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OPPORTUNITIES FOR ENHANCED PRODUCTIVITY AND QUALITY IN INDIAN RECYCLED PAPER MILLS APPROACHING ZERO LIQUID DISCHARGE - UNIDO'S INTERVENTION

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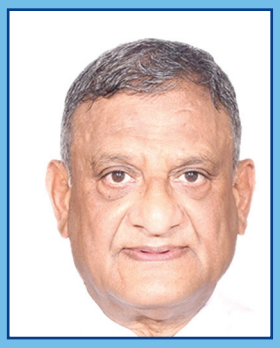

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Abstract:

Tighter limitations being placed on fresh water use and trends towards zero liquid discharge, the RCF based paper mills are faced with serious issues related to unpleasant smell in the finished paper product and loss of productivity, quality and thus revenue.

UNIDO as a part of its on-going paper project identified and demonstrated on mill scale, chlorine-di-oxide (ClO_2) treatment of internal process water as one of the unique approach which could prove to be a potential substitute with greater affectivity to address aforesaid issue. The collaborative efforts have been made by UNIDO in cooperation with an equipment manufacturer and identified paper mill to demonstrate the techno-economic feasibility of the technology.

The present paper would cover a case study of the successful demonstration and implementation of the innovative technology sharing the results of the mill scale implementation highlighting the benefits accrued in respect of productivity, quality and overall mill performance.

Keywords - ClO_2, TBC, Odour, Recycle fiber, Productivity

Introduction

Majority of the recycled waste paper-based mills producing unbleached variety of packaging graded papers are faced with a serious issue related to the foul odour.

Major Factors responsible for the problems are - trend towards increased use of recycled waste paper/ fibre, additive, alkaline/ neutral sizing and water system closer resulting in reduced solid and liquid discharge.

Trends toward increased use of organic additives, fillers, higher system temperature coupled with water system closer cause uncontrolled growth of undesirable microbes / slime resulting in foul odour, increased down time due to paper breaks in paper machine, loss of quality, productivity besides corrosion, felt degradation/ plugging problems..

In extremely closed systems (ZLD), water reuse may include returning water from a primary clarifier which often are large and have low turnover rates. This leads to increased water temperature, decrease in the dissolved oxygen (DO) level in the water & development of anaerobic conditions and subsequent problems such as the accumulation of VFA and foul odour. Bacterial colonies both aerobic and anaerobic (in dead spots of the system) grow at any point in the paper machine white water loop (Head box, wire part, broke chest and save all) causing foul odour.

Microbial colonies after break off attach to the paper sheet, appears a holes, speks, spot and weaken the paper sheet causing frequent paper breaks, thus productivity losses. The odorous substances also adversely affect the product quality resulting in quality complaints and reduced revenue.

Earlier, a successful case study on the use of chlorine dioxide technology in a mill producing brown paper@ 400 TPD has been reported [1]. The present paper highlights the findings of a mill scale demonstration of the efficacy of the ClO_2 treatment of the internal process water on the productivity and quality of the paper produced in a recycled fibre-based paper mill in India supported with data and results of the trials conducted over a period of around three months.

Major Challenges and Issues in Indian Paper Industry:

Post-consumer recycled fibres generally used in RCF based paper mills in India is subjected to moist and dirty conditions are often stored outdoors, uncovered, and exposed thus resulting in increased microbial loading of the system in comparison to the typical of virgin pulp. This coupled with trends toward increased use of organic additives, fillers, higher system temperature cause uncontrolled growth of undesirable microbes / slime resulting in foul odour, increased down time due to paper breaks in paper machine, loss of quality, productivity besides corrosion, felt degradation/ plugging problems. Bacterial colonies, both aerobic and anaerobic (in dead spots of the system) grow at any point in the paper machine white water loop (Head box, wire part, broke chest and save all) causing foul odour. Microbial colonies, after break off, attach to the paper sheet, appear a holes, specs, and spot and weaken the paper sheet causing frequent paper breaks, thus productivity losses. The odorous substances also adversely affect the product quality resulting in quality complaints and reduced revenue

Conventional biocides being used found to be ineffective or to have to a limited efficacy besides challenges on the front of ecological compatibility and environmental friendliness. Many conventional biocides lack the penetrating ability to control the biological growth within the slime layer or effectively remove it.

Experimental

Mill scale trial of ClO_2 treatment

Trials were conducted in a paper mill producing 160 TPD packaging grade paper from recycled fibres (RCF) and with closed water circuits and an approach toward ZLD.

ClO_2 generation and operating conditions

The most commonly used method of onsite generation of chlorine-di-oxide uses sodium chlorite and hydrochloric acid using a specialized generation system called "chlorine dioxide under water generating system" which is considered to be reliable from view point of safety, yield, purity of ClO_2 solution and ease of conduction and employed during the current mill scale trials.

The current trials were carried out using the chlorine dioxide produced on site using the generation system supplied by an identified equipment manufacturer.

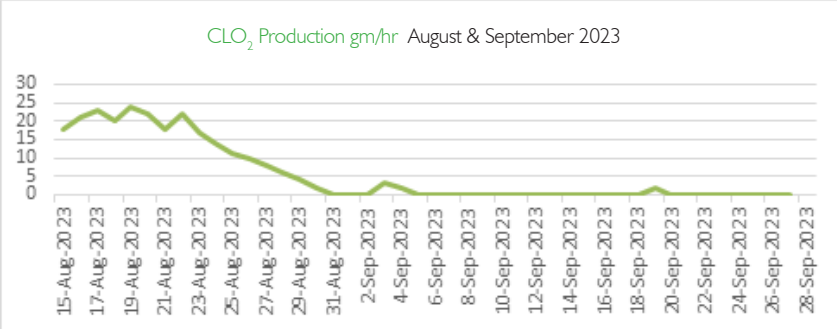

Fig. 1: ClO2 productivity during the trial (Aug-Sep 2023)

After commissioning of the ClO_2 generation plant in the second week of July 2023, the operation was started in the second week of August 2023. Chlorine dioxide was produced in a ClO_2 generator having a capacity to produce 500 g/h of CLO_2 and applied as a dilute solution at identified points, i.e. silo on outlet of the fibre recovery system and in a manner, which permits proper mixing and uniform distribution. The feed point was kept well below the water level to prevent volatilization of the chlorine dioxide.

The required dosages of the ClO_2 were kept slightly on the higher side in the beginning of the trials as shock dose i.e. dosed @ 3 ppm keeping in view of the higher intensity of microbial population and the severity of contamination which were in the range of 10*8 and gradually reduced after 2 weeks.

For an effective control of odour and the bacterial slime, there is a need to maintain residual concentrations of minimum 0.1 ppm for a minimum one-minute contact time.

Fig 1 shows the production of ClO_2 on site during the period August-September 2023 which was dosed in the process water.

Results and Discussion

Monitoring of parameters of interest indicating success of the trials

Parameters of interest being monitored during operation of the pilot plant were total bacterial counts, TBC (Bactaslyde), oxidation-reduction potential (ORP) and total paper machine breaks were monitored over a period of more than one month to access the performance and success of the trials.

Estimation of total bacterial count (TBC) – Bactaslyde and ORP

Total bacterial counts and ORP were measured and monitored on continuous basis to access the efficacy of the ClO_2 treatment using the Bactaslyde and ORP meter.

Fig 2 shows the test results of the bacterial intensity at various time intervals during process water treatment with ClO_2.

Figure 2: Bactaslyde & ORP test of backwater during the trials

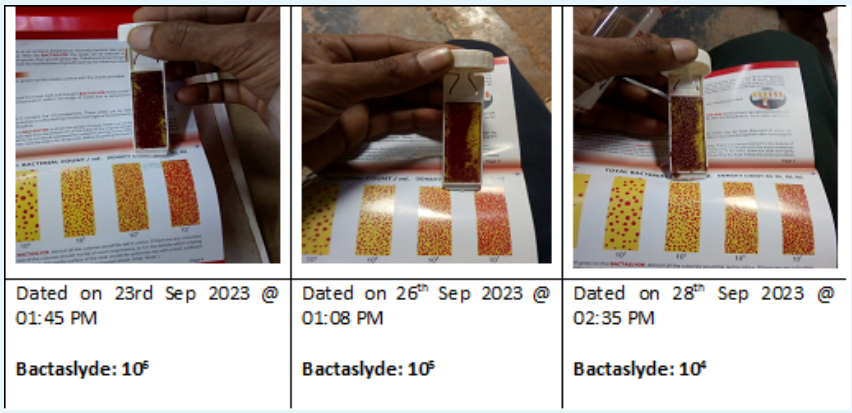

Figure 3: Trends in total bacterial counts (TBC) during ClO2 treatment

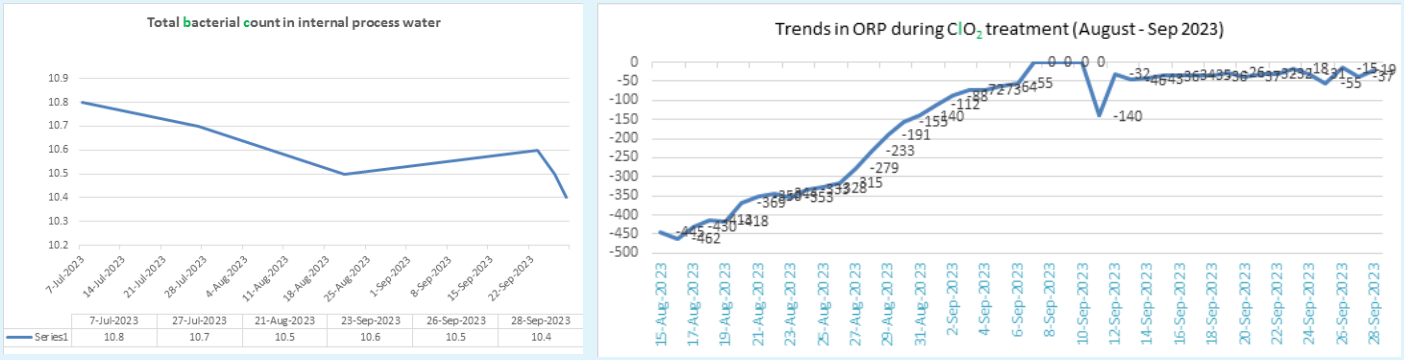

Figure 4: Trends in total ORP during ClO_2 treatment

From the results, it can be seen that the initial bacterial counts were quite high in the range of 10*8 which over a period of time were reduced gradually to 10*4 and will continue to decrease further. Similarly, the ORP was also moved from -450 (initial at the time of starting the trials) to -15 and likely to shift toward positive side once the anaerobic bacterial counts are under control.

Effect on Paper machine breaks and down time - Opportunity for enhance productivity and quality

Figure 5 below shows the number of paper breaks in the paper machine before ClO_2 treatment and after treatment.

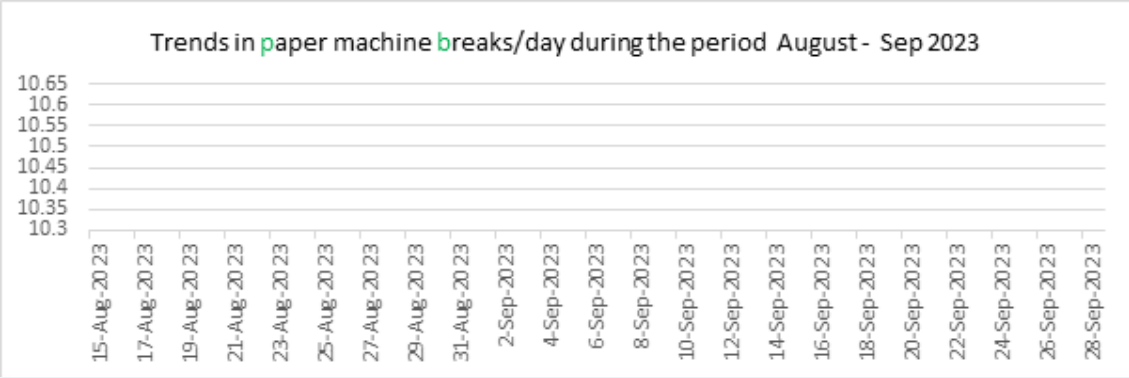

Figure 5: Trends in paper machine breaks/day during the period August - Sep 2023

It can be clearly observed that there was reduction in paper machine breaks which were reduced to an extent of more than 80% resulting significant benefit and advantage in respect of productivity due to reduced paper machine down time.

Operation &maintenance costs and Capex(ROI) of Implementation of ClO2 treatment in RCF based paper mills in Muzaffarnagar:

1. Operational costs (energy, chemicals) : INR 21 /- tonne of paper
2. Benefits accrued due to enhanced productivity, Reduced paper breaks, more draw , (productivity enhanced / day (4-5%) : Around 7 tons/day@INR 5000 INR 35000/- per day
3. Capital Cost : INR 6, 00,000/-
4. Retun-on-investment(ROI) : Less than one month

Conclusions

The mill scale trial on application of ClO_2 treatment conducted in a recycled fibre-based paper mill producing packaging grade paper and boards showcased control of microbial contamination and odour besides reduced paper machine breaks and down time thus enhanced productivity, competitiveness and overall process efficiency of the paper mills. Chlorine dioxide treatment of process water improved the quality of paper by reducing defects such as specks, spots, and holes in the sheet, reduced sheet breaks and subsequent production and finishing losses.

Since chlorine dioxide is used for potable water disinfection and has been found to be a very effective sporicide in food grade paper, it is appropriate to use this versatile disinfectant in food grade paper applications

Thus, ClO_2 treatment of process water, its application and technology demonstration in Indian paper mill approaching toward ZLD could enhance productivity, sustainability and competitiveness of the Indian paper industry at large by reducing input costs, consistency in production and improved higher product quality thereby, increased acceptability both in domestic and export markets.

Acknowledgments

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