Benefits Of Paper Mill White Water Recovery Using Backwash Filtration System

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ABSTRACT

While large quantities of white water are commonly reused in the pulping process, a significant portion of the white water (the clear / super-clear effluent from the save-all filter) is taken out of process circulation because it is not clean enough for reuse in the process. Clear / super-clear white water can still contain significant quantities of suspended material, such as pulp fibers, fillers and other suspended solids. Portions of this stream are typically discharged to a water processing plant, and replaced with fresh make-up water, which must be heated to process temperature for use in various applications. This practice comes at a price, namely the cost associated with fresh water usage and treatment, as well as the energy cost for heating the water.

The use of backwash filtration system for recovery of clear / super-clear white water coming from the save-all is a novel approach using existing, proven backwash technology. It allows the recovery of a larger portion of white water for use as warm process water, and thus provides measurable environmental benefits: reduction of fresh water usage and treatment costs, reduction of steam usage, and reduction of waste water treatment costs. The reduction of steam usage can be significant and translates into a reduction of fuel required for steam generation.

In this work, the author discusses how clear white water recovery through backwash filtration system contributes to environmental protection, including reduction in industrial water use and heating requirement, wastewater treatment costs, steam & coal/crude oil reduction .

Introduction

Pulping and papermaking are the two major manufacturing processes for the paper industry. Though the wastewater generated is from different raw material, manufacturing processes, product grades and discharging units, the characteristics of the discharged water is almost the same with only slight differences. In pulping process, the wastewater is mainly from stock preparation, black liquor evaporation, screening room and bleaching section. In papermaking process, the wastewater is mainly from the paper machine, and is usually called white water because it contains fillers, such as clay, $CaCO_3$ or the bleached fibers. Main pollutants of the pulping and papermaking wastewater are the suspended solids and the dissolved organic and in-organic materials. Reduction of the wastewater and rationalization of the water usage can be achieved by recycling the used process water such as the white water. The white water closed system developed in recent years is a good solution that minimizes the makeup water for the water loss due to evaporation and the water contained in the discharged sludge and reject.

During paper making process, a great amount of white water is collected and reused in the process, such as stock preparation; however, a significant amount is typically drained to a sewer after filtration, as the saveall filtrate is not clean enough for reuse in many applications, e.g. spray nozzles. Mills purchase or treat fresh water and heat it to process temperature for use on various applications. The main objective of this paper is to define the technology of backwash filtration system to reduce fresh water consumption and treatment costs, to reduce water heating costs and to reduce wastewater treatment costs.

A typical white water flow is given in figure 1. The drained white water is clarified or filtered by save-all machines such as the clarifier and poly disk filter. Figure 2 represents the two stages of poly disk filtration and three

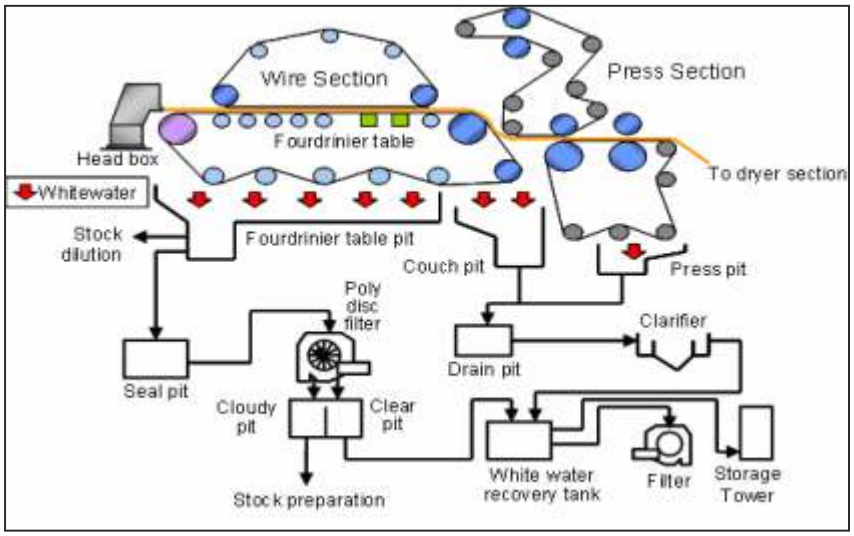

Figure 1: Typical white water flow

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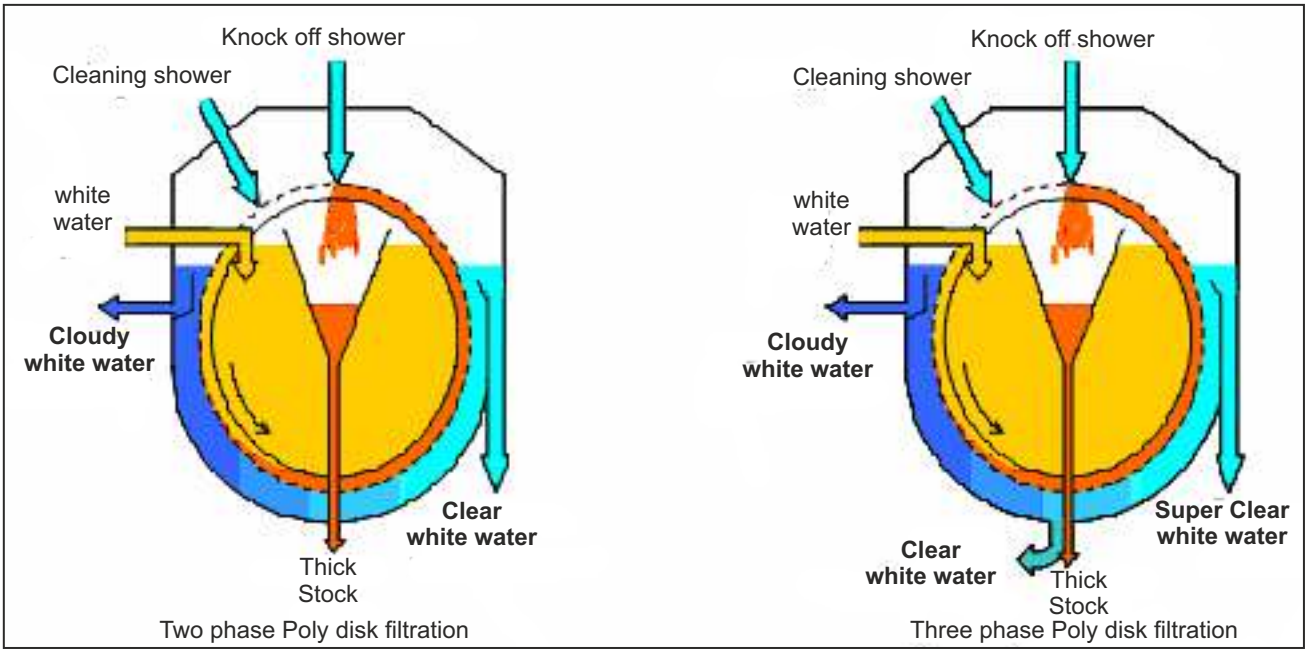

Figure 2: Two phase poly disk filtration & three phase poly disk filtration

stages of poly disk filtration used in paper industries for clarification of white water. Clear white water (outlet of two phase Poly disk filtration) and super clear white water (outlet of three phase Poly disk filtration) can be filtered through backwash filtration system to achieve low total suspended solids level (TSS).

Filtration Technology

The backwash filtration technology operates using thin polymeric disks of a specific micron size. The disks are diagonally grooved on both sides but in opposite directions. A series of disks are stacked and compressed for making the filtration medium. Grooves on both sides have a slightly slanted radial pattern but in opposite directions in each side. When the disks are piled up, the grooves make crossings. The pores formed by the crossed grooves capture contaminants and reduce the total suspended solids in the white water system.

Energy Savings Using Backwash Filtration

As mentioned before, excess white water is drained and wasted with enormous amount of thermal energy with it. The optimal process operating temperature is 45 to 60 degree C for paper machine applications. Hence in order to prevent waste of energy and water resources and utilize it effectively, an automatic backwash filter system could be employed for white water recycling. Clear white water and super clear white water in the clear pit can be filtered by the automatic backwash filter system.

The use of circulating white water rises the temperature of head box, thereby reducing the use of fresh water. It occupies 20 to 30% of the unit steam consumption of a papermaking machine. Filtered white water can be used to heat the fresh water required in process applications of paper industries. Thereby it can result in direct saving of the wet steam used for heating purpose in paper industries. Total heat of steam can be calculated as per following formula:-

$H = h + xL$

Where H = Total heat of dry saturated steam

h = Heat of liquid

x = dryness fraction of steam

L = Latent heat of vaporization

One can determine the quantity of reduction of steam equivalent to reduction of coal or crude oil consumption with a procedure to estimate enthalpy savings and fuel usage based on process data i.e. temperatures, flow rates, etc., specific to individual paper mills. Savings in steam usage can be obtained with data considering efficiencies for the heat exchangers.

Three case studies of backwash filtration systems are shown here in which the clear / super clear white water is filtered through the backwash filtration system to reuse as shower water, warm water and nozzle protection. The energy savings calculation can be determined for the individual paper mills with reference of enthalpy savings, reduction of heat and reduction of fuel usage. In the following case study 1, it has been observed that energy saving was achieved by adding automatic backwash filter system to recycle white water which was disposed to drain before. It was observed that recycling of clear white water using the automatic backwash filtration system was very effective in energy saving and CO_2 emission reduction.

Case Study 1

A Japanese Paper Mill

- Machines: Paper machine no. 4 and

Tests at No. 4 & No. 5 Paper Machines

Paper Machine	No. 4	No. 5
Disk micron size	130 micron	130 micron
Flow rate	2 m^3/hr	1 to 2.5 m^3/hr
Backwash	Every 30 Minutes	Every 30 Minutes
Backwash performance	Running for 4 weeks without any interruption	Running for 2 weeks without any interruption
Backwash filter Effluent (Total suspended solids)	5ppm or less, steady	5ppm or less, steady

Paper machine no.5

- Application: Filtration for clear white water
- Purpose:
  - Re-use of white water as shower water in wire part
  - Re-use of white water as pre-warming cold water
  - Stop plugging of nozzles due to agglomerates of fibers

As a result of success of trials, a backwash filtration system of 130 micron disk was installed in paper machine no. 4 and paper machine no. 5 for the flow rates of 250 m^3/hr and 180 m^3/hr, respectively. These backwash filtration systems have been working in the paper mill since Nov 2007 and the total CO_2 reduction was calculated as 8836 ton/year.

Case Study 2

Another Japanese Containerboard Mill

- Machines: N-9 Paper Machine
- Application: Filtration for super clear white water
- Purpose: Reduction of industrial water consumption
- Cleanliness Level Requirements:
  - Suspended solid
- Influent to backwash system: 15 to 25 ppm
- Effluent from backwash system: 5ppm or less
- The current cleanliness level (Before testing)

Sample fluid of super clear white water taken from N-9 paper machine

- Suspended solid: 15 ppm
- Average fiber length: 470 micron

Two sets of auto strainers of 60 mesh were equipped in N-9 paper machine for reuse of super clear white water from Voith poly disk filter. As a result of frequent plugging of auto strainers, the mill personnel had to use fresh industrial water due to which the daily consumption of industrial water reached 4,000 m^3/day in the plant.

As a result of success of trials, a backwash filtration system of 70 micron disk was installed in paper machine no. 9 for the flow rate of 167 m^3/hr .These backwash filtration system have been working in the paper mill since Feb 2009 and this was observed as successful operation by the customer in terms of reuse of super clear white water for machine showers, reliable operation of backwash filtration system and no early plugging of auto strainers.

Case Study 3

A Paper Mill from Poland

Situation

- Paper mill is producing writing paper.
- The site had already worked on clarified white water filtration after the poly disk equipment.
- The process engineers of this paper mill wanted to upgrade the current filtration to reduce maintenance cost and improve efficiency.

Solution by Pall

- Pall team members performed trials at the paper mill to establish the optimum backwash filtration system.
- Automatic backwash filtration system was installed.
  - The final solution is 7 modules of disk filter rated at 130 µm for a total flow rate of 200 m^3/h.
  - The inlet pressure is 5.5 bars (80 psig).
  - The backwash frequency per module is every 13 minutes on average.
  - The system utilizes the clean fluid as backwash fluid.

Results

- This equipment is considered by the user as a "fit and forget " equipment.
- After filtration, TSS (Total Suspended Solid) was below 5 ppm and allowed for reuse of this treated white water instead of fresh water, without nozzle plugging.

Tests at N-9 Paper Machine

Paper Machine	**No. 9**
Disk micron size	70 micron
Flow rate	3.5 m^3/hr
Backwash	Every 30 Minutes
Backwash performance	Running for 3 weeks without any interruption
Backwash filter Effluent (Total suspended solids)	5ppm or less, steady
Test Period	20 Days

Conclusion

The use of backwash filtration system for recovery of clear / super-clear white water coming from the save-all is a novel approach using existing, proven backwash technology. It allows the recovery of a larger portion of white water for use as warm process water, and thus provides measurable environmental benefits: reduction of fresh water usage and treatment costs, reduction of steam usage, and reduction of waste water treatment costs. The reduction of steam usage can be significant and translates into a reduction of fuel required for steam generation and finally carbon dioxide (CO_2) emission reduction. Hence reuse of white water contributes to environmental protection. Total suspended solids of white water samples were below 5 ppm or less after filtration through the backwash filtration system and hence this treated white water can be used in various applications of the paper mill.

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