SUMMARY

The liquid and solid wastes from natural rubber based industries were characterized and their use for the production of biogas investigated with a view to conserve conventional energy, and to mitigate environmental degradation. The following investigations were carried out to identify, assess and overcome the problems.

1. Characterization and quantification of the wastes
2. Utilization of wastes from rubber processing and rubber wood industries.

The physicochemical and bacteriological analysis showed that rubber factory effluents contain large quantities of solids, both organic and inorganic, creating a high oxygen demand. Bacterial population was higher in crepe rubber effluent (CRE), followed by crumb processing effluent (CPE), sheet processing effluent (SPE) and latex concentrate effluent (LCE). The solid wastes from rubber processing varied depending on the physicochemical properties. Since the major components of the solid wastes are lignocellulosic in nature and the liquid wastes
contain nutrients, both the wastes were used for generation of biogas. The effects of different levels of solid content, sources of inoculum and incorporation of liquid wastes with solid wastes, on biogas production were investigated. The changes in different solids, cellulose, hemicellulose, lignin, cellulolytic, acid producing, proteolytic, lipolytic and methanogenic bacteria and hydrolytic enzymes liberated, at initial, middle and final stages of 10 weeks incubation time, were monitored. The possibility of the use of spent slurry as organic manure is discussed.

Digestion mixture with crumb waste (CW), sawdust, predigested sawdust (PSD) and cowdung was prepared at 5, 10 and 15 per cent concentration of solids and used for anaerobic digestion. The amount of gas evolved and the changes undergone in the digestion mixture were studied. Maximum degradation of TS, VS, cellulose and hemicellulose was observed in PSD at 10 per cent level. The VFA content was also more in this treatment. At 10 per cent level of PSD, the activity of cellulolytic, acid producing, proteolytic, lipolytic and methanogenic bacteria were more in the middle stage of methanogenesis. Corresponding to the population of various bacteria there was a change in the activity of cellulase and β-glucosidase. Enhanced activity of different groups of bacteria resulted in higher production of biogas rich in methane content.
Favourable changes leading biogas generation and quantum of biogas generated in sawdust was next to PSD. Both sawdust and PSD were superior to CW and cowdung for biogas production under the influence of microbial activity and biochemical changes.

Biodigested slurry (BS) with different substrates was identified based on the parameters investigated, as very ideal for biogas production. Among various substrates PSD with BS led to maximum biogas production. The degradation of TS, VS, cellulose and hemicellulose was higher in the treatment involving PSD and BS. Population of cellulolytic, acid producing, proteolytic, lipolytic and methanogenic bacteria as well as the activity of enzymes-cellulase and $\beta$-glucosidase, and VFA were more on PSD inoculated with BS. Activity of cellulolytic enzymes and microbial population generally increased up to middle stage and then decreased with time. The percentage of methane in the biogas was also more in the PSD and BS treatments.

Among the liquid wastes from rubber processing used as diluents in combination with PSD, SPE promoted more biogas production with high methane content in the gas. The factors that favour methane production like TS, VS, cellulose and hemicellulose degradation were favoured in this treatment which led to higher methane biogenesis.
The population of bacteria and the quantity of enzymes that cause degradation of cellulose, the major component of TS and VS were more, especially during the middle stage in PSD and SPE combination. Similarly the population of proteolytic, lipolytic, acid producing and methanogenic bacteria were also more in PSD and SPE.

The spent liquor contained major plant nutrients i.e., N, P and K. PSD with SPE contained 2.26, 0.92 and 0.78 per cent of N, P and K respectively, indicating its usefulness as an organic manure for plants.

The results of the present investigation open a new avenue with significant dimensions in the conservation of conventional energy. The substantial amount of high quality biogas generated from natural rubber and rubber wood industry waste would be a covetable alternative source of energy. Simultaneously this process also abates the environmental degradation. The results further highlight ways and means to use agricultural wastes as alternative sources of energy.