BIOENERGY FROM NATURAL RUBBER PROCESSING WASTES

Jacob Mathew, Kothandaraman.R and Kochuthresiamma Joseph,
Rubber Research Institute of India, Kottayam-9.

Abstract

The most noticeable pollution in rubber industry is caused by the liquid wastes generated from rubber processings, which contain a large quantity of non-rubber substances. The major form of processed natural rubber in India is Ribbed Smoked Sheets (RSS) which accounts for more than 70 per cent of the total rubber production. It is estimated that when one kilogram of dried RSS is produced, on an average 10 litres waste water is generated.

Sheet processing effluent contains readily oxidisable dissolved organic solids in finely divided or in liquid form. Since the effluent is organic in nature, it could be treated anacrobically leading to the production of methane gas, which could be used as fuel for domestic purposes and also in smoke houses for drying of sheets rubber.

Khadi and Village Industries Commission and Deenbandhu model biogas plants are used for the anaerobic digestion of the RSS effluent. The hydraulic retention time is maintained for 30 to 40 days. The pilot plant studies with a 3 m^3 Deenbandhu biogas plant showed an average gas production of 2 m^3/day.

The biogas contains 55 to 65 per cent methane and a substantial quantity of hydrogen sulphide. As hydrogen sulphide could become toxic when released in confined spaces, its removal using chemicals was attempted.

The physico-chemical properties of the water released after the digestion were within the prescribed limit specified for irrigation, which indicates that anaerobic digestion is an economic method of effluent treatment for natural rubber processing waste water.

Introduction

The pollution from natural rubber processing factories poses a serious concern in the rubber industry. The most noticeable pollution in rubber industry is caused by effluents generated from rubber factories which contain large number of non-rubber substances in addition to traces of processing chemicals. The effluents are to be managed judiciously considering their deleterious effects to the environment.

The major form of processed natural rubber in India is Ribbed Smoked Sheets (RSS) which accounts for more than 70 per cent of the total rubber production. Therefore, the maximum quantity of effluent also is generated from the processing of this form of rubber. It has been estimated that when one kilogram of dried RSS is produced, on an average 10 litres waste water is generated. Most of the production units for RSS are small holdings where the average quantity of sheet production is around 10 kg/day. Although the quantity of effluent discharged by small holdings is fairly small, it is worth noting that even this small quantity of effluent, unless properly treated, leads to environmental pollution.

Sheet processing effluent contains readily oxidisable dissolved organic solids (Rajagopalan, 1975). Since the effluent is organic in nature, this could be treated anaerobically leading to the production of methane (Ibrahim *et al.*, 1986). This would not only lead to abatement of pollution but also generate income in terms of energy.

Feed Characteristics

Due to undecomposed organic matter, this effluent is milky in appearance with high level of total solids. The pH of the effluent varies from 4.5 to 5. The Biochemical Oxygen Demand (BOD) as well as Chemical Oxygen Demand (COD) are high (Table.1).

Pilot Scale Biogas Plant

A $3m^3$ fixed dom - type Deenbandhu model biogas plant was used for the pilot scale studies. The RSS effluent was fed to this plant. The pH of the effluent was adjusted to 7.0 with lime. The flow rate was adjusted to 75 L/day in such a way that the Hydraulic Retention Time (HRT) remains 40 days. The plant was initially seeded with the slurry from the gobar gas plant. The plant was run for 60 days to establish methanogenesis as evidenced by satisfactory biogas production with desired methane content of 55 per cent in it. The plant was further run for one year and various observations were made.

Biogas production

The biogas produced was measured daily and the monthly average was calculated. The methane content was quantitatively analysed chromatographically. Hydrogen sulphide (H_2S) was estimated by passing a known volume of gas sample through 10 per cent lead acetate solution. The volume of the gas absorbed by the lead acetate solution was used to calculate the quantity of H_2S present in the gas sample (Kalia *et al.*, 1992).

Biogas production expressed as m^3/day is presented in Table 2. The highest yield of biogas was observed during March to May. This could be due to the high temperature during these summer months (Kirsch and Sykes, 1971).

RSS processing effluent as diluent with different organic wastes resulted in an increase in biogas production (Mathew, 1994). This diluent contains organic acids as well as fine particles of rubber hydrocarbon from latex. The latex yielding plant materials are reported to be producing more gas owing to the rubber hydrocarbon content and available nutrients in (Rajasekharan *et al.*, 1989 and Traore, 1992). RSS effluent is rich in these components which resulted in the biogas generation.

The methane content of the biogas was found to be 55 to 65 per cent and hydrogen sulphide was 5 to 10 per cent. (Table 3).

Removal of H_2S

As H_2S could become toxic when released in confined spaces, its removal was attempted with various chemicals. Among the chemicals calcium hydroxide and lead acetate were found to be the best in removing H_2S completely. Between these two, calcium hydroxide could be recommended which is cheap and eco-friendly.

The biogas generated is passed through a gadget filled with pellets made of calcium hydroxide and soil. The pellets could be prepared by mixing the lime (calcium hydroxide) with equal quantity of fine field soil. This mixture is sieved through a mesh (0.5 mm size) and the pellets are dried under shade. These pellets are filled in the gadget and attached with the gas line between burner and the plant. The gadget could be fabricated using PVC pipes locally as given in the sketch.

Effluent Characteristics

The physico-chemical properties of the effluent from the biogas plant is given in Table-4. All these parameters are within the prescribed limit specified for irrigation indicating the feasibility of anaerobic digestion of the RSS effluent. Considerable reduction in the BOD and COD was noted in the final discharge from the biogas plant. More over this water was devoid of any malodorous.

Conclusion

Anaerobic technology is best suited for the treatment of liquid wastes from rubber processing units. The integral approach of combining anaerobic fermentation and biological utilisation of rubber sheet processing effluent which envisages the possible elimination of the pollution problems with concurrent production of combustible gas has proved to be an ideal waste management technique in natural rubber processing industry. The biogas generated could be used for domestic purposes or for drying of rubber. The treated effluent from the biogas plant is safe for irrigation.

REFERENCES

1.Ibrahim, A.B, Bakti. N.A.K, Isa, Z. and Karim M.Z.A (1986) Cost effective technologies for pollution control in the natural rubber industry. *Proceedings of Rubber Research Institute of Malaysia, Rubber Grower's Conference*, 1986, Kula Lumpur, Malaysia, pp. 377-387.

2. Kalia, V.C., Kumar, A, Jain, S.R and Joshi, A.P(1992) Biomethanation of Plant Materials. *Bioresource Technology*, **41**: 209-212.

3. Kirsh, E.J. and Sykes , R.M (1971). Anaerobic digestion in biological waste treatments. *Progress in Industrial Microbiology*, **9**: 155-237.

4. Mathew,J. (1974). Characterisation of wastes from natural rubber and rubber wood processing industries and their utilization for biomethanatim. Ph.D. Thesis, Cochin University of Science and Technology, Cochin, India.

5. Rajagopalan,K. (1975). The mechanism of methane formation in rubber factory effluent and its reference to palm oil mill discharge. *Proceedings of the Agro-Industrial Waste Symposium*, 1975, Kula Lumpur, Malaysia, pp. 33-38.

6. Rajasekharan, P; Swaminathan, K.R. and Jayapragasam, M. (1989). Biogas production potential of *Euphorbia tirucali* along with cattle manure. *Biological Wastes*. **30**: 75-77.

7. Traore, A.S. (1992). Biogas production from *Calotropis procera* : A latex plant found in West Africa. *Bioresource Technology*. **41**: 105-109.

Table - 1.

Characteristics of the RSS effluent

Parameter	Value (mg/l)
Colour	Milky
pH	5.4
TS	8098
SS	2345
BOD	2910
COD	5075
Nitrogen	420

Table - 2.

Biogas production/day (averaged over the month).

Months	Gas production (M^3)
August	1.50
September	1.66
October	1.72
November	1.75
December	1.72
January	1.82
February	2.21
March	2.44
April	2.51
May	2.55
June	2.32
July	2.20
Average	2.03

Table-3.

Composition of the biogas

Components	Content (%)
Methane	55 - 65
Carbondioxide	15 - 20
Hydrogen Sulphide	5 - 10

Table - 4.

Characteristics of the treated effluent

Parameter	Treated effluent	Limit for irrigation
Colour	Colourless	-
pH	7.2	6 - 8
TS	846	2100
SS	58	200
BOD	68	100
COD	228	250
Nitrogen	-	-

(All values except pH are in mg/l).