

Energy Management and Effluent Treatment by Using Anaerobic and Aerobic Process - Case Study at Emami Paper Mills Limited – Balasore

Abstract: The objective of this study was to evaluate the treatment of recycled fibre (RCF) based paper mills wastewater treatment plant (WWTP) using the anaerobic and aerobic treatment as the core component, to study the performance and to evaluate the economic benefits of chemical and energy consumption. The merits of an energy positive (anaerobic) and an energy negative (aerobic) are highlighted and compared with each other on the basis of treatment effectiveness, resource recovery potential, cost and role of integrated anaerobic and aerobic processes in the wastewater treatment plant.

Keywords: Recycled Fibre (RCF) Based Paper Mills; Wastewater Treatment Plant; UASBR; Energy Consumption.



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1. Introduction

WWTP is a significant power and chemical consumption area and scope exists for cost saving through process selection of treatment technology, process optimization and utilising recovered energy from anaerobic process, utilising sludge as fuel for power boiler and reuse and recycling of treated effluent. Reuse of effluent minimizes discharge to the environment while advancing environmental conservation by reducing fresh water consumption, power consumption and therefore the greenhouse effect. The general trend of treatment processes are discussed in Section 1.1 and 1.2.

1.1 Physicochemical treatment

These processes are used to remove suspended solids, colloidal particles, floating matters, and colour from wastewater. The treatment processes include sedimentation, ultra-filtration, flotation, screening, coagulation, flocculation, ozonation and electrolysis. Most of the pulp and paper mills adapt primary sedimentation such as clarifier / Clariflocculator/ Krofta (Dissolved Air Flotation - DAF) to remove suspended solids.

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1.2 Biological treatment

In general pulp and paper mills are using anaerobic and/or aerobic biological processes to remove organic contaminants in wastewater. Aerobic processes are used in most pulp-and-paper mills because of their ease of operation as well as the relatively low capital and operating costs. Among aerobic technologies, activated sludge (AS) and aeration lagoons are commonly used in the pulp and- paper industry. Although the use of anaerobic processes in the pulp-and-paper industry is not common, a number of mills have employed different anaerobic technologies because of lower sludge production, renewable energy production (biogas), smaller area requirements and facility of further degradation of pollutants. Both aerobic and anaerobic processes have certain disadvantages which includes the high sludge production of aerobic processes and sensitivity of anaerobic bacteria to toxic materials. In order to benefit from different treatment processes, integrated treatment consisting of combined biological processes operating under different environmental conditions (anaerobic and aerobic), or physicochemical and biological processes are used to treat the pulp- and-paper wastewater.

1.3 Recycled fiber based paper mill processes

Wastewater is generated in the RCF based mills in pulp bleaching, paper making as well as in the deinking/secondary fibre treatment plant. In view of this, the main objective of effluent treatment plant is to remove contaminants from wastewater using a series of physicochemical, biological, and integrated treatment processes with nominal power requirement.

2. Study Area

This study was carried out at M/s Emami Paper Mills Limited, Balasore, Odisha, India. The plant is located at the 29m above mean sea level (AMSL) Latitude 21°32'10.13"N and Longitude 86°49'32.50"E, manufacturing Newsprint, Writing/Printing Paper, and Multilayer Coated Board. Total production capacity of all the products is 3.4 lac tons per annum. The streams of wastewater originating primarily from Paper Machine –I, II, III, Board Machine –IV, and Deinking Plant –I & III are discharged as wastewater to physicochemical and biological effluent treatment plant. An effluent treatment plant with capacity of 14500 m3/day is installed..

2.1 Effluent treatment plant components

A schematic overview covering the processes of WWTP is provided in Figure 1 include physical, chemical and biological treatments through primary and secondary treatment stages. The biological treatment process uses anaerobic system of Upflow Anaerobic Sludge Blanket Reactor (UASBR) and aeration system (activated sludge process - ASP) equipped with air diffusion. The by-product of above processes primary sludge

is used as a fuel, and secondary sludge is used as a manure. The treated effluent is either reused or used in irrigation and biogas is proposed to be used as a fuel for sustainable management.

The ETP comprises of the following units, viz. fine screen, equalization tanks – 3 Nos, primary clarifier – 3 Nos, UASBR – 2 Nos, aeration basins – 5 Nos, secondary clarifier – 2 Nos, chlorination, Multi Grade Filters (MGF) and mechanical dewatering device (MDD).

2.2 Mechanical/Physical/Chemical/Biological system

The effluent is first passed through bar screens followed by mechanical screen for removal of plastic and other floating materials before entering to equalisation system. The effluent is pumped into primary clarification system with addition of organic flocculent and coagulant and dose optimized periodically through Jar test conducted in laboratory. After pre-treatment effluent has total

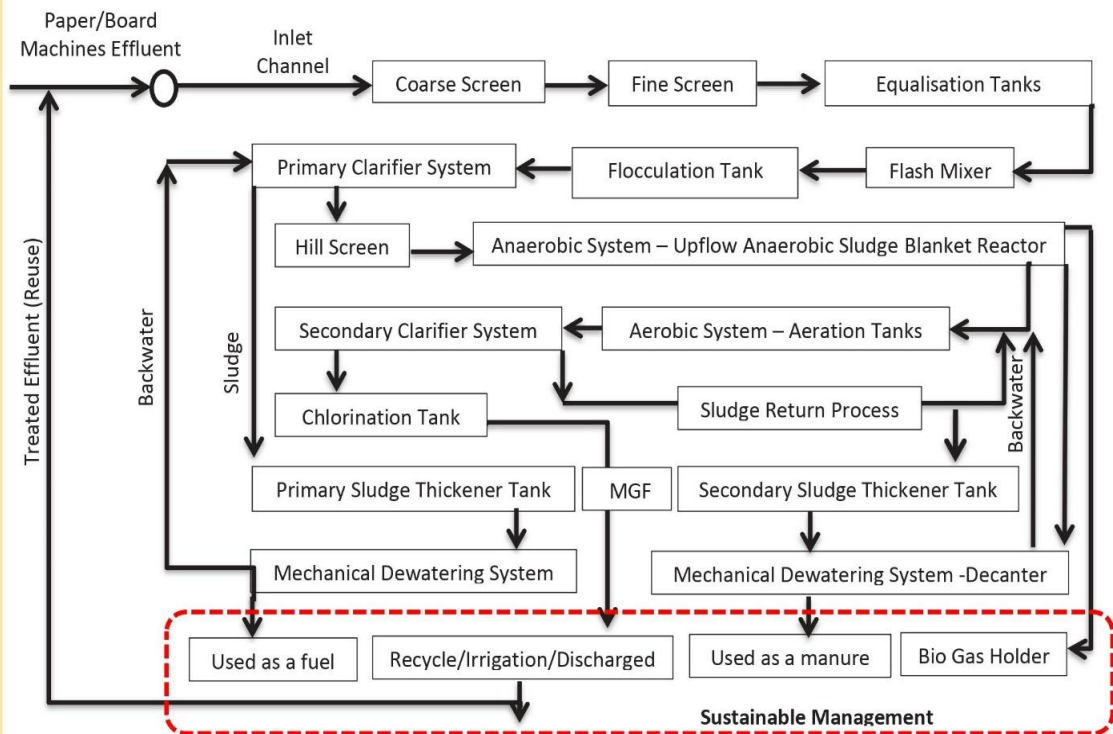


Figure 1 – A schematic overview covering the processes of WWTP based paper mill at M/s EPML

suspended solids <100ppm and almost 98% of TSS are removed in this process. The settled particles receive further treatment as sludge is transferred to Mechanical dewatering device and, the remaining wastewater flows into the next stage.

Primary supernatant liquid is taken to buffer system and fed to anaerobic process (Positive energy system) for reduction of COD/BOD load. The supernatant from the UASBR is equally distributed to fine bubble diffused aeration system (Negative energy system). This is anaerobic and aerobic biological treatment process where the bacteria decomposes the organic matter in presence of oxygen and absence of oxygen respectively. A conventional aeration system works in the lag growth phase of the bacterial growth curve i.e., endogenous phase. To maintain requisite MLSS/MLVSS range between 3500 to 4000 with 60% of biomass and food to micro-

organism ratio (F/M) is 0.2 – 0.5 kg BOD5/kg MLSS/ day, part of settled sludge from secondary clarifier is re-circulated back to the aeration tank. The supernatant from secondary clarifier overflows uniformly over the peripheral launder. It is taken to chlorination sump followed by MGF. The final treated water is either recycled or used in Irrigation or discharged in line with prescribed limits.

3. Data analysis

In this study, the results of treated wastewater from EPML were used to evaluate the performance. The effluent characteristic considered in this study are pH, total suspended solids (TSS), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Figure 2 shows the measured monthly pH, TSS, BOD and COD mean values of raw and treated wastewater for September 2019 – December 2019.

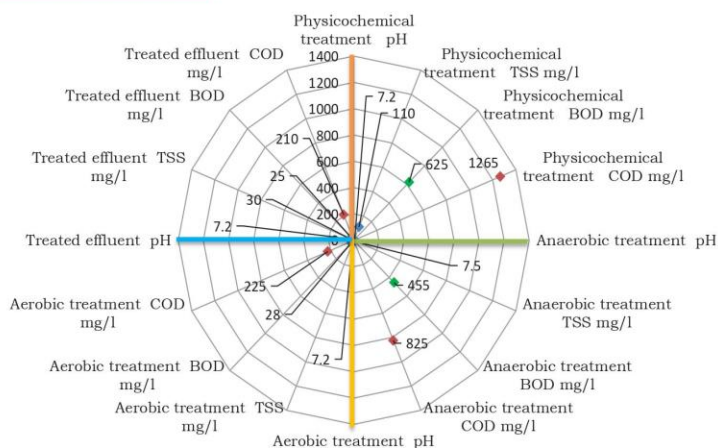


Figure 2 – Wastewater treatment plant stage wise performance

4. Anaerobic systems (Energy Production)

Anaerobic wastewater treatment processes can generally be categorized as suspended growth, sludge blanket, attached growth, membrane-based, or microbial electrochemical systems. Figure 3 shows that anaerobic microorganisms were observed in Upflow Anaerobic Sludge Blanket Reactor. The first step of COD degradation in anaerobic treatment systems is the fermentation of complex organic matter into long chain volatile fatty acids, carbon dioxide, and hydrogen by acidogenic microorganisms. Long chain fatty acids are then further fragmented into acetic acid and hydrogen. Methane (CH_4) and hydrogen gas (H_2) are possible bioenergy products from anaerobic systems. In methane-producing reactors, acetoclastic methanogens ferment acetic acid to methane and carbon dioxide and hydrogenotrophic methanogens convert hydrogen and carbon dioxide to methane.

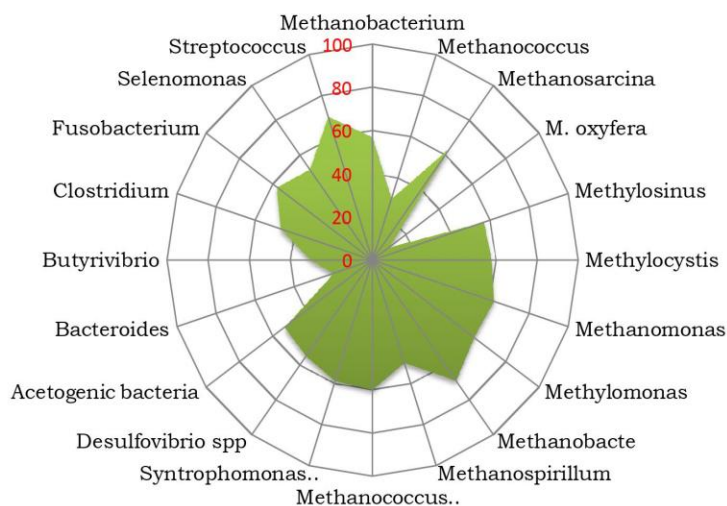


Figure 3 – Anaerobic microorganisms was observed in Upflow Anaerobic sludge blanket Reactor (UASBR)

4.1 Energetic analysis

4.1.1 Energy production

The anaerobic reactors are working at mesophilic temperature (37°C - 42°C) and generate biogas comprising of approximately 65% CH_4 , 25% CO_2 , H_2S etc.. The biomass sludge produced in anaerobic reactor are around 6% as compared to aerobic process..

4.1.2 Energy consumption

The installation of anaerobic system in addition to aerobic system has resulted in an energy saving of around 30% in the overall wastewater treatment plant.

5. The cost economics & the environmental benefits of projects

The key factors that influenced process selection against the conventional aerobic systems were their high energy requirements, unreliable power supply situation in the states, and higher operation and maintenance costs; while those in favour of UASBR were their robustness, low or no dependence on electricity, low cost of operation and maintenance.

6. Conclusion

Energy conservation is becoming a focal point for the entire Industrial sector. Energy minimization strategy begins with identifying the uses and also identifying the sources of wastewater generation throughout the mill to minimise pumping energy and wastewater treatment plant operation costs like chemical and power. Considering these factors an investment in anaerobic process based treatment system yields in COD benefits in terms of cost of operation. However, this technology should be carefully designed to achieve maximum effectiveness and economies based on input parameters to wastewater treatment plant.

Literature reference

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