Turning Black Liquor into Bio Fuel - A Case Study

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ABSTRACT

Presently biomethanation plant in Satia Paper Mills is running at 80% loading with 8000 m^3 gas production, 81% reduction BOD and 54% in COD. The biogas produced is being used as a fuel in the boiler which results with in 20% saving of the thermal energy requirement of the boiler. The article discusses the strategic approach initiated by Satia Paper Mills Ltd. in appreciable reduction of COD and BOD alongwith co-generation of biogas, a non-conventional source of energy. Satia Paper Mills Ltd. had installed an effluent treatment plant based on activated sludge process with diffused aeration system and extended aeration. Black liquor generated during brown stock washing contributes more than 80% of total pollution loads and results in loss of residual alkali and substantial amount of organic biomass which is a good source of bioenergy.

INTRODUCTION

The conventional activated sludge process is used in most of the mills, which is expensive and incapable to reduce the BOD upto the desired level of pollution control norms. Due to above constraints a high rate Demo Biomethanation Plant based on UASB technology has been set up at Satia Paper Mills Ltd., Punjab under UNDP/GEF assited project (1, 2). The full scale biomethanation plant based on USAB process which is , patented technology of Paque water system from the Netherland has been working satisfactorily since 1997 with substantial reduction in COD and BOD.

Agricultural residues differ from forest based raw materials in morphological and physico-chemical characteristics and processing depends on nature of fibrous raw materials and fibre process system, cooking, bleaching, refining etc. A weakness in many small integrated pulp mills based on nonwood raw material is the washing of pulp and difficulty in treating the resultant pollution.

Industrial wastewaters with significant pollution load are normally considered for End of pipe. treatment by an anaerobic-aerobic sequence to meet stipulated regulatory standards of teated water. Among the low strength waste water, weak black liquor from straw based mini paper mills are particularly notable owing to their potential as source of biogas which can be generated during anaerobic treatment. About 80-90% of the biochemical energy potential expressed as BOD is released as biogas.

RESULTS AND DISCUSSION

Performance of Demo High Rate Biomethanation Plant

Biomethanation is based on anaerobic biological treatment process and worked under various microbiological as well as biochemical reactions in the UASB reactor specially designed to treat high BOD concentration of Brown stock wash liquor. This technology first became available to the pulp and paper industry in the early 1980's and well adopted in recycled waste and agro residue based influent.

The demonstration biomethanation plant consists of sump tank, equalisation tank, clariflocculator, clarifier and two. UASB reactors with capacity of 2623m^3 each. These reactors are designed to handle 53 tonne of COD load.

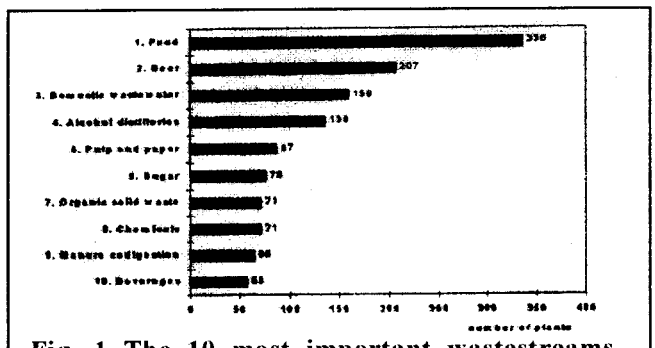

Fig. 1 The 10 most important wastestreams for anaerobic treatment

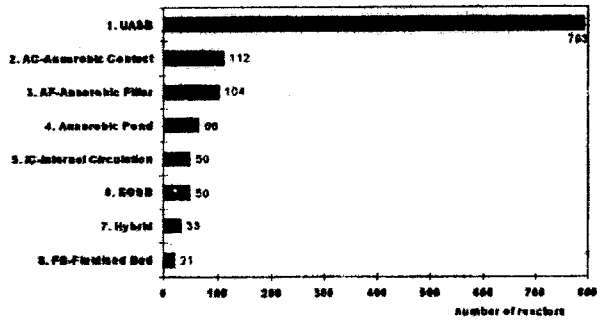

Fig. 2 The 8 most common anaerobic treatment systems

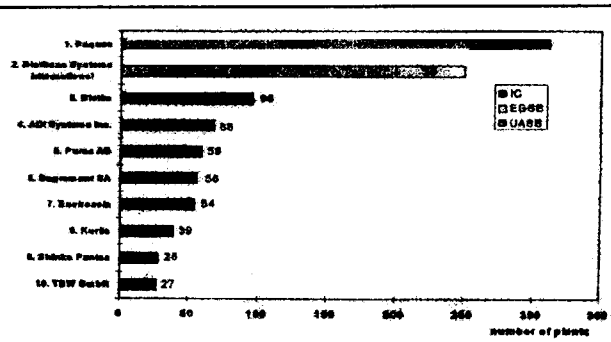

Fig. 3 The 10 leading companies in anaerobic technology on the basis of number of full-scale plants installed.

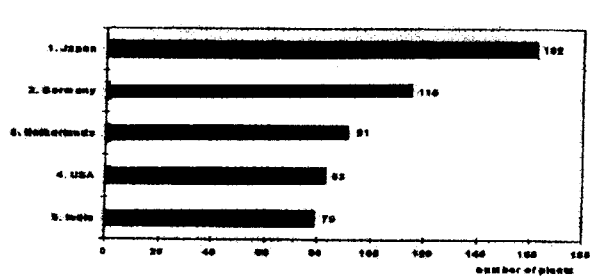

Fig. 4 The 5 leading countries in implementation of anaerobic treatment for industrial wastewaters.

Black liquor is first collected in sump tank and then pumped to equalisation tank where shock load, if any is homogenized. The overflow then goes to neutralisation tank and pH is adjusted to 7.5 by addition of HCl, with gentle mixing. Neutralised liquor is then passed through clariflocculator to clarifier and all the suspended solids are removed with a sludge pump. This sludge is mixed with primary clarifierd sludge and filtered in a twin wire belt press, which is used by a board mill as an alternate source of fibre.

The clarifier overflow then goes to buffer tank from where it is and pumped into the reactors through a distribution network, specially designed to ensure proper and uniform contact between influent and active bioculture. During anaerobic digestion, most of the organic substances are converted into methane and carbon dioxide under series of reactions in the reactor.

A unique three phase separator system ensure the separation of biogas, entrained biosolids and digested effluent. There is a back wash arrangement to clean the distribution pipes to have an uniform liquor distribution through active biomass and to avoid short circuiting. Granulation of sludge in essential for good performance of the UASB system but it is difficult to maintain the quality of biosludge, specially in agro residue based influent due to high silica and lignin over a period of 3 years as a result of which the, gas production and COD reduction dropped. Approximately 30% fresh biomass was added in the reactor after removing equal amount of contaminated sludge, and influent feed was controlled to 10% Fig. 6 and 7. The feed rate was increased gradually and reactor operated on 100% loading within one month's time. The results are given in Table 4, 5.

Economic viability and operational cost

During anaerobic digestion methane rich biogas is produced, which is utilised in boiler as an alternate source of fuel with 20% saving in total fuel requirement of the boiler. Payback of the plant is around 7 years based on simple calculation of biogas production with rice husk saving considering operational and maintenance cost However indirect saving does not include, electricity and chemicals required in activated sludge process to achieve same level of COD and BOD at final discharge.

Problems faced during the operation of biomethanation plant during past 5 years

Sludge quality

Due to deposition of inert mass, silica and lignin

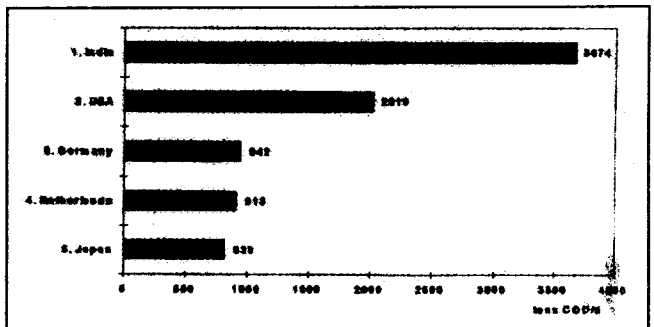

Fig. 5 The 5 countries with the highest COD-removal capacity (in tonnes COD/d) installed.

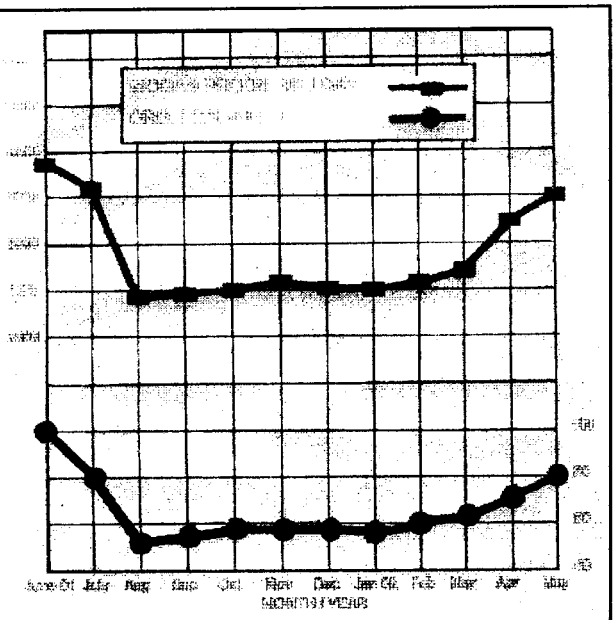

Fig. 6

escaping the clarifier, the sludge quality started deteriorating, resulting in low biogas production and COD/BOD reduction over a period of time. Fresh biomass was added and the reactors started with slow feed alternatively and achieved the same level of plant performance.

Corrosion

Corrosion of gas piping, reactor hood and recirculation pipe lines are noticed after 3 years of operation. Anticorrosive paint was applied to reduce the corrosion and some of the part were replaced.

Sulphite

Since residual sulphite coming from Alkaline - Sulphite cooking digestion, a floating aerator was used to deaerate the sulphite into sulphate.

Other Advantages

- The successful demostration of biomethanation technology for treatment of black liquor generation during alkaline - sulphite pulping has built up the confidence among mill personnel.
- Power requirement is approximately 78 times less than conventional activated sludge process to treat same amount of BOD load.

CONCLUSION

The biomethanation plant is running successfully since 1997, with few teething problems faced during operating over a period of 5 years. The combination

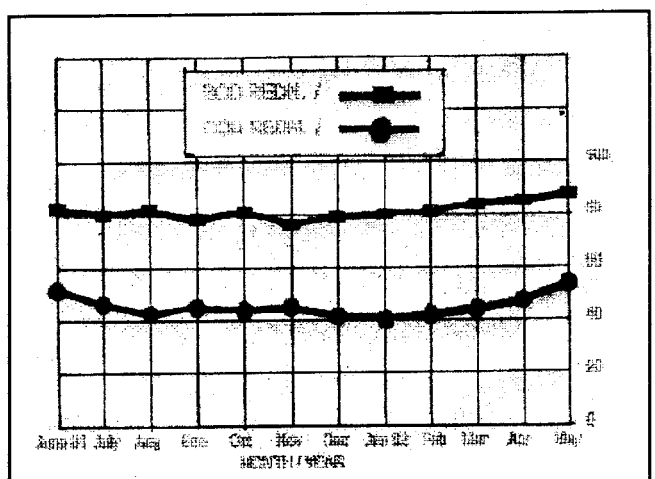

Fig. 7

of anaerobic treatment followed by activated sludge process opened a new horizon to treat the complex organic waste easily with much saving in fuel cost by using conventional source of energy. Unburnt material percentage in boiler ash was reduced by 60% and emmision quality improved substantially; besides less ash handing problem with minimum manpower. Biogas being a clean fuel, it has improved the overall performance of boiler.

A pilot demoplant is set up by CPPRI to recover lignin, prior to biomethanation. It can be another break through in this direction to the prolong deterioration of sludge for 4 to 5 years and better treatment efficiency in terms of colour, COD and BOD reduction. Precipitated lignin can be utilised for number of applications with better properties than commercially available resin and plasticizers in the market.

ACKNOWLEDGEMENT

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