtain similar washing efficiencies, as demonstrated in fig.3. A vacuum washer can obtain an efficiency of close to 87% at the typical outlet consistency of 12%. At the same consistency the pressure washer would have a higher carry over (as a result of the somewhat lower DR value), but they typically discharge at consistencies above 14%, thus having a lower carry over there (efficiency of more than 87%).

Normal presses with pure dilution/extraction washing (e.g. twin roll presses, screw presses or double wire presses) can achieve the same system

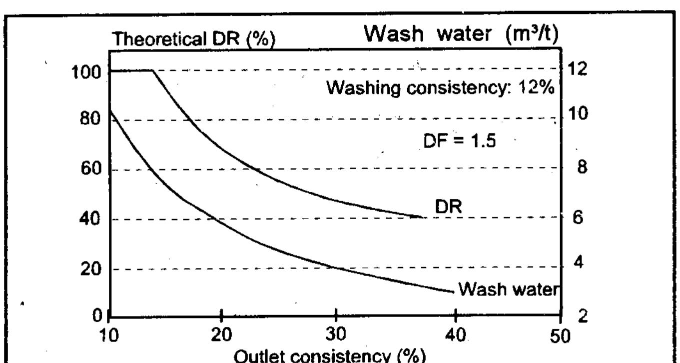

Fig.2: Ideal DR value and amount of wash water as a function of the outlet consistency for a DF of 1.

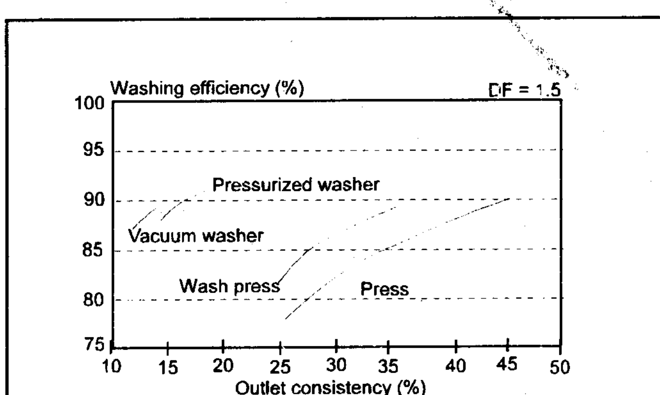

Fig.3: Washing efficiencies of conventional washers as a function of the outlet consistency

washing efficiency as displacement washers if they can provide consistencies close to 40%. At a 45% discharge consistency they are superior to one standard vacuum washer.

The twin roll press with a displacement washing zone should have superior efficiency. But here the fact demonstrated in fig.2 plays an important role. Because of the low amount of wash water available the mat cannot be penetrated efficiently. In addition, a large portion of this filtrate of good quality in the mat is removed again in the press nip and is mixed with the highly loaded filtrate from the first dewatering process, thus contributing substantially to reducing the system washing efficiency. This means that a wash press needs at least 30% outlet consistency to have washing efficiencies comparable to vacuum washers, only in the range of 35% are they superior.

Presses become stronger at a later point in the process, where displacement washing efficiencies are typically lower. This fact is demonstrated in fig. 4, where the DR values were assumed to be 30% lower than described in tab.1.

Assuming there is enough diffusion time for equal distribution of the impurities, only the presses remain at the same high efficiency, but the efficiency of the wash presses is slightly reduced. The efficiency of a vacuum washer is reduced to approx. 75-80%, which is lower than for a normal press with 25-30% outlet consistency. Thus, presses show considerable advantages where displacement washing cannot be performed very efficiently.

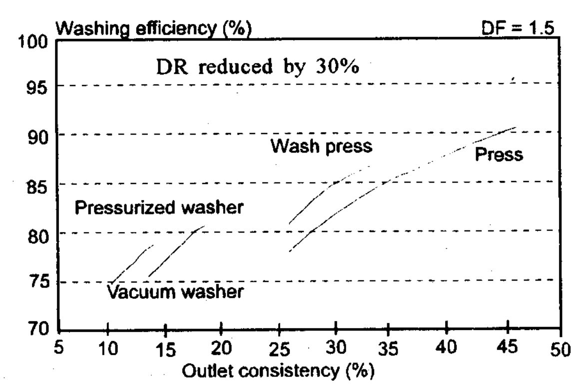

Fig.4: Washing efficiencies of conventional washers with 30% reduced DR values

TWIN NIP WASHERS

The twin nip washer was designed to overcome the shortcomings of conventional press washers by

- o increasing the area and time available for washing,
- o increasing the outlet consistency and by
- o collecting the filtrate with the better quality separately.

The only way to obtain all those advantages was by introducing wire press technology, which can only be used with non-chlorine-containing bleaching agents.

Fig.5 shows a schematic drawing and fig.6 a photo of a 4.5 m twin nip press.

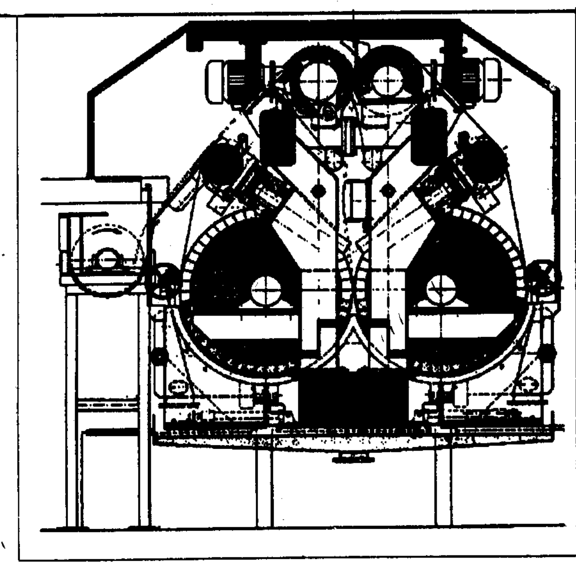

Fig. 5: Schematic drawing of the twin nip press

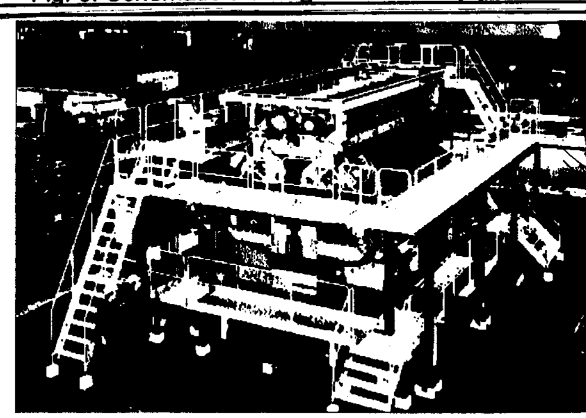

Fig. 6: Photo of a 4.5 m twin nip press

The twin nip press consists a total of 6 rolls: 2 predewatering rolls forming the first nip, 2 press rolls for the second nip and two combined wire stretching and guiding rolls. One wire travels around each group of 3 rolls. The pulp suspension is distributed across the working width on both sides of the machine. In most cases, conventional pumping consistencies between 3 and 5% are used. Due to the conical shape of the formation zone, the suspension is gradually dewatered to approx. 12 - 14 % consistency. Wash water is added after this predewatering zone for efficient displacement washing. The mat then enters the first nip formed by the two formation rolls, where it reaches a consistency of approx. 25%. This consistency is quite low allowing very forgiving operations under upset plant conditions, but it is sufficient to seal the wash water and to prepare the mat for efficient dewatering in a second nip. During the dewatering and washing process, there is no contact with air (completely submerged), thus reducing air entrainment to a minimum.

The two wires lead the predewatered pulp mat to the second nip, where the final consistency between 35 and 40% is achieved. The filtrate from this nip, which contains a major portion of the wash water introduced in the washing zone, is collected separately to be used in the best place as explained later and to avoid losses in system washing efficiency by mixing with a filtrate of a lower quality.

Discharge of the pulp mat could be at the top between the two press nips, but it is more critical than the version chosen for the twin nip press. Here a doctor blade directs the pulp mat to one side, it travels together with the wire to the repulper screw conveyor that is mounted at one side. This eliminates the need for seals along the length of the repulper screw, as would be necessary for discharging at the top.

What are now the main differences compared with conventional wash presses:

- o The large diameter of the predewatering rolls gives enough area for efficient predewatering, which assists optimum mat formation and efficient displacement washing. The displacement ratio values obtained in this washing zone are very close to those values obtainable assuming ideal displacement (Fig.7).

- o The second nip allows much higher outlet consistencies than with only one nip and the filtrate from this nip can be collected separately in order to avoid losses in system washing efficiencies. This, in combination with optimum displacement as described above, results in a much higher washing efficiency than with other conventional washing stages, as shown in fig.8. Whereas the difference between presses and conventional wash presses is quite small, there is a considerable improvement obtained with the twin nip washer. The system washing efficiency of the twin nip press with a consistency of more than 35% is equivalent to approx. one and a half conventional washing stages.

- o There are no narrow channels in this machine that are sensitive to scaling, which becomes a more severe problem if the fresh water use of a chemical pulp mill is reduced drastically. In

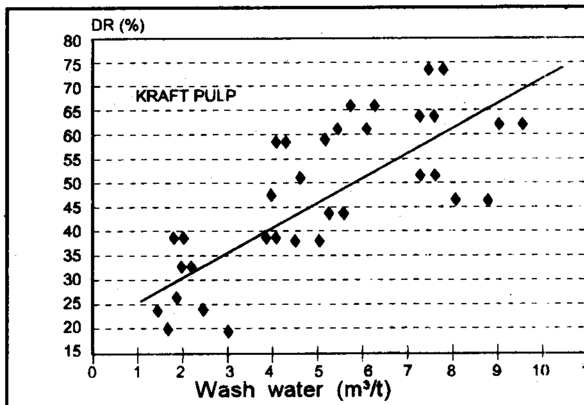

Fig.7: Displacement ratio DR of a twin nip press as a function of the amount of wash water

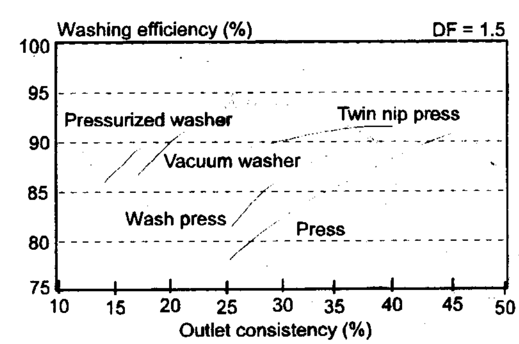

Fig.8: Comparison of system washing efficiencies for conventionl washers and the twin nip washer

addition, all parts of the machine are accesible for cleaning during normal operation.

o It is necessary to use wires in order to obtain all the technological advantages mentioned above. Although wires are not desirable, modern wires can withstand the process conditions of a kraft pulp mill even if both the pH and the temperature are high. Since there is only contact between the sealing and the wires and not the formation roll, this eliminates possible wear on the rolls, thus avoiding expensive repair work after some years of operation.

DOUBLE WIRE WASH PRESS

The twin nip press already improved the system washing efficiency significantly, as shown in the previous section, mainly by increasing the discharge consistency and collecting the filtrate of the press nip separately. In the twin nip application this quite clean filtrate is used for dilution, which is better than mixing with the filtrate from the predewatering zone, but still not the optimum. To obtain both effects, best displacement and dilution extraction washing, two displacement washing zones are necessary ahead of the press and the filtrates from each zone have to be collected separately. This is possible with a double wire wash press as shown in fig.9.

The pulp is fed with a consistency between 3 and 10% to a patented headbox, which allows the pulp suspension to be distributed evenly across the working width, even at medium consistency. In this case, only a very short pre-dewatering zone is required. The pulp mat is washed in two to four displacement washing zones. In oxygen delignification and bleach plant applications, only two stages are required. A slight vacuum that is necessary as a driving force for pre-dewatering and displacement washing is generated by a fan.

After the washing zones, the top wire converges towards the bottom wire and the pulp mat is dewatered in the S-section by the application of area pressures generated by the two wires wrapped around the rolls. The pulp mat obtains its high final dryness of 40 to 45% in a press section with 3 to 4 press nips.

Fig.10 shows a photo of a double wire wash press which is used for dewatering and washing of 700 t/d of softwood kraft pulp.

The wash water is added to the second wash zone prior to the press section. At normal DF values, which are of course calculated with the outlet consistency of the press , the amount of wash water that can be used is low. For instance at a consistency of 40% and a DF of 1.5, only 3 m^3/t are available. Since the consistency in the washing zone is much lower (10 to 15%), the actual DF is quite negative and no real high DR-values can be achieved. Most of the clean filtrate displaced in the washing zone is pressed out again in the press zone, resulting in quite good filtrate quality there. If this filtrate is combined with that from the second wash zone, it can be utilized in a first washing zone. There is now so much wash water available that the actual dilution factor is also 1.5, thus allowing high DR

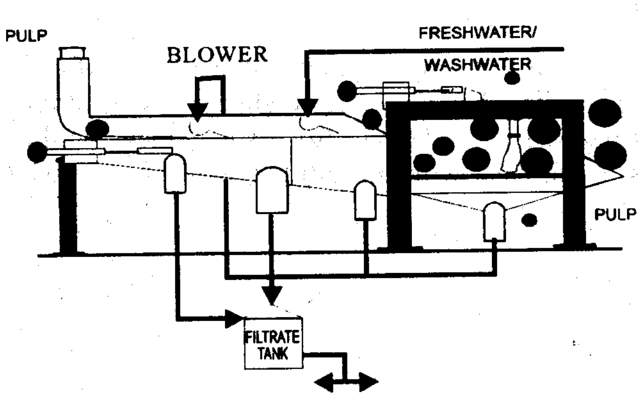

Fig.9: Schematic drawing of a double wire wash press

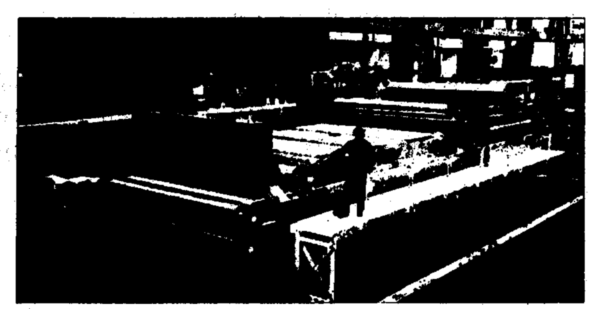
Fig. 10: Photo of a double wire wash press with two washing stages

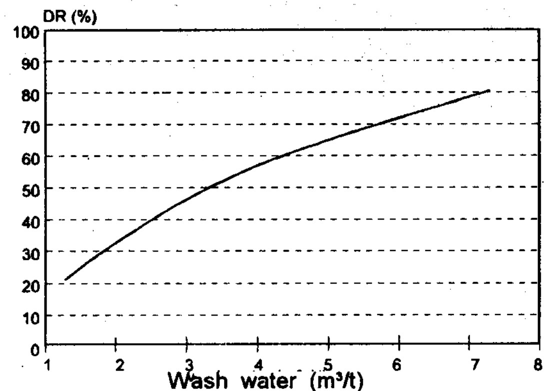

Fig.11: DR values obtained in one stage of a double wire wash press as a function of the wash water input

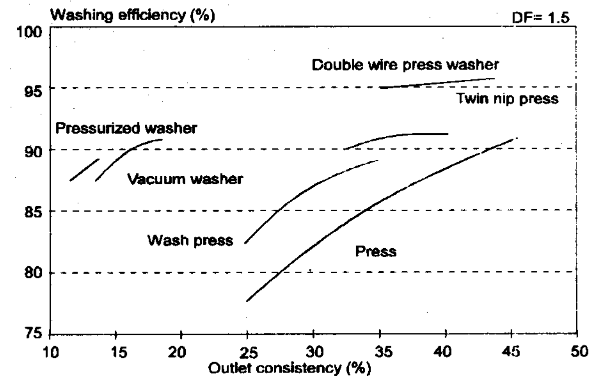

Fig.12: System washing efficiency of the double wire wash press in comparison with conventional washers

values. This good displacement in the first zone lowers the load of the filtrate from the second wash zone and the press zone, which is again returned to the first zone and further improves the washing efficiency of this stage.

Fourdrinier type washers achieve quite high DR values in the first washing stage. Since there is not enough diffusion time to allow the impurities to come out of the lumen of the fibres, these DR values level off if several consecutive displacement washing stages are used. Fig.11 shows the DR values per stage measured in a two-stage double wire wash press. Quite high DR values are obtained even at small wash water quantities.

Since very high outlet consistencies of 40-49% are achieved, the system washing efficiency of a double wire press washer is significantly higher than that of the twin nip press. With two washing zones, this press is equal to approximately two conventional washing stages (Fig.12). Up to four displacement zones are possible. In this case the machine is equal to 3 conventional washers.

The limitation of the double wire wash press is the throughput. Only upto 1000 t/d can be dewatered on a single unit. Although this is not sufficient for large greenfield mills, one has to take into account that the average capacity of North American bleaching lines is in the range of 600 t/d. Thus, there is quite a potential for upgrading existing plants.

CONCLUSIONS

Modern presses can achieve outlet consistencies of 40 to 45%. Their washsing efficiency obtained by dilution extraction washing is at least as high, in many cases even higher, than those of conventional displacement washers.

Combining an efficient press with displacement washing results in significant improvement of system washing efficiency, if

- o a high outlet consistency is retained and
- o the press filtrate can be collected separately.

These criteria are fulfilled by the newly developed twin nip press.

A further improvement of washing efficiency is possible when a second washing zone is added to utilize the press filtrate for displacement washing, as is the case with the double wire press washer.