ABSTRACT

The vast majority of rural people in the developing and under-developed nations, which make together around half of the world's population, are totally dependent on **biomass** for their fuel requirements.

On the basis of extensive literature survey it has been found that most of the biogas plants use cattle dung as feedstock and this technology is well established. The rapid mechanization of farm practices has resulted in the decline of cattle population and hence short fall in cattle dung availability. This has necessitated the need to look for the alternative materials for biogas generation. Agricultural and forest residues have been thought to be the viable alternatives that could replace or supplement the conventional cattle dung for biogas production but very little work on biogas generation from agricultural and forest residues has been reported. Thus in order to promote and enhance the biogas production, a systematic study of biogasification characteristics of these materials is necessary.

Based on the availability in large quantities, eight biomass materials which are often wasted/burnt or composted were selected for experimentation. These biomass materials were Ipomoea fistulosa plant stem (IFPS), Ipomoea fistulosa leaves (IFL), Cauliflower leaves (CFL), Rice straw (RS), Mirabilis leaves (ML), Banana peeling (BP), Wheat straw (WS) and Dhub grass (DG). Cattle dung (CD) was used for comparative studies. The

physico-chemical analyses of these biomass materials show that thses have low lignin to cellulose ratio (in the range of Ø.14 to Ø.45) in comparison to cattle dung (Ø.6Ø). This suggests better digestibility of these materials through anaerobic digestion in comparison to that of cattle dung. The nitrogen content of these materials is also satisfactory (except that of RS and WS), to fulfil the requirements of nutrient availability for microbial growth. In the course of extensive laboratory scale experimentation carried out to investigate the biogasification characteristics, all these materials have been found to be suitable for biogas production with or without supplementation of cattle dung. The biomass materials investigated, with the exception of WS and DG, have been found to yield gas more than two times of that produced from cattle dung. Blending of these biomass materials with cattle dung, shows improvement in the methane content of the gas as well as volume of biogas per unit mass of substrate with the increase in the percentage of these materials in the blend.

During anaerobic digestion, under the controlled mesophilic temperature, there is need to control pH and total volatile fatty acids (TVFA) concentration for IFPS, IFL and CFL to obtain satisfactory digestion. It has been seen that, in general, a judicious control of pH and TVFA concentration results in the enhancement of biogas production.

Particle size of the feedstock has been seen to have a profound effect on the digestibility of biomass materials, the

size reduction upto certain (optimum) level has been found to enhance the biogas generation. The study on the effect of temperature of the slurry on biogas generation (in the range of 20°C to 45°C) has shown that the biogas production has a linear variation with the logarithm of inverse of temperature upto 37.5°C. Beyond 37.5°C the gas production begins to decline and totally stops at 45°C.

Adjustment of carbon to nitrogen ratio to bring it to a value around 25 by the addition of nitrogen compounds enhances the gas production to some extent but the materials resistant to microbial attack are not digested satisfactorily regardless of their carbon to nitrogen ratio. Thus the role of nitrogen present in-situ in the biomass materials has been seen to be significantly different from that of the nitrogen added externally. In this context, the contention of some of the previous investigators regarding optimum carbon to nitrogen ratio of around 25 could not be confirmed because IFPS, RS, DG and CFL with carbon to nitrogen ratio of 155.7, 73.5, 34.0 and 12.1, produced 485, 487, 282 and 520 litres of biogas/kg of total solids, respectively.

Preincubation of agricultural and forest residues with water and alkali treatment has been found to enhance the biogas production upto 16%. The laboratory results have also shown that the stirring of the digester substrate can enhance the gas production upto around 11%.

The methane production during eight weeks of digestion from

unincubated biomass materials under controlled conditions were found to vary in a wide range. The relative importance of the biomass materials in terms of methane production in the descending order is found to be:

IFL, CFL, BP, IFPS, RS, ML, WS, DG and CD.

On the basis of this study, it can be stated that a number of crop/plant residues could be successfully used as substitutes or supplement to cattle dung for biogas generation and an appreciable improvement in biogas production could be brought about by judicious blending of biomass materials, preincubation, pretreatment, stirring and control of pH, TVFA, temperature and particle size of the substrate.