Mixing of Waste Streams (MWS) - An Effective Tool for Recycling/Reuse of Waste Water Towards System Closure

RATHI B. H, TYAGI M. K. AND BHORALE V. K.

Water is not only the resource for life - without water the production of paper would also not be feasible. It has to fulfill numerous functions during paper manufacturing as a transport medium, for cleaning and cooling, as an energy carrier, as a lubricant and finally as the binding agent for forming hydrogen bonds between the fibers within the paper sheet. Initially, paper was produced with high specific fresh water consumption in the range of 200 - 350 m^3 per tonne of paper. For economical and also ecological reasons, the industry has to think towards system closure for minimizing the process water requirements. In so many mills in developed countries, reduction has been achieved by adopting various techniques such as internal water recycling, reuse with mild treatment and mixing of waste streams.

Mixing of waste stream is well known method by the industry but there is a lack of systematic approach for optimum mixing waste streams. The team of West Coast Paper Mills in consultation with an expert in the field is doing extensive study to develop effective tool for recycling wastewater for reducing the specific water consumption in the mill.

This article highlights the systematic approach being studied at The West Coast Paper Mills for mixing the waste streams for minimization of effluent load towards system closure.

Keywords

Waste Stream pH, COD, Permissible Limit, Reuse, Recycling, Backwater, Bleaching, Concentration, Conductivity, Hardness

INTRODUCTION

Indian pulp and paper industry is one of the major water intensive industry. It has to fulfill numerous functions during paper manufacturing as a transport medium, for cleaning and cooling, as an energy carrier, as a lubricant and finally as the binding agent for forming hydrogen bonds between the fibers within the paper sheet. In manufacturing steps, water is drained at various processes which contains traces of most of the raw materials used in paper making, this drained water called "effluent" is very costly to treat and dispose off due to its volume and chemical contamination and hence paper mill over the world are making all efforts to economize on water consumption. Water use per tonne of paper in developed countries has drastically reduced to 55 to 100 m^3 per tonne of paper. In composite paper mill, water is used mainly for two parts i.e pulp mill and paper machine. As maximum chemicals are used in pulp mill section, effluent from pulp mill has very high concentration of mineral chemicals and organic chemicals due to natural impurities and it is very expensive to treat this effluent.

Looking into this, team of The West Coast Paper Mill worked with help of expert/consultants in the field of water conservation to identify and assess fresh water consumption in various sections of the mill. The possibility of selectively reusing wastewater within internal circuit is a very attractive option for pulp and paper industry. The wastewater reuse / recycling can be performed with or without intermediate treatment. This would have a significant impact on overall fresh water usage as well as in the effluent generation and waste water treatment. However the reuse and recycling of waste stream by mixing of low. concentration streams with high concentration streams is to get permissible concentration level to overcome water deficit in the system. This simple technique has shown a progressive reduction in water consumption and is marching towards systematic & effective tool for recycling / reuse in pulp and paper mills.

Methodology

The methodology adopted for mixing of streams for recycling/reuse of waste water towards system closure is given below;

The West Coast Paper Mills Ltd., P. B. No. 5, Bangurnagar, Dandeli - 581 325 (Karnataka)

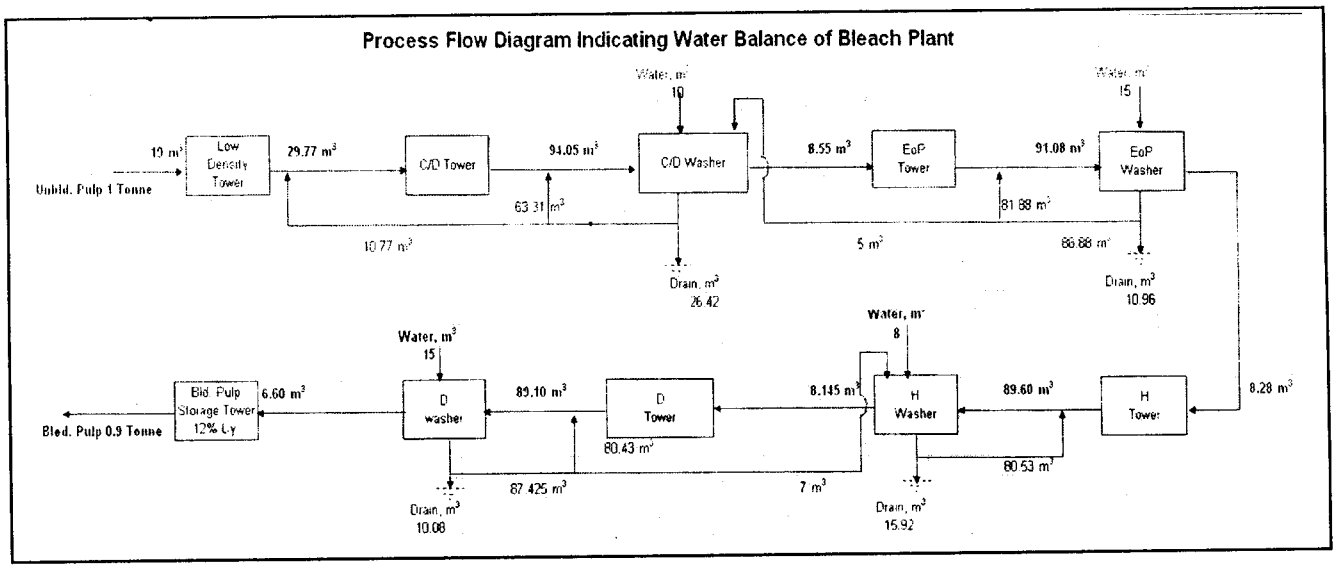

Figure 1: Water Balance of Bleach Plant

- Preparation of water balance for the various sections in the mill.
- Analysis of waste stream characteristics
- Extract the data in the form of Input (deficit/fresh water) and output (surplus/waste)
- Identify & setup permissible limit for recycle/reuse
- Preparation of input and output table for extracted data
- Mixed stream analysis based on dominating contaminant within the system
- Repeat for other contaminants (if required)
- Optimize the mixing streams without compromising quality of product with reduction in effluent load.

Application of Mixing of Waste Streams (MWS) in Bleach Plant

The bleach plant is one of the major chemicals consumption section in paper mills and also generating high

Table 1

Bleach Plant Waste Water characteristics

S.N	Section	pH	TS mg/l	COD mg/l	Hardness µg/l	Conductivity µs/cm
1	C/D Washer	2.2	3228	1472	270	5.907
2	EoP Washer	7.1	3050	960	365	3.917
3	H Stage	10.5	3052	950	350	3.75
4	D Stage	2.7	2378	595	800	3.777
Fresh Water, Back Water and Mixed Water Characteristics						
1	Fresh Water	7.5	225	-	260	0.882
2	Back Water from Paper Machine	6.2	505	240	290	0.957
3	Mixed Water (Fresh water 67.5% + Paper Machine Back water 32.5%)	7.1	316	78	269.75	0.906
4	Mixed Water (Fresh water 50% + Paper Machine Back water 50%)	6.8	365	120	275	0.919
5	Mixed Water (Fresh water 75% + Paper Machine Back water 25%)	7.2	295	60	268	0.90

Table 2

Extraction of Data for Bleach Plant

S.No	Unit	Input Flow m^3/t	Input/ permissible limit, mg/l (TS)	Output Flow m^3/t	Output concentration mg/l (TS)
1	C/D Washer	108	2463	108	3228
2	EoP Washer	105	2663	105	3050
3	Hypo Washer	104	2787	104	3052
4	D stage Washer	103	2120	103	2378

concentration waste water. However due to various chemicals in the bleach plant waste water, it cannot be used back into the process and need to be treated further for removal of dissolved solids organic solids, color, hardness and turbidity etc. In present condition, this waste water cannot be further recycled directly in the process. The mixing of waste streams (MWS) emerged as one of effective tool for further recycling/reuse towards system closure. The figure 1 shows the water balance for bleach plant having C/D Ep H D sequence.

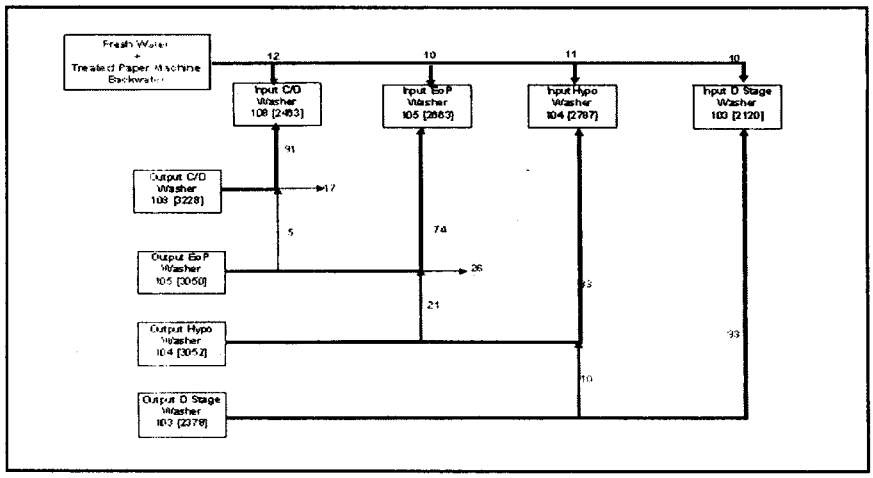

Figure 2 : Mixing of Waste Stream (Includig Water Specific Consumption)

Analysis of waste water characteristics

The analysis of waste streams characteristics is important step in MWS and is ineeded to identify the limiting parameters (pH, Total solid, Color, COD, and Hardness & Conductivity), which are playing a significant role in recycling and reuse of waste water used in process. The major challenge in this methodology is selecting the contaminant for the study that can take care of all the parameters and which are limiting the recycling/reuse. The analysis of different waste streams characteristics are shown in table -1.

Extraction of data from the Water Balance

The extraction of data from the water balance is a difficult task especially for bleach plant. Rigorous study has been made and the results are shown in Table-2. By this step, we have arrived at the permissible limit for recycling of waste water and from the analysis of two streams, mixing of fresh water and paper machine back water, the optimum combination appears to be (Fresh water 67.5 % + Paper Machine Back water 32.5 %). Likewise, other combination may also be tried.

Recycle / Reuse through Mixing of Waste Streams (MWS)

Optimization of waste water stream through mixing of different waste streams from bleach plant and fresh water with clarified paper machine back water has shown a remarkable saving potential of about 32% reduction in fresh water consumption in bleach plant without compromising quality of paper. Further reduction is possible by adopting modern filtration technology towards system closure. Fig. 2 shows clear pictorial representation of recycling for reduction of specific water consumption and effluent load.

Mixed stream characteristics for different proportion of fresh water and clarified back water from paper machine is shown in table 1. The optimization of mixing is done keeping in view that the quality of water is within the permissible acceptable limit of system.

Towards System Closure

The global standards for water consumption figures per tonne of paper

Table 3
Characteristics of treated effluent for reuse

Characteristics	Paper machines effluent	
	*Before treatment	After treatment
Total quantity, m^3/t	67.5	60
pH	6.2	7.0
Total Solid, mg/l	505	230
COD, mg/l	240	70
Hardness, mg/l	290	265
Conductivity, μs/cm	0.957	0.88

*From SAVEALL water

are being continuously reduced by adopting systematic approach of recycling and reuse with modern filtration technology. Looking into the need of system closure, the waste streams from paper machine and highly concentrated pulp mill effluent have to be made suitable for reuse in the process.

In paper machines, proposed effluent treatment system consist of coagulation & settling (SAVEALL) units followed by dual media filtration to remove color and suspended solids. The dual media filtration consists of sand and activated carbon beds for filtration, which would reduce the color and suspended solids about 80-90 %. The before and after treatment characteristics of paper machine effluent is shown in Table No.3. By adoption of this proposal, mill can use backwater in place of fresh water in existing practice, which would automatically reduce the effluent generation and fresh water consumption.

Pulp mill effluent has more chemical contamination. No technology is economically feasible for treating the pulp mill effluent for reuse in the system. This is the area which needs to be given a fresh look for R&D to develop a cost effective technology for treating the pulp mill effluent to make it suitable for reuse This may facilitate towards complete system closure of pulp and paper mill effluent.

Saving potential of water consumption

The study envisaged the huge saving potential in term of reduction in effluent load as well as fresh water consumption. About 50% reduction in fresh water consumption and effluent load is possible by adopting the systematic approach of mixing of waste streams (MWS) with modern filtration technology for effective recycle and reuse. In this case pulp mill is consuming optimized quantity of fresh water with paper machine clarified water and effluent generated from this section is effectively recycling for pulp dilution. The feasibility of mixing of waste streams (MWS) approach is depending, upon the motivation towards system closure despite of many limitations.

Barriers towards system closure

Mixing of waste streams (MWS) is an effective tool for recycling/reuse of waste water towards system closure looking into the present scenario but many barriers (limitations) are restricting the recycle and reuse of waste water generated from the paper mills. Indian paper mills are facing many barriers towards system closure & some of these are given below;

- Higher tendency towards corrosion especially in old / outdated machineries.
- Slime formation and its control
- Unexpected breakdown due to chocking of showers nozzles in washer.
- Economic feasibility of modern filtration technology.
- Highly concentrated effluent.
- Effect on quality of product.
- Effect on specific energy consumption.
- Effect on capital and operating cost.

CONCLUSION

Indian paper mills are gradually moving towards system closure despite of many barriers restricting system closure. The developed systematic approach for mixing of waste streams has demonstrated remarkable savings potential of fresh water consumption. Extensive inputs from research and development are required for treating the highly concentrated effluent economically to recycle effectively without affecting quality of product.

Acknowledgement

The authors are thankful to the management of WCPM for permitting this paper for presentation.

References

1. Dilek F B, Bese S., "Treatment of Pulping Effluent by Using Alum and Clay - Colour Removal and Sludge Characteristics" Water SA Vol. 27 No.3 July 2001
2. Gautam M., Dixit M. K, Kumar A, Tyagi M. K. "Colour Removal from Kraft Mill Effluents a Review" IPPTA Vol. 24, No 2 (Suppl.) June 1987
3. Linnhoff, B., Tainsh , R. A, and Kumana, J. D., "Intelligent Networking of Process Waste Water Streams in Chemical Industry" Technical White Paper, August 5, 1998
4. Proceedings of National Seminar on Paper Industry Towards 2000 A D held at Dandeli on 21-22 Feb., 1995