Utilization of Agricultural Wastes for Biogas Production in Indonesia

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Abstract

Indonesia has been facing the fuel energy problems in some parts of the country, especially in rural areas. In order to reduce dependence on commercial energy, steps have been taken to develop an alternative source, such as biogas. The main constraints for installing a digester, however, are the initial investment cost and the competition over kerosene. In this paper, the application of an anaerobic process for biogas production from cassava solid waste, water hyacinth, and manures are explained.

Key Words: Biogas, Methane, Energy, Anaerobic digestion, Pollution control, Agricultural wastes, Indonesia

Introduction

Most of the Indonesian population live in rural areas. According to 1990 census, they are about 69.07% of the total population (1). They are using non commercial energy such as firewood and agricultural wastes as much as 40% of total national energy consumption (2). Survey on rural energy done in 1990 revealed that about 88% of rural families used firewood, and only 17% of them used charcoal and agricultural wastes as an energy source for cooking (3). High consumption on firewood can lead to destruction of forest and the environment; therefore, the need to utilize more agricultural wastes as an energy source is apparent. Recently, diversification on the use of energy has increasingly become an important issue because the oil sources are depleting. Up to now, commercial energy (oil and gas) is still an important export commodity and a source of devisa income for Indonesia. However, it was estimated that in the early of year of 2000, Indonesia will become a net oil importer if new oil sources are not found and the domestic consumption on commercial energy is maintained at the same rate (2).

Various kinds of agricultural wastes are generated in Indonesia. Some of these wastes, listed in Table 1, are potential to be used as raw materials for biogas production. The process (anaerobic digestion) converts organic materials into methane which can be used as an energy source. Utilization of agricultural wastes for biogas production can minimize the consumption of commercial energy source such as kerosene as well as the consumption of firewood. In addition, the anaerobic digestion process reduces the content of organic pollutant that can be hazardous to the environment. Three examples of the application of this process, treatment of cassava solid

waste which is polluted river around tapioca starch industry, treatment of water hyacinth which is problematic to Curug dam, and utilization of manures, are explained in this paper.

In the anaerobic digestion process, organic matter is digested in the absence of air. The degradation of the large molecule, such as agricultural wastes, is carried out in three stages. The first stage is known as liquefaction where complex organic materials in solid forms are broken down by external enzymes into soluble forms. The second stage is the acid formation where the bacteria produce volatile fatty acids such as acetic, propionic and butyric acids. Carbon dioxide and hydrogen will also be liberated in this stage. The third stage is the methane formation where the methanogenic bacteria utilize products of the second stage and convert them into methane.

The Implementation of Biogas Technology in Indonesia

Some programs have been carried out by the government of Indonesia to promote the use of biogas technology, such as installing a demonstration plant and training for the public to operate the digester. However, biogas has not yet been popular in rural areas. In 1984, the number of biogas digester installed in Indonesia was only 100 units (5). Nine years later, this number increased to only 350 units (3). The reason for the insignificant increase in the number of installed biogas digester was more on the expensive capital cost to install the digester. In addition, kerosene has been relatively inexpensive due to government subsidies on commercial energy.

There are many research activities in biogas technology carried out by research centers and universities in Indonesia. The raw materials used for biogas production are agricultural wastes, ranging from animal manures to a diverse selection of crop residues. Cassava solid waste, water hyacinth, and animal manure are among the agricultural wastes that have been reported in more detail and will be explained in the following sections. In general, the use of crop residues as the materials for biogas production is more difficult than that of manure. The reason is that hydrolysis of cellulosic materials of crop residues is known to be a slow process and can be a major rate limiting factor in the anaerobic digestion. In addition, the imbalance ratio of carbon to nitrogen of the raw materials can limit the rate of organic conversion into methane.

Biogas Production from Water Hyacinth

Water hyacinth (*Eichhornia crassipes*) is one of the aquatic weeds found abundantly in some areas of Indonesia. It has a very high growth rate, and in huge amount this aquatic weed can create problems such as blocking waterways and irrigation. At Curug dam, Purwakarta, West Java, the production of water hyacinth was estimated to be 4.9 ton/day in 1977. Studies on the use of water hyacinth into biogas was done by Institute for Ecology, Padjadjaran University in Bandung (9).

The digester was built from ferro cement with total volume of 1 m3, and a 0.5 1 m3 gas holder was placed on top of the digester. Cattle manure was used as the inoculum at the beginning of the process. Before being fed into the digester, water hyacinth was treated by washing with water to remove dirt and then it was cut into pieces. Water content of the fresh water hyacinth was 89.5% and the ratio of carbon to nitrogen was 27. The biogas produced from

the process was 620 L/kg dry water hyacinth with methane content of 52%. This amount was obtained when only part of leaves and stalk used for digestion. If the whole part of the plant (including shoot) was fed into the digester, biogas production dropped to 331.4 L/kg dry weight. This gas was used to boil water. It was found that biogas consumed to boil two liters of water was 83 liters and the time needed was 35 minutes.