# ANAEROBIC WASTE WATER TREATMENT WILL TURN COSTS INTO BENEFITSFOR THE PULP AND PAPER INDUSTRY IN INDIA

- Dudhbhate,J.A.*, Lobo,A.J.*,Khanolkar,V.D.* and Pudumjee,K.D.*

## PREAMBLE

Pudumjee Pulp and paper Mills Limited is today one of the first units to undertake a full scale activated sludge treatment process for its effluent way back in 1972. This plant has been undated from time to time to meet the standards of the Maharashtra Pollution Prevention and Control Board for use of effluent on land for agricultural purposes.

From the early eighties, however, a trend of gradual urbanisation was noticed in our area. This trend had turned into a flood by 1982 and agricultural land was being converted unauthorisedly to non-agricultural and commercial uses on a very vast scale. This tendency brought about a drastic reduction in the green belt that was being maintained around the factory for purposes of effluent treatment. Projecting this trend of reducing agricultural land into the future, we found that a strategy needed to be evolved on a short term as well as a long term basis. A number of short term measures were evolved which gave substantial relief to the mills right upto the present date However, the options for long term solution appeared to be only three:

1. To undertake chemical recovery.
2. To undertake a very large expansion of the aerobic activated sludge system.
3. To look at never technologies that were evolving at that time in Europe for the purpose of waste water treatment.

Due to the size of our pulping operations (30 TPD) the first option was a non starter due to the uneconomic costs of installing a chemical recovery system.

---

* Pudumjee Pulp and Paper Mills Limited, Thergaon, Chinchwad, Poona 411 033, Maharashtra.

With the experience gained by us over a decade of operations of the aerobic system we felt that the operating costs specially with regard to energy appear to be extremely high and would be prohibitive in time to come with the rising electricity rates in Maharashtra.

With regard to the emerging technologies, one of the options appeared to be anaerobic digestion of effluent which had then been tried at a number of Sugar Mills and one unit was to be commissioned at a Paper and Pulp Mill in Sweden. Some of the major advantages which we felt were -

1. Very low power consumption.
2. Recovery of energy was possible from the system instead of chemicals.
3. Substantial reduction of BOD was possible.
4. Skill requirements for operating the plant were minimal.

A number of suppliers of such systems were contacted by us and an eventual selection fell on Sulzer Brothers, Winterthur, Switzerland. One of the major reasons being that Sulzer Brothers were the only ones doing further intensive development work to reduce retention time thereby reducing the size of the plant as also capital cost.

We at Pudumjee Pulp and Paper Mills Ltd. will now be installing India's first Anaerobic Digestion System for Pulp and Paper Mill waste water which is expected to go on stream by the last quarter of this year. The system will obviously be one of the first of its kind in the industry and similar plants could be supplied to other mills wishing to install such systems.

## THEORY AND PRACTICE

In waste water treatment, the process technology will influence the growth of the micro-organisms and their performance. This is especially true for anaerobic waste water treatment, where the concentration of pollutants to be degraded and the growth rate of the micro-organisms are so low that it would require days or weeks to degrade them.

The process and plant technology has thus to fulfill two duties in the most economical way:

- Concentrate the microorganisms, for example through 'sludge' separation and recirculation or through attached growth in fixed or fluidized bed.
- Control the original growth conditions like pH, temperature, nutrient and intermediate concentration.

This is very much pronounced in an anaerobic treatment process, where the microbial reactions involve two different stages viz., the relatively fast fermentative stage and the following, slower, acetogenic and methanogenic stages which occur simultaneously. The last two are strongly influenced by the first step and also of course by the specific nature of the waste water to be treated.

The above point is of major importance if one considers the differences found in waste water characteristics from sugar mills, distilleries, brewries, paper mills, food or pharmaceutical industries which can readily be treated anaerobically. In certain cases one is faced with very good degradability with high suspended matter and the presence of high quantities of calcium like in the Sugar Industry. In other cases the waste waters are diluted and requires the presence of high concentrations of micro-organisms to be treated in short time. In few other cases the presence of salts like ammonium or sulfates requires another process design.

The anaerobic treatment of industrial effluents has fundamental advantages as compared with the aerobic treatment with activated sludge only. The most important are:

- Very low excess sludge production
- Very low nutrient requirements
- Minimal energy consumption coupled with production of energy rich biogas.
- Sludge activity remains unchanged even after long periods of shutdown.

The organic loads which can be applied to the AN-OPUR-P process are higher when compared with classic anaerobic systems and aerobic activated sludge systems or other aerobic wastewater treatment techniques.

The biological methane generation process proposed is a microbiological process where the substrate, which consists of soluble or insoluble complex organic matter, is converted to methane gas and carbon dioxide.

The insoluble organic matter is attacked by a first community of microorganisms called the fermentatives. The organic molecules are solubilised, hydrolysed and converted to organic acids, ethanol, hydrogen and carbon dioxide. These intermediates produced during the solubilization hydrolysis or acidification phase are subsequently transformed by another community of microorganisms, to methane and carbon dioxide.

Recently, it has been recognised that of the intermediates, only hydrogen, formic acid and acetic acid can be used directly by the methanogens whilst all other intermediates need to be converted to these substances by a quite special group of microorganisms. These are the so-called obligatory hydrogen producing acetogenic (OPHA) bacteria. The latter live in very close association with the methanogenic bacteria, hence in one particular reactor. In practice, one can say that the anaerobic fermentation succeeds roughly in two phases: on one hand the solubilisation - hydrolysis or acidification phase and on the other hand the methanogonic phase.

The anaerobic process can be of three types -
- Sludge bed or mixed sludge bed
- Fixed bed
- Fluidized bed.

The selection of appropriate process depends very much on waste water characteristics.

The AN-OPUR-P process gives a better overall COD loading and much reduced sensitivity to load variations, especially to certain substances which have a negative influence on the microorganisms. A suspended sludge bed can show a quicker start-up, within days in some cases, whereas fixed and fluidized bed may show starting up periods of weeks or months. The suspended sludge bed shows very low sensitivity towards incoming or produced suspended solids as in the case of paper mill or sugar mill wastes.

The main comparison criteria for three processes are the COD loading rates, which are:

- Sludge bed 0.5 - 5 Kg COD/$M^3$.d.
- Fixed bed 2 - 20 "
- Fluidized bed 10 - 40 "

The AN-OPUR-P for pulp and paper industry waste is specially developed mixed sludge bed process. The general advantages in this new technology are:

- high hydraulic load capacity and tolerance because of very efficient sludge separation system.
- high COD/$BOD_5$ decomposition rate due to the excellent retaining factor with the residual of high biomass concentration in the reactor.
- very high process stability also under stress situations (i.e. high calcium ion contents or COD fluctuations) because of volume conditioned large buffer capacity.
- No damage of sensitive biomass and no costs at the sludge recycling side because sludge is not pumped or otherwise subjected to mechanical shearing forces.
- No external gas buffering required, as intentionally very low partial pressures are worked with.

Our extensive R & D work on anaerobic treatment of Pulp Mill waste water on the bench scale facility together with several years of experience on aerobic activated treatment gave us confidence while deciding on the best appropriate technology for waste water treatment suited to Indian conditions. The stringent requirements for discharge have made all of us to go for a viable system.

The comparative costs for aerobic treatment also indicated strongly in favour of anaerobic treatment. In fact, a net gain of energy equivalent to the tune of Rs. 40 lacs per annum (depending upon the BOD reduction required) can be visualised on a 30T/day Pulp Mill which is doing aerobic treatment today. For a new mill the gains are still higher.

Following tables give salient features of AN-OPUR-P process:

TABLE - 1

COMPARISON OF ANAEROBIC AND AEROBIC BIOTECHNOLOGY PER METRIC TON COD DESTROYED.

| | Anaerobic | Aerobic |
|---|---|---|
| Electricity | - | 1100 KWH |
| Methane | $1.1 \times 10^7$ BTY | - |
| Ne excess sludge produced | 20 - 150 Kg | 400-600 Kg |

TABLE - 2

REDUCTION OF COD & BOD AND BIOGAS PRODUCTION AT VARIOUS TEMPERATURE RANGFES

| Temperature °C | Reduction | | Biogas $M^3$-/day |
|---|---|---|---|
| | COD | BOD | |
| 25-27 | 53-57 | 68-70 | 10000-10400 |
| 28-32 | 60-64 | 78-80 | 11400-11600 |
| 34-36 | 68-72 | 85-90 | 12900-13000 |
| 39-41 | 72-75 | 90-95 | 13100-13200 |

Full scale anaerobic treatment plants are running at several Pulp and Paper Mills abroad The published reports have shown encouraging results.

The following installations are notoworthy:

| | |
|---|---|
| 1. Hylte Bruk | Sweden |
| 2. Julca | Spain |
| 3. MODO | Sweden |
| 4. Anjala | Finland. |

The AN-OPUR plant at Aarberg Sugar factory in Switzerland is also worth mentioning for results achieved in the treatment.

A computer programme has also been developed for evolving optimum plant capacities and other parameters. We need to know values of basic characteristics of waste water to obtain various details on plant size and net energy equivalent.

We are prepared to give this print out for a nominal charge to anybody interested in knowing the requirements. A questionnaire is taken out for the abovementioned purpose. The basic requirement is that the characteristics like, BOD, COD, flows, temperatures, etc. need to have been collected over a period of time to judge the variations or fluctuations in their values.

CONCLUSIONS:

The AN-OPUR-P process is a collective concept for anaerobic treatment of Pulp and Paper Industry waste waters. It is possible to degrade the waste waters by anaerobic methods and a high specific biogas production can be achieved.

We are quite sure that our anaerobic system has a large potential that can be utilized now which will make a significant contribution to CLEAN ENVIRONMENT.