

Environmental Sustainability in Indian Pulp & Paper Mills

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Abstract:

With the rapid expansion in capacities of the Pulp & Paper Market in the last few years and more expected in the days to come, the constraints on the amount of natural resources that it can mobilize for its purpose is rather disproportionate on the availability of such resources and the ever-changing administrative responses to factors like climate change and urbanization.

Although “Environmental Sustainability” can encompass multiple factors, the focus here will be on Water, as there is a gap in the traditional water treatment technologies meeting the requirements of Pulp & Paper Industries. The impact of water closure on the productivity and quality aspects of paper making is not a considered factor in a traditional water treatment approach.

This paper wishes to highlight the current limitations in water treatment within the Industry by technique and scale and possible options to effectively adapt to the new regime by exploring new technologies.

Mandatory Online monitoring of water discharges through central grid and forthcoming rules on defining extent of recirculation by statutory agencies puts added pressure on the treatment philosophy used by mills.

Keywords: Sustainability, Contaminants, Properties, Volatile Fatty Acids, Methanization, Biological, Reduce, Re-Use, Recycle, Zero Liquid Discharge, Odour, Putrifaction, Ultrafiltration, Electro-Coagulation.

INTRODUCTION

Categorizing Effluents in Paper Industry

The extent of defining waste water within Paper Industry would depend on the type and source of water.

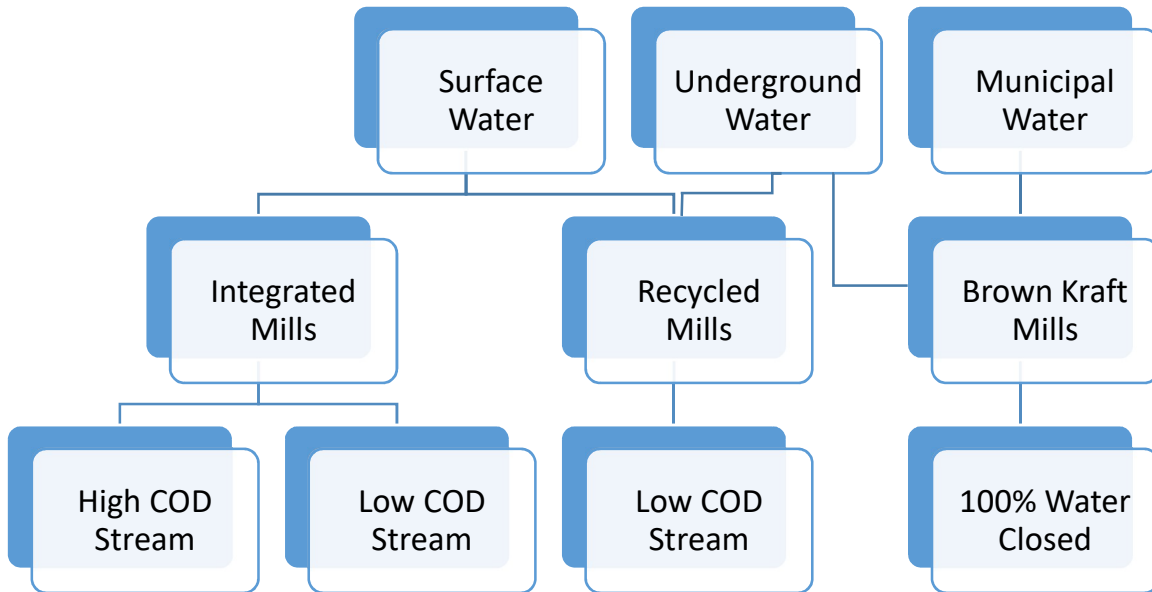


Fig 1: Categorizing Effluents in Pulp & Paper Industry

In several mills, the source water could also be a combination in different percentages.

EFFLUENT DISCHARGE CLASSIFICATION

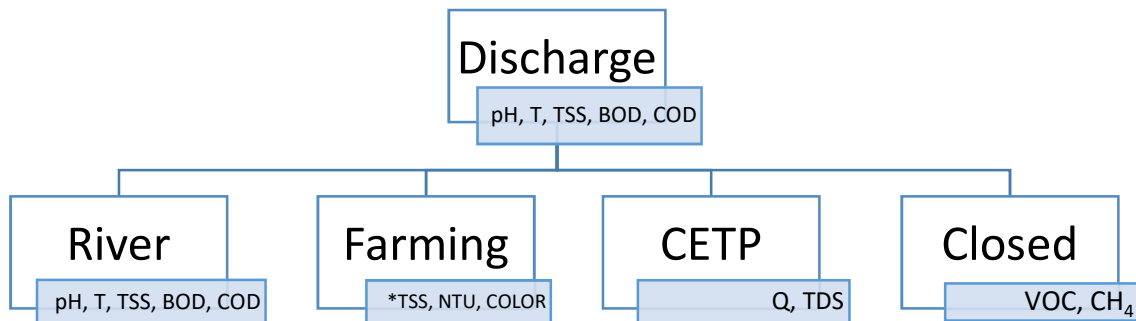


Fig 2: Effluent Discharge Classification

Simplified first response parameters. *Nutritional value to agriculture also matters.

In order to understand the nature of waste water in this Industry, it would be prudent to understand the mechanism of transition of water to wastewater, in different streams of papermaking. It was and still is, a common practice to combine various effluents from different streams in the Common Effluent Treatment Plant for years. It is therefore a common perception that any recovery or conservation efforts begin inside or after the Effluent treatment plant. However, considering the extent of quantity and quality in any paper plant, this is often a difficult proposition technically and financially.

The transition from fresh water to waste water happens due to the primary nature of water:

Water is a universal solvent!

Water finds its own balance – property wise!

When water evaporates, its constituents don't!

Significance of Treating Raw Water Vs Process / Waste Water

Effluent is generated in three different mechanisms:

- By chemical reactions and leaching in Pulp Mills where compounds are dissolved in water, as in Pulping & Bleaching in Integrated Plants signified by high TDS and COD.
- By addition of suspended/coagulated matter in water as in Paper Machine systems, usually signified by high TSS and Turbidity
- By Increase in concentration due to evaporation of water, as in Utility Systems / Heat Exchangers usually signified by scaling or corrosion tendencies.

It would be much easier to treat water in the same way that it is added and there are technologies available for the same. First step in Sustainability is in reducing the utilization of water for a particular process (specific water consumption). The reduction in specific water consumption must be stretched to the extent of reducing water consumption of a particular process to the extent of retaining past achieved productivity and quality.

Next is to apply the REDUCE – REUSE – RECYCLE principle.

REDUCE is to make Process optimization to Avoid Spillages, Overflows, Reduce unwanted dilutions, or handling higher consistencies where possible, etc.,

REUSE is to use existing process water to replace current fresh water applications. The common misnomer here is the wrong understanding that the existing process water as such is used to replace fresh water. This will create problems in water-associated problems such as scaling, corrosion or productivity or quality losses. The unspoken norm here is to treat these waters to the nearest fresh water quality parameters before use.

In order to maintain the chemical integrity of the process, this should be a short loop solution.

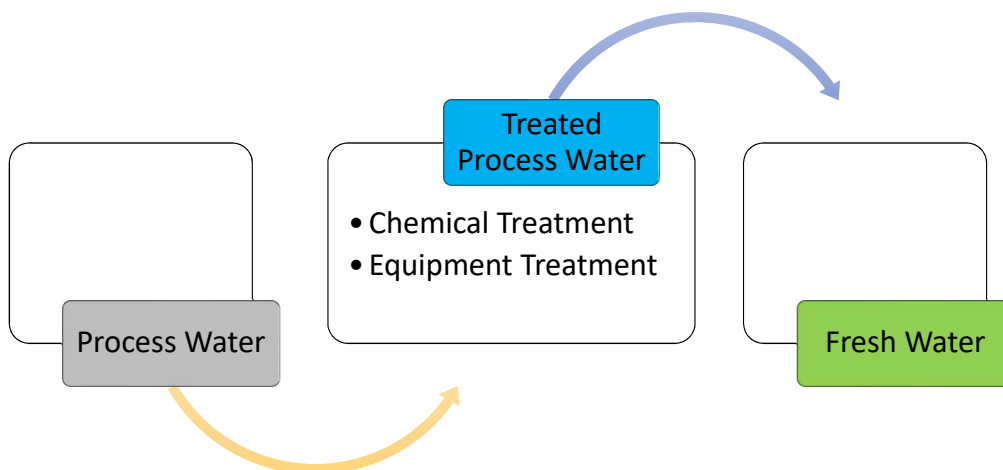


Fig 5: Re-Use Methodology

RECYCLE is the final option to remove contaminants at ionic level. This would be and should be the last option after exhausting REDUCE and REUSE cycles. Again traditional thinking is to use Recycle options at the final discharge quality water and re-use it back in mill. This method, considering the huge quantity of water used in P&P Industry, would not be financially viable most times.

It is better to apply this at a loop level as indicated above, ie., source water from Point A and use it in Point B while treating it in between.

ZERO LIQUID DISCHARGE [ZLD]

It's an oft quoted term that is being used but the concept as well as the demand and steps to achieve it is not fully understood. Considering the quantity and quality of water handled, it is almost impossible for Integrated mills to achieve it, there is a certain possibility for Recycled mills or Brown Kraft mills to achieve the same or be closer to it. But the path towards it demands much study in the approach and a scientific process to achieve the same.

Care must be taken to differentiate between Water Closed Mills and Zero Liquid Discharge Mills.

A poorly designed ZLD can result in high Capex and Opex costs affecting financial viability of the mill. A large extent of water closure before stepping into the final ZLD phase is very critical for success! Steps to ZLD

Steps to ZLD

What do Mills do ?

- Re-routing their water circuit to the best of their knowledge that mainly includes short-circuiting
- Chemical solutions to offset shortfall in treatment capacities
- Unit addition of treatment systems at specified locations just fit for one purpose
- Addition of new water treatment plants (capex)
- Include new treatment plants during expansions (capex)
- Postpone project plans due to sizing or cost considerations

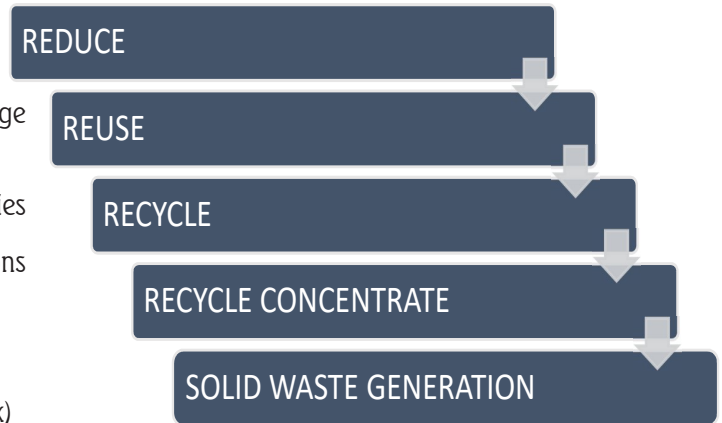


Fig 6: Zero Liquid Discharge Steps

Path to Better Water Sustainability

Vision, Mission and Goals

It is important that the mills has a clear understanding of what they want to achieve. This needs to be a long term plan considering the futuristic opportunities and compulsions.



Fig. 7. Vision, Mission and Goals

- Vision: What motivates us? Compliance? Environmental Empathy? Branding? Leadership?
- Mission: Do you have a plan?
- Goals: Did I achieve my objective? Am I on target? How has it helped me? Change Plan?

Categorize Opportunities and Timeline Recommendations

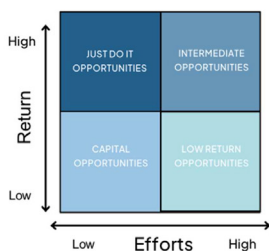


Fig 8: Planning for the Mission (1)

Categorize Opportunities and Timeline Recommendations

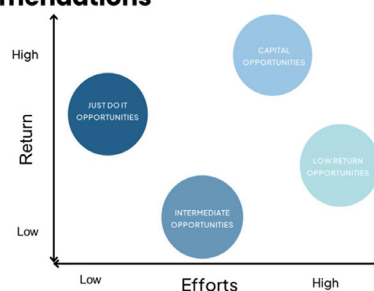


Fig 9: Planning for the Mission (2)

MEASUREMENT

Major step towards Water Sustainability is to measure it. Many mills do not have flow measurements in significant locations causing assumptions or mistakes or creating an inability to increase chemical or mechanical efficiencies as well as an inability to create an accurate water balance. The probable reasons could be the expense related to it especially for large flows or pipelines. However, there are inexpensive options today which can be imaginatively used to achieve our goals.

Approach to Sustainability

Final Mill Sustainability = \sum Sectional Sustainability

Water Audits

Beginning this effort with a narrow objective, unplanned method, limited applications and immediate results would result in imbalances in the system and may not help achieve desired objectives or even prevent in achieving better results.

Conducting a mill-wide audit across all sections would help prepare a long-term objective mapping with short-term staggered goals. It would also set a guideline on the Why, What and How aspect of effort in each section while care would be taken not to upset productivity or quality. Haber undertakes mill-wide water audit contracts to support the mills objectives. It is important that the auditors are well versed not only in water related issues but production and chemical application knowledge to achieve better results. Water Audits are to be conducted in Project Management Mode.

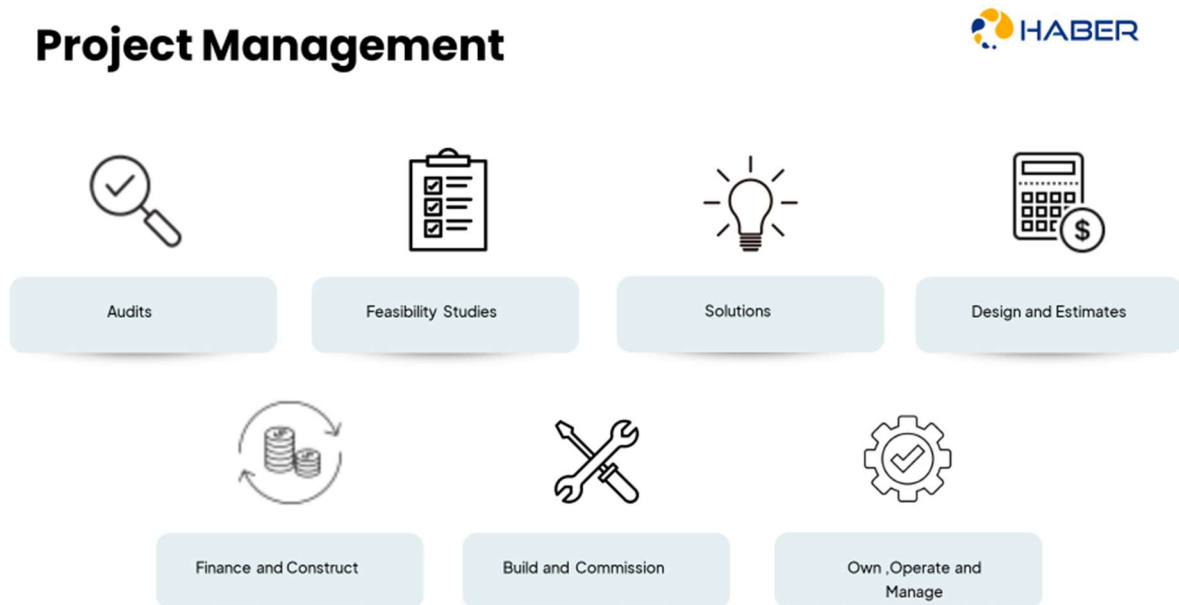


Fig 10: Coverage of an Audit

There needs to be a change in the mindset regime, as we will be progressing to a higher Cycle-of-concentration (COC) and higher TDS cycles and still need to achieve our target and productivity goals.

MAXIMIZING EFFICIENCY OF WATER TREATMENT EQUIPMENT

All Water recovery systems within the premises like Krofta, DAF, SediCell, Disc Filters, Pressure Filters, Sand Filters, Clarifiers etc., need to be reviewed for individual efficiencies and should be at their peak.

Similarly all Heat Exchangers / Cooling Towers especially where fresh water is replaced by treated process water should be optimized for peak efficiency.

MAJOR AREAS OF FRESH WATER CONSUMPTION

As regards Pulp & Paper Industry, major fresh water consumers are Pulping & Bleaching section, Paper Machine Showers and Chemical Additive Plant and in some cases, vacuum system. Recycling EOP Filtrate, Back Water for Showers or even CAP would remain the primary target for substantial reduction in fresh water reduction.

While clarified waters are used in recirculation mode in pulp mill as well as paper machine for dilution directly without treatment, it would make a better system if maximum TSS is removed within the system before dilution for the Pulping or Wet End Chemistry to perform at their best!

SELECTIVE RECYCLING OF SHORT LOOPS

In many cases, both the Pulp Mill effluent and Paper Machine effluents are mixed either before or after the Primary and Secondary treatment. More so, in many mills the Low COD stream acts as a dampener for transgressions in High COD stream. However, with proper design and planning, these two can be dealt with. (Ref. section "Adopting New Frontiers in Technology")

However, the Low COD stream lends itself to recycling at lower conversion costs. This must be used for several closed short loop recycling to directly replace fresh water.

In effect the overall inflow to the ETP will reduce and will provide more opportunities to treat this in a different way.

SHIFTING THE TECHNOLOGY BARRIER

Since the 60's, Krofta/DAF was the common fibre recovery / water treatment system within the Wet End. The efficiency of these are usually 90% and prone to transgressions. The designs of these are flow based, and with age, as the productivity of the mill goes up, they lose efficiency while catching up with the increased production. However, there are systems today, like Haber's AIML-based IOT platform that can maximize the efficiency of such systems.

Pressurized filters came soon, but these are highly design sensitive, lack adaptability as the process changes, and are also maintenance intensive.

Disc Saveall became popular in the 90's (In India) with far better filtration prowess, but in the last 3 decades, the quality of wood or pulp or recycled fibre has gone low, the average particle size of the suspended particles have been low, and the colloidal load of the suspensions are high. This is especially so in mechanical fiber based systems, where there is a limitation in even Retention and Drainage (which is actually a filtration process!) of paper machines and downstream solid-liquid separation systems. It requires a relatively higher level of chemical dosages which once again affect the COD levels and residual surfactants or polymers in the system.

It is time to shift the technological level by one more step with a capability to handle filtrations far exceeding Disc Saveall.

The reason to highlight the above is that majority of components of white water are all added substances either in the form of fibers (fines – that are basically fibers below a certain length), fillers, Colors (that are colloidal in nature, but with certain molecular size) – the most sustainable way to remove these are filter these out, instead of a chemical route.

Recent advancements enable filtering above 0.1 micron where all Suspended solids, majority of Colloidal Solids and Bacteria / Virus / Algae are removed.

A DIFFERENT MECHANISM IN BROWN KRAFT PAPER MILLS

Kraft mills are Totally Water Closed Mills – This is different from Zero Liquid Discharge – where they simply do not have an option to let effluent go and therefore the water becomes hold up volume for several months altogether. Only the evaporation loss is compensated and some more fraction.

Meanwhile the solids content to the extent of balance of yield keeps adding up. The basic input being cellulosic fibers, being organic in nature are immediately weakened by the water being a universal solvent, and with subsequent recirculation between Pulper and ETP, it undergoes much shear, and finally becomes of a fluid having very low particle size components.

The Anionic charge goes up, Dissolved Solids go up, and Hardness go up. Beyond a point, effectiveness of liquid – solid – separation chemicals are not effective.



Fig 11: Specialized Ultrafiltration

The solids undergo decomposition / putrefaction and develops VFA which is the source of foul odour. This happens all across the mill hence both the paper and the mill has odour.

Various technologies have been tried out including Aerobic, Anaerobic treatment etc., but none of these are effective.

Once again, the solution lies in filtering to a high degree and removing the sludge out.

Innovative application of technology in achieving sustainability

Haber has been in the forefront of identifying root causes and developing a solution for process water recovery. We have determined Ultrafiltration concept to be the most effective solution in pushing the frontiers of filtration.

However, the standard tubular Ultrafiltration modules of PES/PVDF would not be suitable due to its low temperature handling capacity and Suspended solids handling capacity.

A submerged Ultrafiltration design made of ceramic flat plates having higher temperature resistance and suspended solids handling capacity is used to filter out particles > 0.1 – 0.4 microns and clean water is obtained.

The concentrated solids can then be separated out and sent to process back again or to the Effluent treatment plant.

The quality of water obtained is suitable to replace fresh water in showers and with further RO treatment can be used for CAP as well.

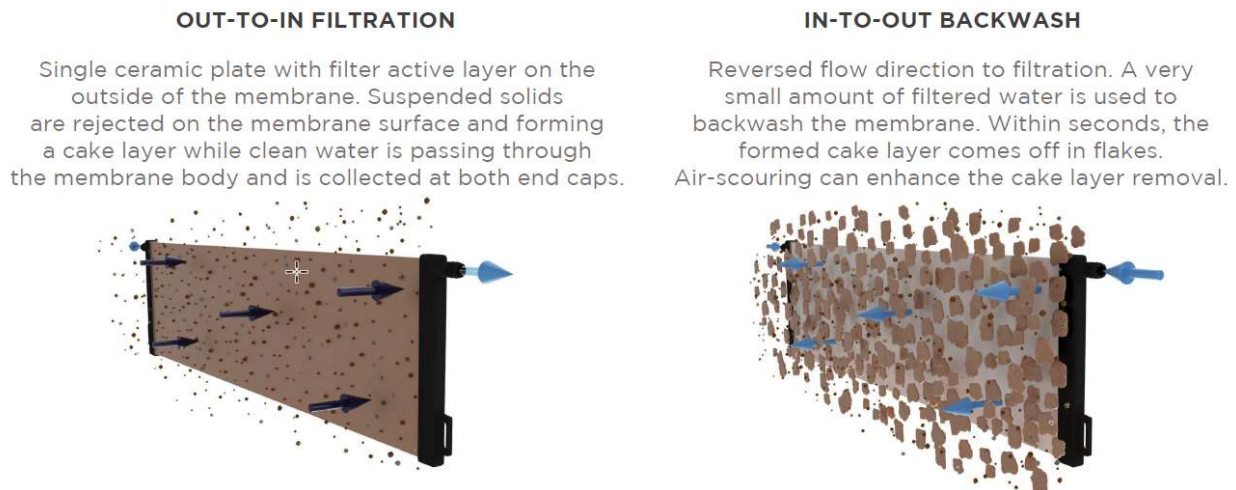


Fig 12: Working Principle of Specialized Ultrafiltration

This technology has proven to remove complete suspended solids, majority of colloidal solids, even color and the water is fit for use in mechanical showers or in sufficient quantities can be used for dilution to manage the overall cleanliness of wet end.

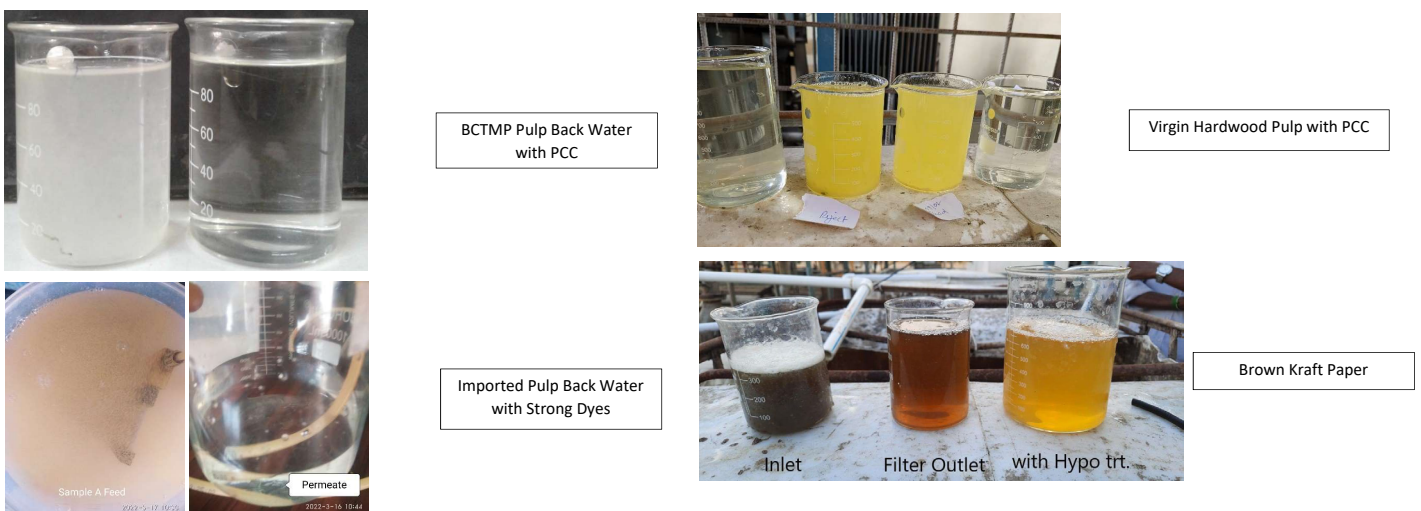


Fig 13: Efficacy of treatment of different samples through Specialized Ultrafiltration

ADOPTING NEW FRONTIERS IN TECHNOLOGY

Statutory Rules stipulate that the major parameters are conveyed to the Central Grid online for all discharges. The Agency may going forward stipulate the extent of recirculation, which would be substantial, by 2027. In view of this, mills need to identify ways and means for such action. Knee-jerk reaction may bring forth more obstacles in the path.

Traditional methods of water treatment, like Primary Clarification, Aerobic Treatment, Anaerobic Treatment and even traditional Tertiary Treatment like Tubular Ultrafiltration and RO plants can provide limited options while handling the large and demanding needs of Paper Industry.

The Industry will be constrained to look for newer technologies to obtain feasible solutions. Haber has investigated alternate options apart from the Submerged Ultrafiltration above, that may bring solution while keeping in check the footprint, cost of operation – power, chemicals and manpower. However, as with any newer technologies, higher the adoption in the market, lower the rates will be with time.



Fig 14: Clarification of Agro-based EOP Filtrate through Electro-coagulation



Fig 15: Efficacy of treatment of ETP water with Electro-coagulation & Specialized Ultrafiltration

A significant technology that may suit difficult effluents like Bleach plant effluent, EOP Filtrate and Agro/TMP based furnishes is the Electro-coagulation method. Our recent studies have shown these could be a worthwhile option to look into.

Ultrafiltration can be used in tandem to remove sediments that are separated with Electro-coagulation in a way that not possible with traditional chemical approaches.

CONCLUSION

Water Sustainability is no more an option but a necessity looming large on the operational efficiency and profitability of the mill. In some cases, it can supercede the presence of mill over providing job opportunities or revenue that it can generate to the larger social cause. Early induction into this exercise would help ratifying the right process and achieve cost optimization.