Anaerobic Waste Water Treatment At Pudumjee Pulp And Paper Mills, India

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ABSTRACT

The Indian Pulp and Paper Industry Consists of small to medium sized mills operating on a relatively smaller scale of operation, as compared to those in Europe and America. Pudumjee Pulp and Paper Mills is an agro-residue based mill, producing specialty papers. Since the setting up of a fill-scale chemical recovery plant is uneconomical, the mill is forced to seek alternate methods for treating its waste water to reduce the BOD, COD and SS levels to acceptable standards, meeting stipulated norms. In this paper, the effluent treatment efforts, using the 'Pudumjee-an-Opur-P' anaerobic treatment plant are discussed. The system benefits from two angles are demonstrated, firstly, reducing the environmental impact of the process waste waters and secondly, the considerable energy savings arising from the generation of biogas, used as a fuel.

INTRODUCTION

Pudmjee Pulp and Paper Mills, located near Pune, India, is one of the best mills manufacturing specialty papers in the country. It is an agricultural residue based paper mill, that employs bagasse as a raw material. It has several locational advantages, in terms of its proximity to its water source, the river Pawana, abundant agricultural land around it for discharging its treated waters and the presence of several sugar manufacturing industries that supply it its raw material. The mill is spread over 20 hectares of land and has the additional advantage of a good road and rail link to Mumbai city.

The relatively small scale of operations, precludes the possibility of setting up a conventional chemical recovery system. Smaller mills are thus left with no option but to look for alternate modes of waste water treatment. These usually entail conventional aerobic treatment of the waste water generated, which is then discharged in agricultural fields. Aerobic treatment, by itself has been found to be combination of both aerobic and anaerobic treatment is more suitable and effective, in reducing the discharge BOD and COD to the desired levels. Anaerobic treatment additionally produces biogas as a by product, which can be used as a substitute for conventional fossil fuels. Pudumjee Pulp and Paper Mills has made trend setting progress in recent years, in optimizing its effluent treatment best results.

The effluents generated by the mill come from two main sources, the black liquor from the pulping and brown stock washing operations and the effluent from the bleaching section. After extensive R&D work, it was concluded that only the black liquor

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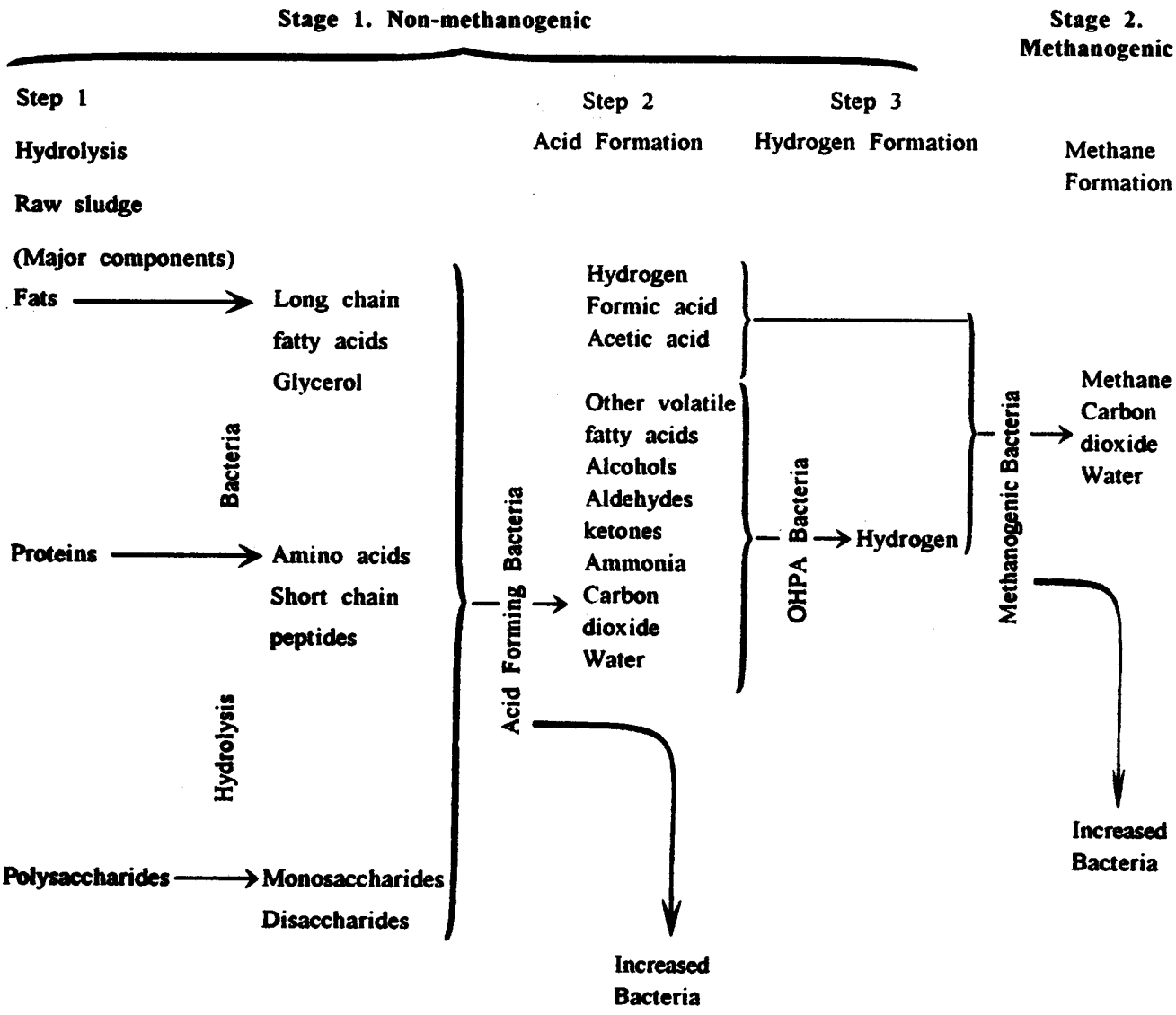

Biochemical transformations involved in anaerobic degestion

generated from the pulping operations was suitable for anaerobic biological treatment. The bleach effluent was found on the contrary, to inhibit the growth of the methane generating anaerobic bacteria. As a result, in the mill, the black liquor is first an aerobically treated and subsequently, this treated black liquor mixed with the bleaching effluents are aerobically treated,. Although many sludge stabilization methods exist, anaerobic deigestion is unique for it has the ability to produce a net energy gain in the form of methane gas, it optimizes cost effectiveness and minimizes the amount of final sludge disposal, thus decreasing the hazards of effluent treatment by-products.

SUMMARY OF THE ANAEROBIC DIGESTION PROCESS

An anaerobic treatment system is a complex three-step process that produces methane gas (in addition to other products) from the biological digestion of waste water. The first stage is the hydrolysis of lipids, cellulose and protein. Extra -cellular enzymes produced by the Inhabiting bacteria breakdown these macro molecules into smaller and more digestible forms. Next, these molecules are decomposed into fatty acids such as propionic, acetic, and butyric acid. This decomposition is performed by several facultative

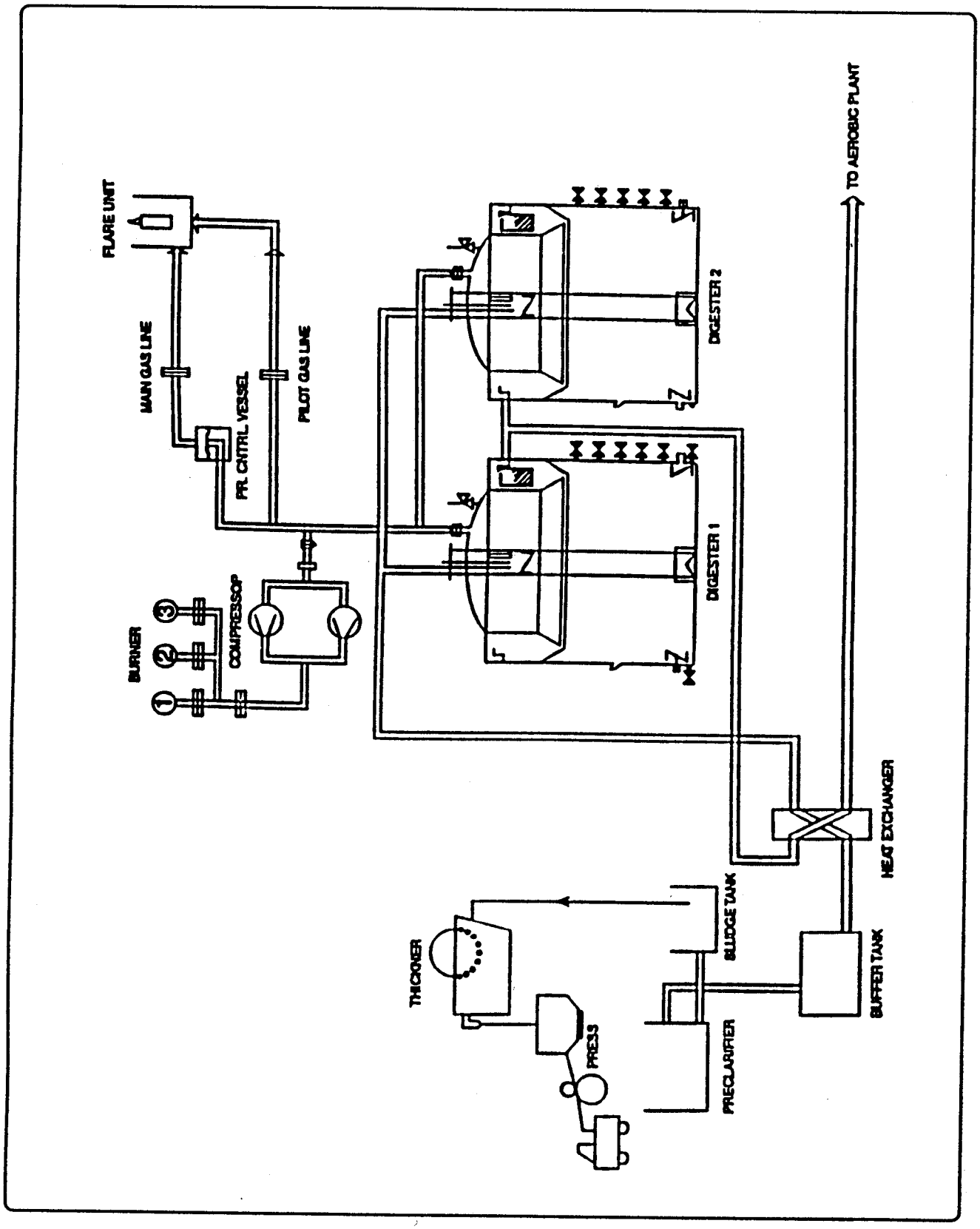

Fig. 1 : Schematic diagram of the anaerobic treatment plant at Pudumjee Pulp and Paper Mills.

TABLE 2. SUMMERY OF EFFLUENT TREATMENT

Parameter	Anaerobic treatment Inlet	Anaerobic treatment Outlet	Aerobic treatment Outlet
pH	9-9.5	7.4-7-5	7.5 -7.9
Temperature (°C)	36	36-37	37
BOD_5 at 20.°C (mg/l)	3000-3500	350-400	50-60
COD (m/l)	11000 -11500	3500-4000	1000-1200
Suspended Solids (mg/l)	3000-4000	100-130	100-120

and anaerobic bacteria such as Clostridium, Bifidobacterium, Desulphovibrio, Actionmyces and Staphylococcus. Finally, methanogenic bacteria such as Methanobacterium, Methanobacillus, Methanococcus and Methanosarcina digest these fatty acids, resulting in the formation of methane gas. Anaerobic digestion results in loss of roughly half of the solids and the digested sludge is more dense than raw sludge. Little mixing and no aeration are required during the digestion While this suggests that an anaerobic step for waste treatment should be inexpensive, very large vessels are required because digestion is slow. The production of methane gas is the slowest and most sensaitive step of the anaerobic digestion process, because it requires specific environmental conditions for the growth of methanogenic bacteria. These bacteria can only digest effectively at a pH of 6.6-7.6 and if the growth of the acid forming bacteria is excessive, there will be an overproduction of acid leading to a decrease in the pH causing many problems. Also, the methanogenic bacteria have a limited temperature range for optimum performance, usually in the mesophilic range (32-41.°C). Often this requires pre-heating of the waste before entering the digester. Methane evolved during the digestion is collected and burnt.

SYSTEM OPERATIONS

The anaerobic treatment plant at Pudumjee Pulp and Paper Mills, called 'Pudumjee an-Opur-P', was set-up in 1988, in association with Mess. Sulzer Brothers Limited, Switzerland. Incipient operations at the time of the start -up in 1988, began with the 'seeding', which involved a one time initiation of the anaerobic bacteria. Digested municipal sludge and fresh cowdung slurry was used for this purpose and adequate gas generation had begun with a fortnight.

The system has a special mixed-bed type reactor, with a fully integrated large area separating system at the top. It consists of two large digesters each having a capacity of 6,200 M^3. The gas holding capacity of the digesters is 400 M^3 each. The digesters are fed from top to bottom, resulting in a counter current distribution, in the central inlet tube. Two lateral agitators are provided for adequately mixing the components. The system has lamella clarifiers and siphon agitators for solid-liquid and liquid-gas separation. The entire process is regulated using the built in microprocessor based auto control. Refer to Table-1 for further digester details. Various process parameters like pH, loading, temperature, Organic suspended solids, volatile acid concentration are regulated to maximize biogas generation and control the reduction in the Biochemical Oxygen Demand (BOD) and the Chemical Oxygen Demand (COD) in the liquor. Table-2 summarizes the change in process values, of the entering effluent, before and after treatment. Additionally, adequate safety measures like auto flare-off system, flame traps. Quick shut - off valves and pressure release system have been deployed within the system.

Table 1 : Digester Details

DIGESTER PARAMETER	VALUE
Volume (M^3)	6200
Inlet flow (M^3/hr)	100-125
Retention time (hrs)	50
COD loading (kg/M^3day)	5
Gas Production (M^3/day)	4000
Specific gas production (M^3/kg COD destroyed)	0.45-0.50
Calorific Value of Biogas (KCal/M^3)	6400
pH range	6.8 -7.6
Temperature (°C)	35-37

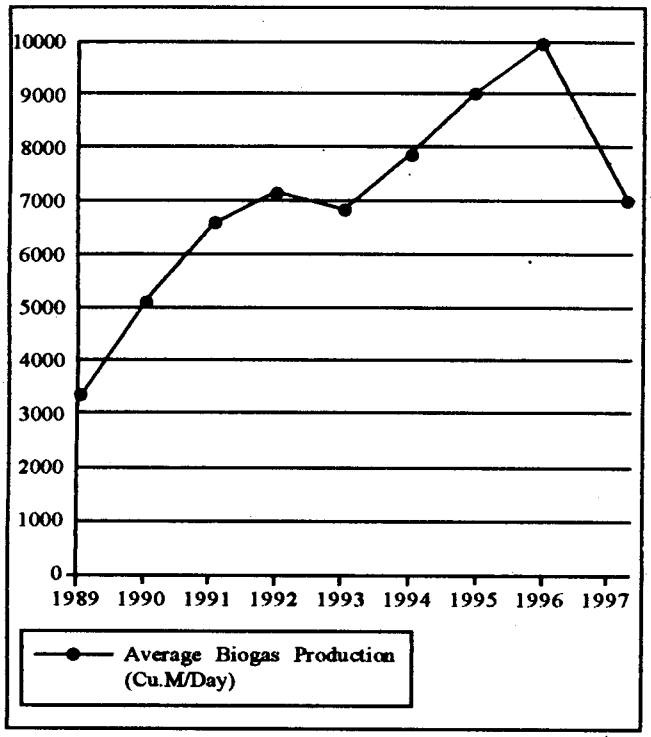

Fig. 2

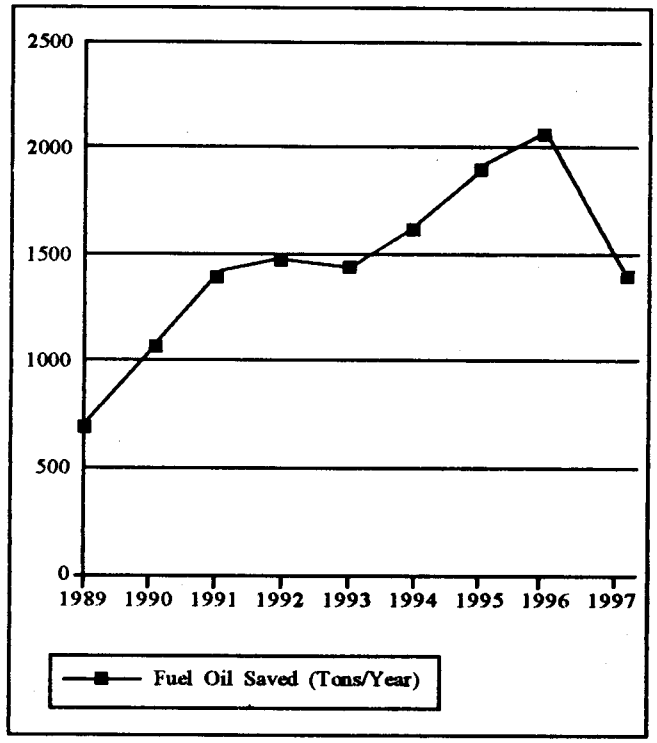

Fig. 3

SYSTEM PERFORMANCE

Pudumjee Pulp and Paper Mills has been successfully running the anaerobic treatment plant, for the last ten years now, giving satisfactory results year after year. It should be noted that inspite of the high capital cost invested initially, the system paid back the investment made, during the first five years itself. The performance evaluating graphs present the record of anaerobic treatment at Pudumjee, in recent years. The Biogas generated in the plant is transported and used as fuel in the boilers, in lieu of boiler fuel oil. Biogas burnt accounts for about 15% of the total fuel oil requirements, resulting in tremendous, continuous savings for the mill. Figure-2 shows the amount of Biogas generated annually, while figure-3 shows the corresponding savings in terms of boiler fuel. The anaerobic treatment plant has been performing commendably, consistently giving a BOD reduction of 85-90 %, decreasing levels from about 3000-3500 mg/l to about 350 -400 mg/l and a COD reduction of 70-75%, decreasing levels from 11000-11500 mg/l to 3500-4000 mg/l. This has been summarized in figure-4. Moreover the anaerobic treatment plant considerably reduces both the effluent load and the power requirements, in the aerobic treatment plant, to which the effluent is subsequently sent, further reducing the BOD and COD levels in the effluent. It must be mentioned, that the average

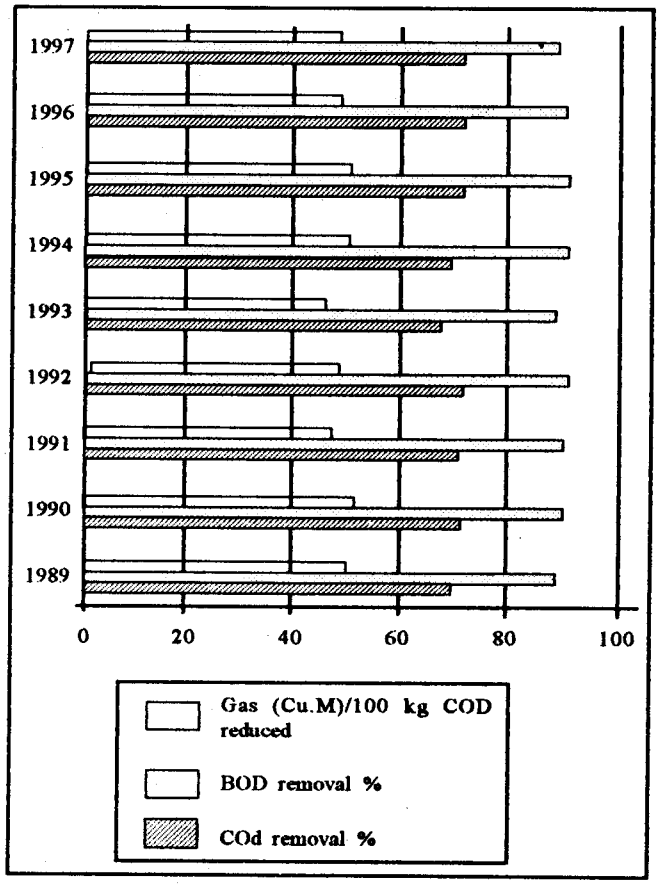

Fig. 4

biogas generation during the year 1997, was low, because of lower than normal pulp production in the mill. Yet, this did not adversely affect the system performance, as indicated by the corresponding BOD and COD removing efficiencies. This system has the added advantage, that it can adapt itself to irregular power supplies and non-uniform raw material supply and process conditions, a situation not uncommon in Indian Mills.

CONCLUSION

Pudumjee Pulp and Paper Mills have pioneered the use of anaerobic treatment of effluent waste waters from small agro-residue based mills in India. This treatment is a suitable substitute for small mills, that find setting up a conventional soda recovery plant unfeasible. Not only is it successful in reducing the BOD and COD of discharged waste waters to appropriate levels, it is also able to save on a considerable portion of the energy requirements by generating biogas.

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