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To Introduce & Optimize Suitable Biocide Program to Reuse Water in Paper Manufacturing Process

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Abstract - *Security Paper is being manufactured in Paper Mill from cellulose fiber pulp. Water is being used in various stages of pulp & paper manufacturing processes. Security Pulp & Paper Mill (SPM) is having full flagged effluent treatment plant (ETP). Back water is being treated in effluent treatment plant. SPM has installed & commissioned a state-of-the-art Filtration plant for recycle & reuse of the treated water of ETP. The recycled water is being distributed through pipelines to various sections of the Paper Mill through overhead tank. SPM has faced some technical problems while utilizing the filtration plant recycled water in paper making process. There was microbial growth (slime & algae) observed in recycled water, as back water contains fines of cellulose fibers & residuals of other paper making additives and these are good sources of food for microorganism under favorable conditions of pH and temperature, these helps in generation of slime & algae in the water tanks, pipe lines and paper making process. We studied the problem & to eliminate the microbial growth, it was planned to add biocide dosage in recycled water system to avoid growth of slime & algae. By using biocide treatment, recycled water quality has been improved and it is being recycled for paper making process as well as for the horticulture purpose.*

I. INTRODUCTION

The pulp and paper making process requires huge amount of water for each and every stage of manufacturing process in the Pulp and Paper Mill. Fresh water is required for pulp and paper machines and other auxiliaries equipment's for their continuous operations like Pulp production, wire felt process etc. The water discharged from these operations is almost equal to the intake water and termed as back water. The back water discharged from Paper manufacturing operations has limitation in its reuse/recycle due to quality and quantity. This may be due to-

- Excess generation of back water in the paper machines due to the use of low capacity paper machines.
- Higher disorder w.r.t. TDS, Colour & High level of TDS, Colour & Dirtiness/Turbidity.

To recycle the treated waste water of ETP, SPM has installed and commissioned filtration plant. Recycled water of filtration plant was being used in paper making process. SPM observed that with the use of recycled water there was growth of slime & algae on paper machine fabrics and deposition stated on fabrics, due to these reasons there was less re-use of recycled water.

II. LITERATURE SURVEY

SPM had studied the issues and to eliminate the growth of slime, algae, fungi & bacteria it was decided to add slight dosage of biocide. SPM decided to start dosage of biocide in filtration plant recycled water storage tank, from where it is being pumped to overhead tank for the distribution in process & horticulture. The survey for this study was conducted on below mentioned scenario

(i) Requirement of Biocide in Paper Making:

Adequate availability of nutrients, favourable conditions of pH and temperature make pulp and paper mills a suitable ground for breeding of micro- organisms. With the closing of the white water circuits, mills experience increased microbial activity resulting in gelatinous accumulation of bio- films or slime. These accumulations adhere to the inner surface of pipe lines, chests, screens and other submerged surfaces. With time, the enlarged deposits may break or dislodge from the attached surfaces and reach the paper machine causing web breaks, paper defects like holes and odour problems in the mill. The reuse of contaminated white water may also inoculate previously sterile section and further aggravate the problem.

To avoid microbial contamination, most of the mills depend upon the use of biocides. An effective slime control program however depends upon an optimum dosage and frequency of application of a suitable biocide.

(ii) Dosage of Biocide (PREVENTOL D7 of M/s Lanxess) in recycled water:

Composition of aqueous, formaldehyde-free formulation of various isothiazolinones. Use for the preservation of polymer dispersions, aqueous coating, solutions and dispersions of adhesives and thickeners, filler suspensions, concrete additives, oil emulsions, polishes etc. for the preservations of antimicrobial pesticide (slimicide), cleaners, disinfectants and other surfactants in paper manufacturing process. Preventol D7 can be added at any stage of the pulp & paper production process, is best added in feed water first. However, if higher temperature (>40oSR) and pH(>9) values occurs during pulp & paper manufacturing process, Preventol D7 should be added at the end of the process. The Plastics commission of the German Federal Health Office (BgVV) in their recommendations XIV and XXXVI approve the use of these active ingredients to protect dispersions against decomposition and as a antimicrobial pesticide (slimicide) in the manufacturing of paper and cardboard for food packaging. The constituent of Preventol D7 are approved by the Food and Drug Administration.

III. EXPERIMENTAL OBSERVATIONS AND RESULTS

(i) Dosing of PREVENTOL D7:

Initially biocide dosage was started manually in recycled water storage tank in Under Ground Tank-2 (UGT-2) @ 5-6 ppm once in shift. SPM has installed continuous dosing pump for the dosing of Biocide & dosage was increased to 8-10 ppm. 4.5 MT of Biocide i.e. PREVENTOL D7 has been procured to use in recycled water of filtration plant on regular basis.

(ii) Testing of Total Bacteria Count (TBC) in Recycled water:

- Recycled water of equalization outlet to filtration plant Inlet.
- Recycled water filtration plant outlet after Biocide dosage at UGT-2

(iii) TBC (Total Bacteria Count) + Yeast & Fungi test method:

Ready to use slides (BACTASLYDE) were used to TBC in recycled water.

(iv) Method of the determination:

Removal of Slide: Open the polybag and unscrew the cap of the tube. Remove the slide from the tube.
[Note: Care to be taken not to touch the media surfaces during removal of Slide.]

Sampling(Liquid):

- Take out slide carefully and plunge it into the test liquid ensuring the media surfaces are absolutely immersed in the liquid.
- Hold it (slide) in vertical direction in the liquid for 20-25 seconds.
- Take a clean container/vessel to hold the test material.
- Shakes the slide 3-4 times gently to remove the excess water.
- Keep the slide back into the tube/container and close it tightly.

Labeling:

Fill in the label details like entering the date, time and place of sampling. Stick the label on the tube and make sure that label stuck right from the bottom rim of the tube in the arrow side down direction.

Incubation:

Incubate the slide keeping in an upright position at a suitable temperature (37°C).
[Note: Usually bacteria take around 18 to 24 hours to produce colonies which can be seen by the naked eye.]

IV. Reading & Interpretation of results:

After incubation of the media surface, compare the density of the colonies grown on the slides with the chart provided below at Fig. 1

(Figure -1: BACTASLYDE Density Chart).

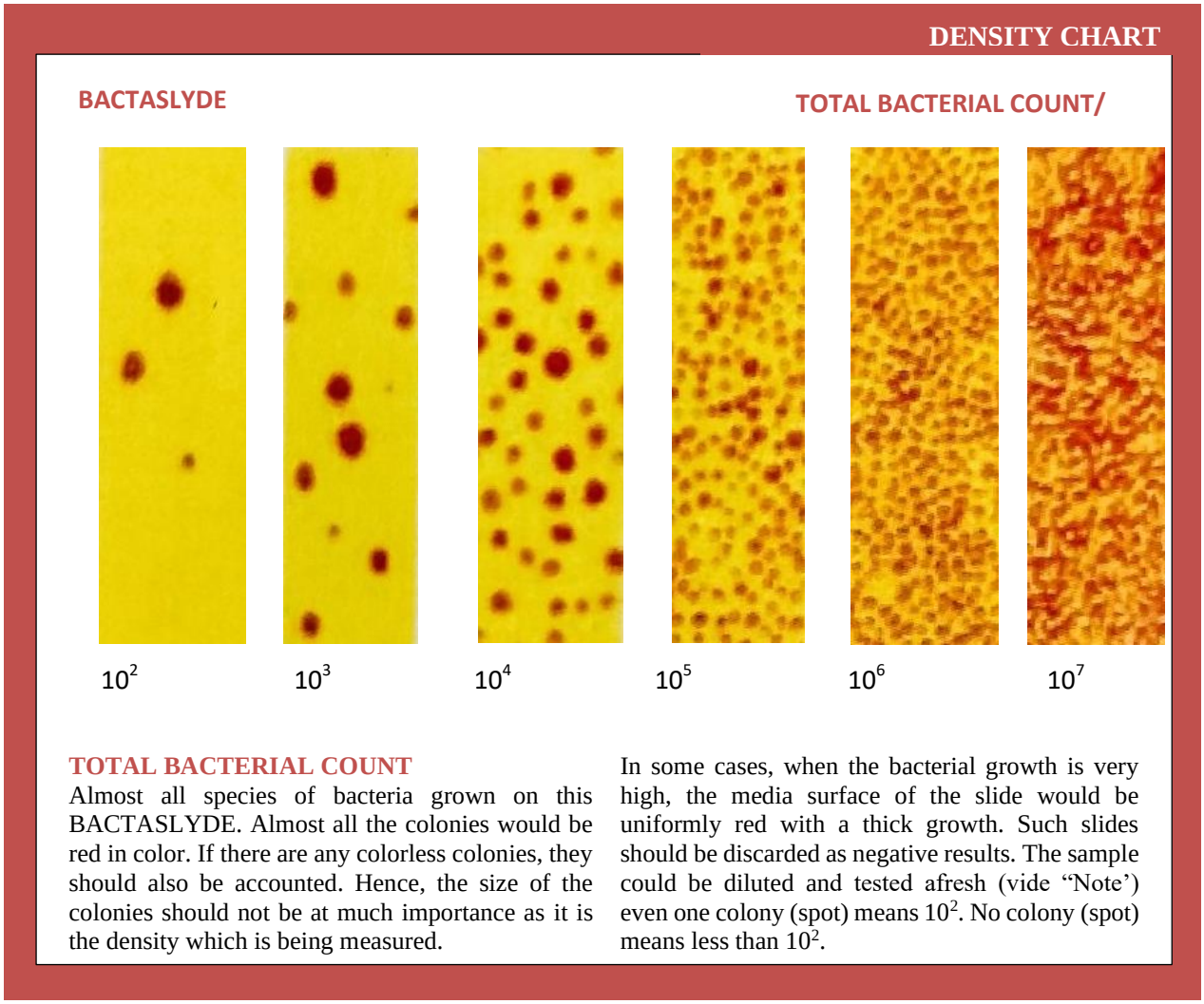

Fig-1 Photograph of Total Bacteria Count – Density Chart:

Fig-2 Photograph of Total Bacteria Count of Samples:

Fig-1 Photograph of Total Bacteria Count – Density Chart:

[Note: If the sample requires dilution, there is a provision in slide (BACTASLYDE) to dilute the sample 10 times. There is arrow marked on the bottom of the label. After sticking the label (making sure that it is stuck right from the bottom rim of the tube), fill the original sample up to the arrow marked on the bottom of the label and add sterile water (H2O) (or in case of non-availability of sterile water, we can boiled water for 20 minutes & subsequently cooled) to the top of the label. Insert the slide and tightly screw the cap on. Mix the mixture by inverting the tube a couple of times. Hold the slide in for 20 seconds, before discarding the fluid, follow the earlier procedure for the rest of the operation.

Fig. 1 Photograph of Total Bacteria Count – Density Chart:

Fig-1 Photograph of Total Bacteria Count – Density Chart:

Recycled water sample of Equalization Outlet to Filtration plant (Sample-1)	Recycled water sample of Equalization Outlet to Filtration plant (Sample-2)
	

Fig-2 Photograph of Total Bacteria Count of Samples: TBC observed at 10^3 (compared with Density Chart)

Recycled water sample after Filtration Plant (UGT-2) with Biocide dosing	Recycled water sample after Filtration Plant (UGT-2) with Biocide dosing
	
No bacteria count observed compared with Density Chart	Trace ($<10^2$) of bacteria count observed compared with Density Chart

Fig-3: Recycled water sample after Filtration Plant (UGT-2) with Biocide dosing

4.1 Recycled Water Consumption before & after the use of Biocide:

Table-1 Recycled Water Consumed, KL/Day (Month Avg.) before use of Biocide:

Month	Month Avg. Recycled Water Consumed, KL/Day
Jul'2021	546
Aug'2021	719
Sep'2021	559
Oct'2021	567
Nov'2021	346

Table-2 Recycled Water Consumed, KL/Day (Month Avg.) After use of Biocide:

Month	Month Avg. Recycled Water Consumed, KL/Day
Dec' 2021	613
Jan'2022	1192
Feb'2022	1428
Mar'2022	1233
Apr'2022	1282
May'2022	1644
Jun'2022	1524
Jul'2022	1679
Aug'2022	1228
Sep'2022*	505

Trial of Biocide dosing started from Dec'2021
*Recycled water consumption got reduced due to existing machine were not running.

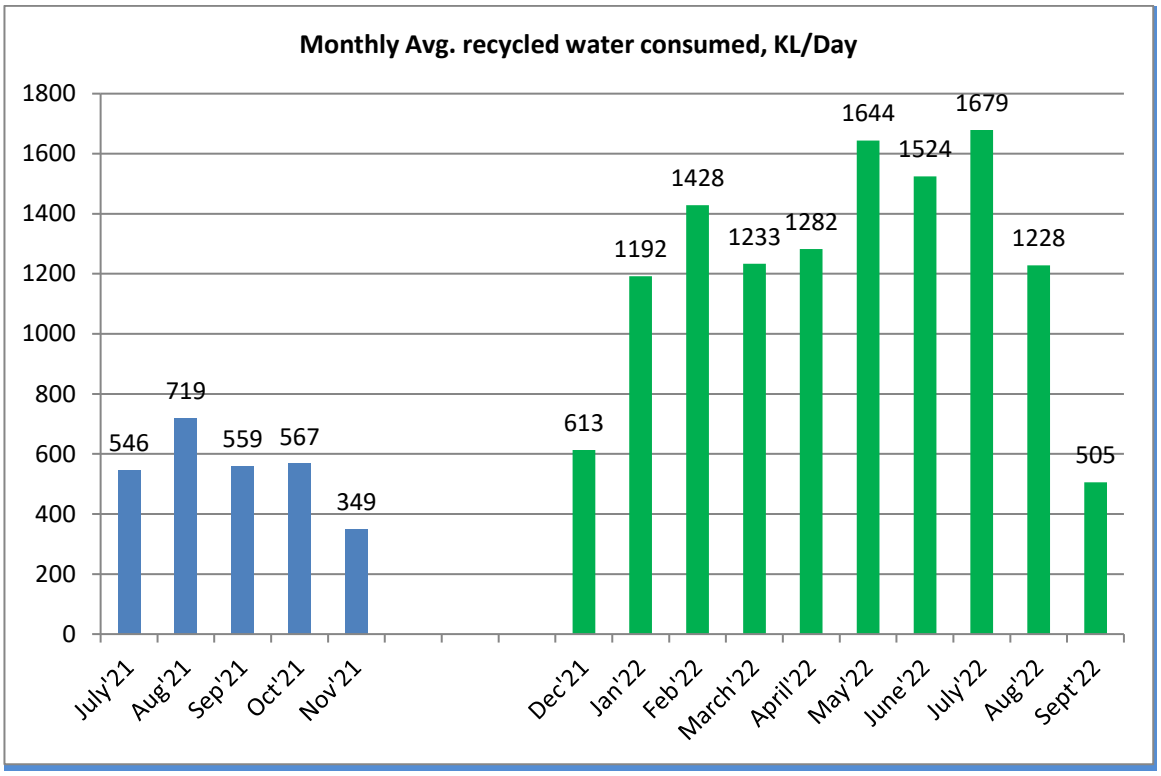

Fig-4 Consumption of monthly recycled water, KL/D (month avg.):

4.2 Table-3 Characteristics of recycled water:

Particulars	Standards for discharge into ISW	Paper Machine back water (from ETP Sump Existing Machine Only)	Inlet to Filtration Plant	Outlet to Filtration Plant
Date of Sampling		13.07.22	13.07.22	13.07.22
pH	5.5-9.0	6.62	7.20	6.78
SS, mg/l	100	374	47	16
COD, mg/l	250	220	164	156
BOD, mg/l (3d, 27◦c)	30	26	20	18
TDS	2100	325	346	292

4.3 Utilization of recycled water in different process areas:

1. Rang Boilers
2. Pulper
3. Breakers &Beaters
4. Mixing Chests
5. Paper Machines Silo
6. Paper machine vacuum pump sealing water

Horticultural purpose:

1. Inside the mill premises
2. Outside the mill premises in colony areas (Pipe Line by CPWD).

V. OBSERVATION

- Recycled water sample of equalization outlet going to filtration plant was collected and sample was checked for total bacteria count (TBC) with ready to use slides (BACTASLYDE) and compared the TBC colony growth with the density chart (Fig-1) Total bacteria count (TBC) was found in the range of $10^3 – 10^4$, Photographs enclosed (Fig-2).
- Recycled water sample after biocide dosage was collected from filtration plant recycled water store tank (UGT-2) and sample was checked for total bacteria count (TBC) with ready to use slides (BACTASLYDE) and compared the TBC colony growth with the density chart (Fig-1). Total bacteria count (TBC) was Nil/Track, Photographs enclosed (Fig-3).
- After the use of Biocide dosage in recycled water, recycled water consumption has been increased from 500-550 KL/day (average) to 1200-1500 KL/day (average), details are given in Table -1&2.
- Other parameter of recycled water like pH, SS, COD, BOD & TDS are within the standard range, results are given in Table-3.

VI. CONCLUSION

- Total bacteria count (TBC) results shows that there was slight microbial growth rate found in recycled water. Dosage of biocide i.e. 8-10ppm is to be added on regular basis into the recycled water after filtration plant.
- Plant scale trial has been completed and dosage of biocide is being added on regular basis at filtration plant into the UGT-2.
- By the use of biocide in recycled water, quality of recycled water of filtration plant has improved and it is helping to maintain recycled water quality.
- In paper making process back water TDS increased, due to the high level of TDS, it is not possible to recycle 100% treated back water for paper making process.
- In SPM, recycled water, there is not a problem of any colour & turbidity.

VII. REFERENCE

[1] Paper Standards- Technical Association of the Pulp and Paper Industry (TAPPI)
[2] Security Paper Mill, Narmadapuram
[3] Central Pulp & Paper Research Institute, Saharanpur
[4] Advanced Instrumentation Research Facility (AIRF), Jawaharlal Nehru University (JNU), New Delhi
[5] The Australasian Pulp and Paper Technical Association (Appita) Guide 2015
[6] Crow, W.D.; Leonard, N.J. A synthesis of 3-isothiazolones. *Tetrahedron Lett.* **1964**, *5*, 1477–1480. [Google Scholar] [CrossRef]
[7] National Physical Laboratory, New Delhi
[8] American Forest & Pulp Association - https://www.afandpa.org/news/2021/history-paper
[9] Oklahoma State University, America - https://extension.okstate.edu/fact-sheets/basics-of-paper-manufacturing.html
[10] https://www.pulpandpaper-technology.com/articles/pulp-and-paper-manufacturing-process-in-the-paper-industry