Sustainable Water Management in Pulp & Paper: MPS Pilot Breakthroughs

Dr. R.S. Dahiya*, Sharad Dahiya**, Anju Gauba**

Dr. R.S. Dahiya*

Abstract

Present study is oriented in signifying the application of Micro Plate Settler for Pulp and Paper at Machine Back Water and underflow of River Water Clari-Flocculator streams. Major streams where MPS finds its applications are Wash Water from Wet Cleaning (Agro Based Industries), Machine Back water, Deinking Sludge, Black Liquor, River Water and Pulp Mill Effluent. Successful installation of MPS are –Bagasse wet Wash Water (M/s Pakka Ltd.), Machine Back Water (M/s Eco Tech Papers, M/s JK Papers, M/s Star Papers, M/s Naini Papers/s Pakka LTD., M/s kuantum Papers, M/S Khanna Papers), Deinking Sludge (M/s Khanna Papers), Black Liquor (M/s Shreyans Papers) and River Water (M/s Shreyans Papers). Total suspended solids and Turbidity are reduced to the tune of 92-99 % and underflow consistency reached as high as 2-3% thereby making sludge treatment very easy.

Keywords: MPS(Micro Plate Settler), TSS(Total Suspended Solid), pt.-co (platinum cobalt scale), NTU (Nephelometric Turbidity Unit), HRT (Hydraulic retention time).

Introduction

Machine back water constitutes a significant portion of the used process water, containing suspended fibres, fillers and other process chemicals. Its effective management plays a crucial role in optimizing water usage and enhancing sustainability within paper manufacturing operations. Paper industry is one of a major consumer of fresh water, utilizing 5-40 m^3 of water per ton of paper manufactured in its production process [2]. Effective raw water treatment is critical to ensure consistent process performance & protect equipment in pulp and paper industry. Again this huge quantity of water after being used in process has to be treated and recycled for economic and enviro-legal issues.

Drawback of Conventional Clarification Technology:

The conventional clarification technology uses high retention time, high chemical addition or consumable filtering media to clarify the water.

- An equipment designed on high retention time occupies large floor area and faces problem with septicity of fibre and increased organic load of the clarified water.
- The high power and consumable cost in technology like disk filter increases the Opex cost, maintenance downtime and disposal of used consumable causes enviro legal issues.
- In all conventional

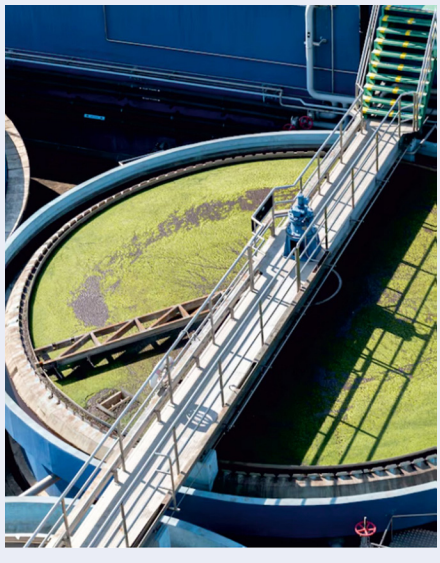

Figure 1: Slime/algae collected on top gets carried forward into accept.

*Managing Director, **Director and ***GM Projects, Sharad Projects India Limited (SPIL), Panchkula, Harayna, India.

clarification technology, the slime, oil, plastic and colloidal etc. in the system gets carryover in clarified water, as shown in figure 1, which causes problem in papermaking when this clarified water is reused.

- In case of clarification with chemical aid, the clarified water contains residual polymers/chemicals which can pose complex problems in paper production process if this water is reused.

Problem due to residual polymer/ chemical in recycled water[1]: -

- Thin layer of chemical deposition on dryer surface, reducing heat transfer efficiency
- Increased steam consumption.
- Increased paper break due to adhesive nature of chemical deposition
- Formation of stickies' due to accumulation of polymer in the system
- Increase in slime and colloids generation which clogs LP shower in PM section and severely affect the life and efficiency of membrane system installed.
- Result in high ionic charge disturbance in the process, causes issues in paper formation.

A Sustainable Solution:

In today's industry scenario marked with rising cost of raw material, chemical, raw water and electricity coupled with stringent environmental regulations and competitive quality demands - SPIL MPS (shown in figure no. 2) represents an optimal sustainable solution to meet the evolving needs of the industry.

SPIL MPS is an advanced technology based on Hazen law that offer high efficiency and profitability to the industry with minimum impact on environment and reduced carbon footprint. Unlike conventional technology that utilizes physical filtering media (fabric, metal screens etc.) or chemically induced liquid-solid separation, SPIL MPS utilizes sheer fluid dynamics and engineering to achieve liquid clarification with high efficiency at low operating cost.

SMALL FOOTPRINT - > SPIL Micro Plate Settler (MPS) employs dual media in vertical design, customised media construction and its advanced hydraulic design allows it to perform at higher efficiency than conventional technology at low retention time and smaller space requirement (approx. 1/5 th size of conventional technology). Due to its compact size the process temperature is maintained in the clarified water

WATER RECYCLE - > SPIL MPS due to its unique design and PLC/ DCS based automation system works at 90-99% clarification efficiency without use of chemicals/ polymers[1] therefore the clarified water can be easily reused in the system without affecting the production parameters.

ANTI-SLIME - > The advanced outlet siphon pipe design of MPS prevents the light reject like slime, oil, plastic etc. to get carried forward to the clarified water, instead these get collected at the top of MPS and removed automatically with the help of Scrapper.

REDUCED CARBON FOOTPRINT - > In MPS the power consumed in the system is minimal comparable to other technology, also the MOC of filtering media is stainless steel which is non corrosive, so practically there is no need of spares hence reduced waste generation and low cost of clarification.

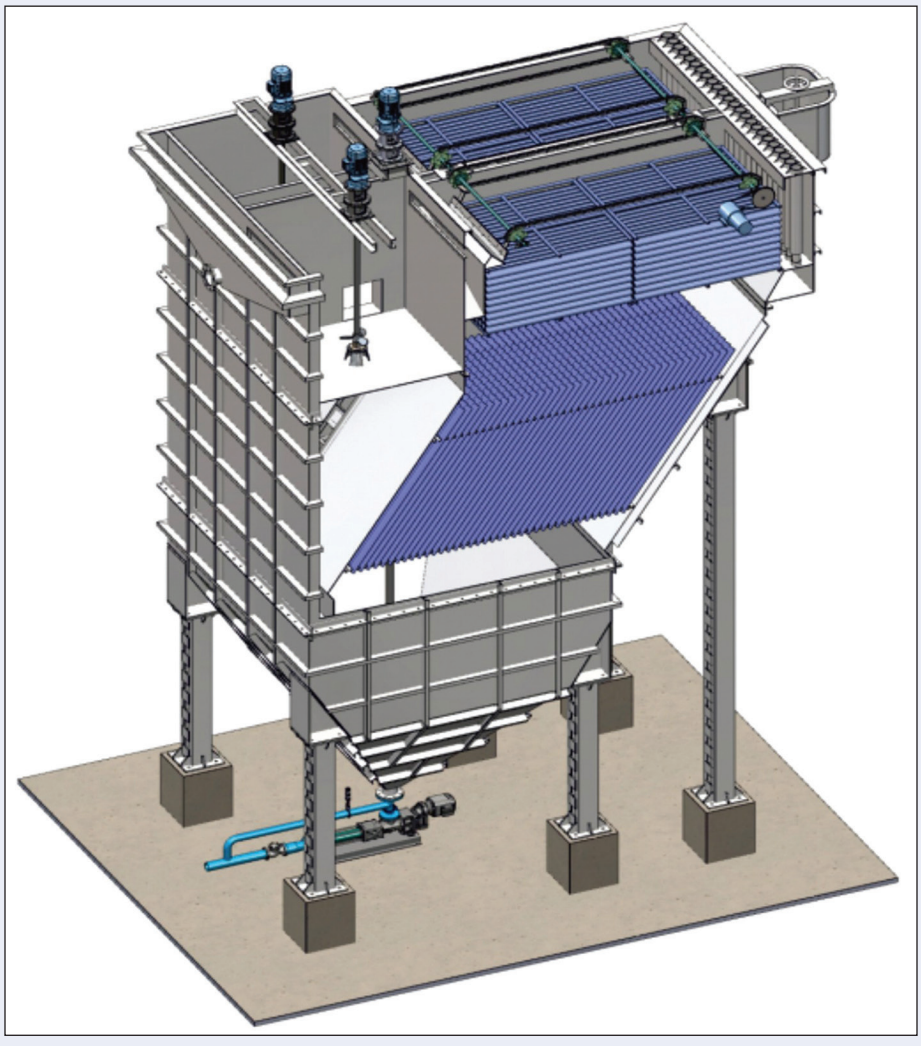

Figure 2: SPIL MPS (Micro Plate Settler).

EFFICIENT SOLUTION - > It has been observed that with high standard deviation in inlet parameters of MPS the standard deviation in outlet clarified water are minimal, Thus, MPS stands as a high-performance technology that the paper industry can depend on for reliability and efficiency.

#[1] In few applications minor dosing of chemical may be required.

Pilot Trials:

Recently SPIL has conducted pilot trials first at ITC limited, PSPD, Bhadrachalam unit and second at West Coast Paper Mills Limited Dandeli, Karnataka to study the efficiency of MPS at different water sources. The pilot trials were conducted on following water streams: -

Pilot Trial – No 1

At ITC Ltd., PSPD, Bhadrachalam

a) Paper Machine Backwater

b) River water Clari-Flocculator underflow sludge

Pilot Trial – No 2

At West Coast Paper Mills Limited Dandeli, Karnataka

a) Paper Machine Backwater (White Paper)

b) Paper Machine Backwater (Colour Paper)

c) Fiber mizer reject

The pilot plant is designed for capacity of 10 m^3/hr flow but during the Trial the pilot plant was operated at a flow as high as 15 m^3/hr on specific application with slight increase in outlet TSS and colour comparable to results seen on designed flow capacity shown in Table 3, Table 4, Table 5 & Table 6.

Pilot Trial – No 1

a) Paper Machine Backwater

The trial was conducted in ITC limited, PSPD, BCM unit on PM6 machine backwater, during the trial white paper was being manufactured on the machine. The main focus of the trial was to observe the efficacy of the MPS in comparison to disk filters already installed in ITC and to increase the reusability of machine backwater reducing freshwater consumption. As per results in Table 1 there is an average reduction in TSS and Turbidity to the tune of 98.1% and 98.6% respectively without any chemical addition, sample shown in Figure 3. Moreover, a recovery of 85 to 90% of machine backwater as clean water with an average TSS of 15 PPM was achieved during the pilot trial comparable to recovery of 30 % super clear water in poly disc filters[3].

Figure 3: MPS Inlet feed and outlet clarified water (from L to R).

Table 1: TSS and Turbidity Reduction in White Paper Machine Back Water Treated by MPS Pilot.

Date	Time	Flow rate (m^3/hr)	Suction Source	Inlet TSS (PPM)	Outlet Clear water TSS	Inlet Turbidity (NTU)	Outlet Clear Water Turbidity (NTU)
29 - Feb	11:30	11	Rich B/W	810	19.4	646	12.8
01 - Mar	09:30	11	Rich B/W	820	10.8	620	7.8
02 - Mar	09:30	11	Rich B/W	720	20.4	568	11.2
05 - Mar	10:30	11	Rich B/W	840	13	720	7.6
09 - Mar	17:15	11	Rich B/W	784	13	542	7.4
11 - Mar	12:15	11	Rich B/W	750	12	630	6.4

Note:- *No chemical addition was done during trail.*

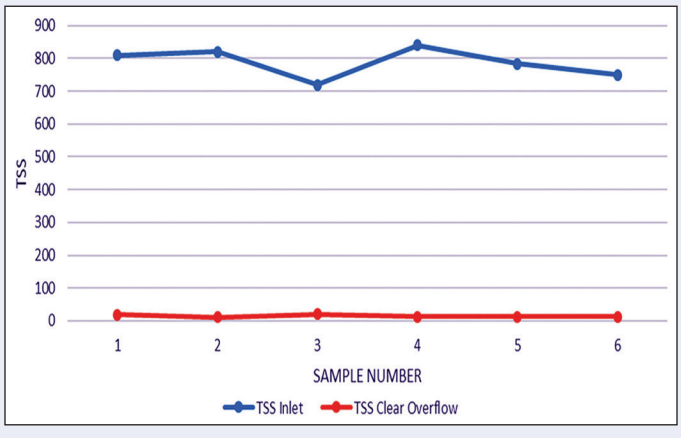

Figure 4: Time series chart for inlet TSS, clear overflow TSS.

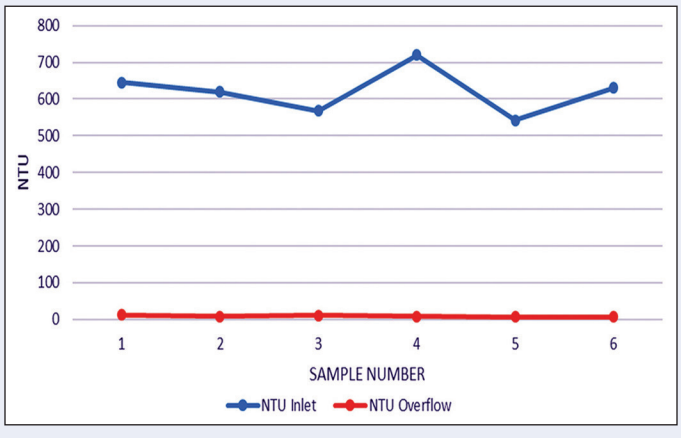

Figure 5: Time series chart for inlet Turbidity, clear overflow Turbidity.

As seen from Table 1 values, the standard deviation in inlet TSS and inlet NTU is 44.6 and 61.7 respectively and the standard deviation in outlet clear water TSS and NTU is 3.6 and 2.3 respectively; also shown in chart depicted in Figure 4 and Figure 5 it is clear that with a very high standard deviation in inlet TSS and NTU there is negligible variation in outlet clear water TSS and NTU - confirming stable and reliable performance across multiple trial days.

b) River Water Clari-Flocculator underflow sludge:

Pilot trial was conducted in ITC limited, PSPD, Bhadrachalam unit. In this unit river water is being used as raw water source for process and other utility requirement. This river water is being treated by two no. clari-flocculator which generates sludge, mainly consisting of mud and water, at a rate of 30 to 65 m^3/hr having consistency of around 1-2%. This low consistency sludge is being discharged into river, which is a direct loss as this discharged quantity is billed unit and also discharging the sludge into river will be a problem due to upcoming strict environmental norms. MPS pilot trial was conducted to find efficiency of recovery of clean water from river water clari - flocculator underflow sludge. During the pilot trial 90% of the inlet to the MPS pilot was clarified and 10% reject was drained. As per data shown in Table 2 the TSS reduction efficiency of 99.8% is achieved without any chemical addition and turbidity as low as 4 NTU is observed during pilot trial, samples shown in Figure 6. It was concluded in the trial that 90% of Clear water was recovered from Clari-Flocculator underflow sludge which is direct saving, with clarity better than the quality of the clarified water from clari - flocculator installed in ITC. Also as the sludge volume is decreased by approximately 90% of initial sludge volume, hence disposing of sludge would be easier.

Figure 6: MPS inlet feed, outlet clarified water and underflow sludge (from L to R).

Table 2: TSS and Turbidity Reduction in Clari - Flocculator Underflow Treated by MPS Pilot.

Date	Inlet TSS (PPM)	pH	Outlet Clear water TSS (PPM)	Outlet Turbidity (NTU)
20-03-2024	11176	7.1	18	8
21-03-2024	12660	7.4	12	4
Note:- *No chemical addition was done during trail.*				

Pilot Trial- No 2:

a) Paper Machine Backwater (White Paper)

This trial was conducted in West Coast paper mill, on PM2 machine backwater, during the trial white paper was being manufactured on the machine. At the time machine backwater was being treated using DAF technology with TSS of clarified outlet water in range of 70-150 PPM which the industry was unable to use in machine showers. The trial was aimed to achieve the quality parameters of clarified outlet that can be efficiently used in shower application. The results in Table 3 and samples in Figure 7 clearly shows that with an average reduction of 98.3% in TSS and 97% in turbidity, Clear Water can be easily used in machine shower application without any clogging issues [3]. Table 3 shows that 90% of the machine backwater was recovered as clear water with an average outlet TSS of 19 PPM, reusing of this water effectively reduces the freshwater consumption also the recovered fibre with an average consistency of 1-2 % can be reused back into the process (owing to low HRT in MPS), both resulting in direct financial benefit. This complete trial was conducted without addition of any coagulant or flocculants (unlike DAF), which will result in savings from recurring chemical cost hence reduced Opex.

Figure 7: MPS Inlet feed, outlet clarified water & underflow recovery (from L to R).

Table 3: TSS and Turbidity Reduction in White Paper Machine Back Water Treated by MPS Pilot.

Date	Time	Inlet flow (m^3/hr)	Outlet clear water flow (m^3/hr)	Inlet TSS (PPM)	Outlet clear water TSS (PPM)	Underflow recovery TSS (PPM)	Inlet Turbidity (NTU)	Outlet clear water Turbidity (NTU)
26.05.2025	11:00	10	9	1155	15	10490	560	20
	14:30	10	9	1205	10	10165	600	27
	16:00	10	9	1230	12	11390	1200	20
27.05.2025	14:30	15	13.5	1120	35	11190	760	27
	16:00	15	13.5	1190	24	12390	760	21
Note:- *No chemical addition was done during trail.*								

b) Paper Machine Backwater (Colour Paper)

This Pilot Trial was conducted in West Coast Paper mill on PM2 Machine Backwater. On PM2 paper of different colour shades are being manufactured and the excess machine backwater is being sent to ETP for further treatment due to complex nature of different coloured dye involved. Due to high fibre and dye content in machine backwater there is an increased organic and inorganic load on ETP requiring increased equipment sizes and increased OpEx & CapEx in ETP plant. The aim of the Pilot Trial was to analyse the reusability of the machine backwater, reduction of load on ETP and attainability of overall financial benefits. The results of pilot trial on Green and Blue shade colour paper machine backwater are shown in Table 4, Table 5 and Table 6 respectively.

As per results shown in Table 4, Table 5 and Table 6 it can be seen there is a recovery of 90% of machine backwater as clear water with an average TSS reduction of 98.4% achieved in both Blue and Green paper machine backwater and average colour reduction in outlet clear water is achieved in the tune of 97.1% and 94.5% in Blue and Green colour machine backwater respectively. This clear outlet water with an average TSS of 16 ppm and average colour of 100 co.pt can be easily reused back in the system for process and paper machine showers, which can effectively reduce the fresh water consumption.

As mentioned in Table 5 and Table 6 the Underflow recovery from MPS Pilot consist of on an average 21500 pt.-co and 19300 pt.-co in Green and Blue machine backwater sample respectively, i.e. it contains maximum dye content along with suspended solids (as shown in Figure no. 8 & 9) and this underflow can be reused in the process and there will be a considerable reduction in pigment, fillers (like calcium carbonate, titanium dioxide etc.) and fiber consumption hence reduction in manufacturing cost[4]. It was concluded in above trial that MPS not only reduces the COD load on ETP but also drastically reduces the manufacturing cost of paper by recovery of valuable Clear water, fibre and Dye content, positioning MPS as a sustainable and high performance solution in this application.

Figure 8: MPS outlet clarified water, Inlet feed water and underflow recovery (from L to R).

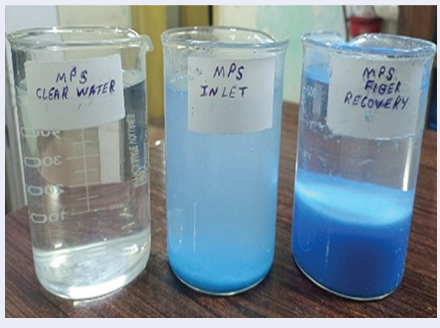

Figure 9: MPS outlet clarified water, Inlet feed water and underflow recovery (from L to R).

Table 4: TSS & Turbidity Reduction in Green Paper Machine Back Water Treated by MPS Pilot.

Date	Time	Inlet flow (m^3/hr)	Outlet clear water flow (m^3/hr)	Inlet TSS (PPM)	Outlet clear water TSS (PPM)	Underflow recovery TSS (PPM)	Inlet Turbidity (NTU)	Outlet clear water Turbidity (NTU)
22.06.2025	12:00	10	9	500	25	1190	370	16
	16:00	10	9	512	8	3204	480	10
23.06.2025	11:30	10	9	590	25	4920	490	18
	16:30	10	9	820	14	7280	540	10
24.06.2025	10:30	10	9	1860	10	12240	880	16
	15:00	15	13.5	1890	24	25680	1340	32

Note:- *No chemical addition was done during trail.*

Table 5: Colour Reduction in Green Paper Machine Back Water Treated by MPS Pilot.

Date	Time	Inlet flow (m^3/hr)	Outlet clear water flow (m^3/hr)	Inlet colour (pt.-co)	Outlet clear water colour (pt.-co)	Underflow recovery colour (pt.-co)
22.06.2025	14:50	10	9	1690	132	_
	17:15	10	9	1700	103	_
23.06.2025	11:00	10	9	1730	55	16875
24.06.2025	11:00	10	9	3300	173	12200
	15:00	15	13.5	4410	241	35425

Note:- *No chemical addition was done during trail.*

Table 6: TSS, Turbidity & Colour Reduction in Blue Paper Machine Back Water Treated by MPS Pilot.										
Date	**Inlet flow (m^3/hr)**	**Outlet clear water flow (m^3/hr)**	**Inlet TSS (PPM)**	**Outlet clear water TSS (PPM)**	**Underflow recovery TSS (PPM)**	**Inlet Turbidity (NTU)**	**Outlet clear water Turbidity (NTU)**	**Inlet colour (pt.-co)**	**Outlet clear water colour (pt.-co)**	**Underflow recovery colour (pt.-co)**
26.06.2025	15	13.5	905	10	10750	520	17	1590	31	7000
28.06.2025	15	13.5	1012	20	16030	740	16	2420	87	31600
Note:- *No chemical addition was done during trail.*										

c) Fibermizer Reject :

This trial was conducted in West Coast Paper Mill on Fibermizer reject stream. This reject stream is being discharged to ETP for further treatment. The purpose of the trial was to accesses the recovery of clear water from reject stream and possibility to reduce the reject volume for easy handling and disposal. From the results in Table 7 it is clear that on an average 78 % of Fibermizer reject was recovered as clear water with an average TSS of 26 PPM and remaining 22 % of fibermizer reject is removed as MPS underflow reject having an average consistency of 2.6-10.6%, also samples shown in Figure 10. The recovered clear water can be reused back in the system resulting in 78% of volume reduction of fibermizer reject with high consistency value. This remaining reject stream can be easily disposed off using belt press.

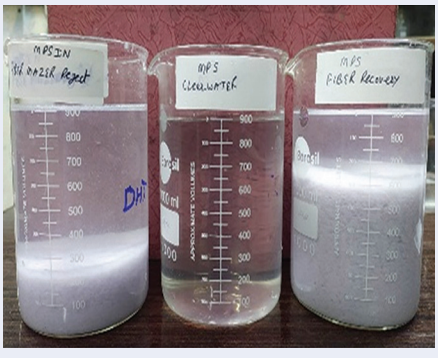

Figure 10: MPS Inlet feed, outlet clarified water and underflow reject (from L to R).

Conclusion

The pilot trials conducted at ITC Limited, PSPD Bhadrachalam and West Coast Paper Mills Limited, Dandeli have clearly established the Micro Plate Settler (MPS) as a high-performance, chemical-free solution for water recovery, fibre reclamation, and dye reuse in the pulp and paper industry.

- **Superior Treatment Efficiency:**

  Across diverse streams—machine backwater (white and coloured paper), clari-flocculator sludge, and fibermizer reject—the MPS consistently achieved 97–99.8% reduction in TSS, 96–98% reduction in turbidity, and 94–97% reduction in colour, producing outlet water of <20 ppm TSS and <30 NTU turbidity suitable for direct reuse in sensitive applications like machine showers.

- **High Water Recovery:**

  The system delivered 85–90% recovery of clear water from backwater and sludge streams, and 78% recovery from fibermizer reject, significantly reducing freshwater intake and wastewater discharge.

- **Resource Reclamation:**

  The MPS underflow stream, enriched with 1–2.5% fibre and concentrated dye , low HRT of MPS (< 40 minute) prevents fiber septicity and enables reuse of valuable raw materials, reducing fibre loss, dye consumption, and overall manufacturing cost.

- **Operational & Economic Benefits:**

  Unlike conventional DAF or disc filters, MPS operates without coagulants, flocculants or pulp sweetener, lowering Opex while ensuring stable outlet quality even under fluctuating inlet loads. The compact reject stream also simplifies sludge handling and disposal.

Table 7 : TSS & Turbidity Reduction in Fibermizer Reject Treated by MPS Pilot.							
Date	**Inlet flow (m^3/hr)**	**Outlet clear water flow (m^3/hr)**	**Inlet TSS (PPM)**	**Outlet clear water TSS (PPM)**	**Underflow TSS (PPM)**	**Inlet Turbidity (NTU)**	**Outlet clear water Turbidity (NTU)**
23.05.2025	4.5	3.5	26580	20	27380	4240	5.2
24.05.2025 4:30 pm	4.8	3.8	49590	20	106154	4550	17
24.05.2025 6:00 pm	4.8	3.8	33220	40	100350	3710	18
Note: - *No chemical addition was done during trail.*							

- **Sustainability Impact:**

  By reducing freshwater dependency, lowering ETP load, and enabling circular reuse of fibre and colourants, MPS directly supports mills in meeting environmental compliance and sustainability goals while delivering measurable financial savings.

The trials confirm that MPS is not just an alternative but a next-generation solution for the pulp and paper sector—combining technical reliability, economic advantage, and environmental stewardship. Its adoption positions Industry to achieve long-term operational resilience and sustainable growth.

Refrences :

1) Rong Xu, Chengyun Wang, Shubin Wu and Kunting Chen; Effects of the polymeric additives on the stickies formation in recycled fibers based papermaking process. Article-Nordic Pulp & Paper Research Journal · December 2017.

2) World Bank Group. Environmental, Health, and Safety Guidelines for Pulp and Paper Mills; 2007. (Benchmarks for water consumption, effluent, and reuse strategies.)

3) Rajasankar R., Saveall Closing of Water Loop In Paper Machine. IPPTA J. Vol.23, No. 4, Oct. - Dec., 2011.

4) Dieter Münchow, Process for recycling fillers and coating pigments from the preparation of paper, paperboard and cardboard; patent -US6214166B1.

❖❖❖❖