Development of Biogas Processing for Small Scale Cattle Farm in Indonesia

Dr. Teguh Wikan Widodo and Dr. Agung Hendriadi

Indonesian Center for Agricultural Engineering Research and Development (ICAERD)
Tromol Pos 2 Serpong, Tangerang, Banten 15310 Indonesia
E-mail: teguh_wikan_widodo@yahoo.com

ABSTRACT

Small scale cattle farm in Indonesia in average has 2 – 5 heads that spread on wide area. Such conditions made difficult to handle the waste wisely by integration to the farming system in order to minimize negative effects on environment. Generally, farmer manage the waste in simple way, such as by composting or spread directly into farming field. To improve animal husbandry sector, Ministry of Agriculture (MOA) introduced several policies on development of animal husbandry, i.e., cooperation, nucleus plasma scheme, special regional development for animal husbandry, integrated region, crop-livestock-system (CLS) and agropolitan. In relation to policies implementation, it is possible that development regions could be used as target of zero waste concept application on agricultural farming practices by sustainable and environmental friendly ways. Therefore, in 2005 ICAERD has been developing a digester for small scale cattle farm. Digester was disigned for 18 m^3 capacity of cattle dung from about 10 – 12 heads. Based on design calculation, digester could produce biogas 6 m^3/ day that will be used to generate stove and lighting. Moreover, effluent is applied to farm field or pond as fertilizer. Further development of our research, it is planned for bottling of biogas and generating the combustion engine as electric or mechanical power. However, it was identified that biogas technology development had several constrains such as: lack of technical expertise, misfunction of digester (leak, miscontruction,etc.), design was not user friendly, need manually handling (when feeding/ taking out effluent from digester), and cost for construction was expensive. Thus, it is needed a strategy and strong comitment from every component, e.g. society, government and stake holders, for supporting development of biogas technology.

Keywords : waste management, cattle farm, cow dung, biogas digester system, renewable energy, sustainable, agricultural development.

Introduction

Energy consumption in Indonesia has been expanding at relatively high rate, with an average of 10% during period of 1970-2002 [2]. Energy fossil sources mainly come from oil, natural gas and coal. These fossil energy resources, if new reserves can not be found, the oil reserves will be depleted in ten years, natural gas in 30 years and coal is more than 50 years. Indonesia is blessed with abundant potential of renewable energy like geothermal, hydropower, biomass, solar energy, and wind energy. However, the utilization of renewable energy in Indonesia is still very low compare to its huge potential.

Energy in form of electricity has been an important element in achieving national development goals. Availability of electricity in term of sufficient quantity and quality at affordable prices will stimulate economic growth. However, according to the data [2], the electrification ratio in 2002 is only around 52%. It is, therefore, increasing this electrification is urgently needed. In relation with the depletion of energy fossil and environmental degradation, developing new power plant based on renewable energy and technology improvement to increase efficiency use of energy are the best way to fulfill the electrification requirement.

As effect of rising oil price, provision of basic energy need for rural household especially for cooking and lighting become a critical energy issue. It is roughly estimated that rural household requires about 115 MJ/HH/d of energy for cooking which is equivalent to about 49,9 BOE/cap/y. About 80% of this energy needs is fulfilled using fuel wood or agricultural wastes and if accounted in terms of national energy consumption the total share is still significant [1].

Biogas energy is one of some renewable energy sources, it could be found from sewage, liquid manure of hens, cattle, pigs, organic waste from market, food industry, and so on. Biogas production enables a sustainable agriculture with renewable and environmental friendly process system. Generally, biogas contains methane gas (CH_4) about 55 up to 80%. Methane gas that is produced from manure is around 4800-6700 Kcal/ m^3. As compare with pure methane gas contain energy of 8900 Kcal/ m^3. Biogas production systems have several benefits, such as (a) eliminating greenhouse gas, (b) reduction of odor (c) betterment of fertilizer (d) production of heat and power [6, 8, 12, 13].

Some constraints related to develop a renewable energy, including biogas, are its availability, security of supplies, price, ease of handling and ease of use. In addition, external factors like technological development, introduction of subsidies, environmental constraints and legislation play the role in bringing its development [7]. In Indonesian agricultural, still lack of a national professional institution which responsible in managing energy conservation and its efficiency use. Considering the potential of biogas production and its utilization in agriculture at rural area, Indonesian Centre for Agricultural Engineering Research and Development (ICAERD), AARD, MOA desire to participate in implementing researches on that renewable energy. The objectives of the project are (1) to develop small scale biogas production unit and utilize it for sustainable agriculture in rural area, (2) to develop an information center of biogas energy (3) to promote zero waste concept on agricultural farming practices by sustainable and environmentally friendly ways.

Role of Agricultural Mechanization

By research and develoment of biogas technology, ICAERD could play a role in efforts to help the government in solving the problem of oil crisis in Indonesia recently. Oil price is very high, therefore government consider to reduce oil subsidy. Technology biogas is became possible to be used as energy alternatif because of its competitivenss with conventional energy. Moreover, biogas also potential to be developed in centers of animal husbandry development that the waste is not optimally utilize yet and generating environmental problems[10].

Although Indonesia is one of oil and gas producer country, however, depletion of oil reserve and decretion of environmental quality, it caused Indonesia utilize renewable energy as alternative resources that its availability are huge. Biogas is one energy resource that could

fulfil the need of energy and organic fertilizer for a sustainable agriculture and healthy environment.

Biogas production needs a digester. Digester could reduce methane gas (CH_4) emission by decomposition of organic matter from agriculture and animal husbandry sectors. Using digester, cow dung is fermented and resulted methane gas (CH_4). Methane gas is one of glasshouse gas that could affect to global warming. Local efforts for reduction of methane gas would be have a positive efect to global climate change. Indirectly, it also indicate a participation of international program, namely Clean Development Mechanism (CDM) of Kyoto Protocol.

Biogas Technology Development in ICAERD

In 2005, ICAERD has been developing a fixed dome type digester for 10 heads of cow with cow dung of 20kg/day/head, retention time 45 day and digester capacity is 18 m^3. Estimated biogas production is 6 m^3/ day (with average biogas production of 30 liters gas/ kg cow dung). Schematic flows of biogas processing are shown in Figure 1. Building of construction was conducted in 3 steps, as follows: (1) water reservoir (2) design and development of digester, gas holder and purification of methane gas, and (3) analysis of biogas quality and analysis of environmental impacts. Figure 2 and Figure 3 are design drawing and realization of construction building, respectively. Biogas is utilized for stove and lighting as shown in Figure 4 and Figure 5 [11].

Further development, in 2006, biogas utilization are planned to several uses such as gas bottling and generating combustion engine for electric generator and/or other utilization such as generating chopper, mixer for animal feeding, etc.

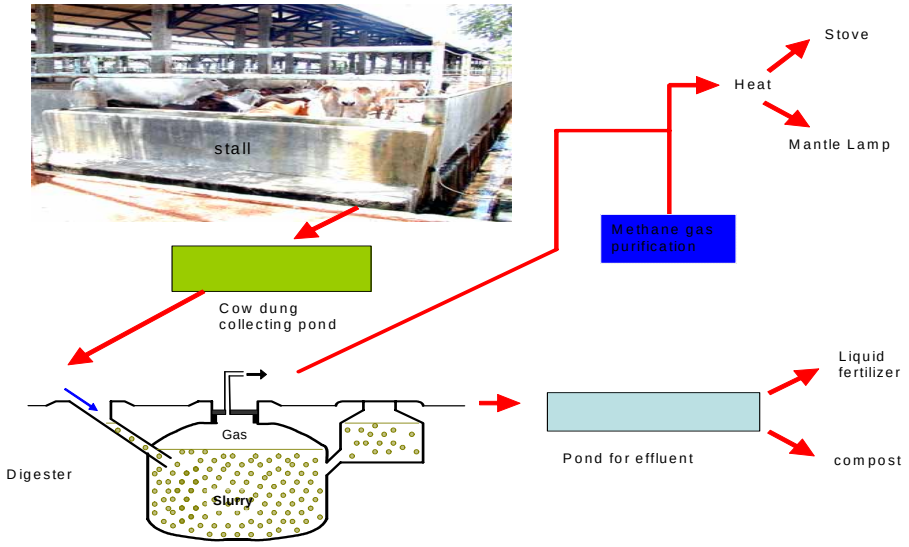

Figure 1. Schematic flow of Biogas Processing

Strategies for Biogas Technology Development

1. Integrated System and Assessment of Bioenergy

The economic, social , environmental, and ecological consequences in growing and using biomass are important to understand and consider when addressing technological, market, and policy issues associated with bioenergy systems. It is therefore, some economic issues concerning the use and development of bio-energy as renewable energy sources are considered as follows [5] :

a. Sustainable Development

In regard to agricultural development as the fundamental of the national economic development for the developing countries such as Indonesia, biomass and bio-energy technologies are one approach to moving our economy to a more sustainable basis because they move us away from fossil fuels. One of the biggest impediments to sustainable development is our economic system that places little value on the environment or on the future.

b. Energy Security

For the countries which are categorized as an oil importing countries, as a domestic energy source, bio energy can substantially reduce dependence on imported crude oil. But in te long run, the oil exporting countries such as Indonesia, should considered the potential used and development of using bio-fuel as the alternative source for energy. Biomass is more evenly distributed over the earth's surface than other finite energy sources and therefore provides opportunities for local, regional, and national energy self-sufficiency.

c. Rural Economic Growth

Producing biomass and using agricultural residues for bio energy technologies will stimulate rural development efforts in farming, forestry, and associated service industries by creating new products, markets, and jobs. Technology innovation should be strongly directed to utilized more local and renewable resources, that is beneficial for the welfare of the people and finally the nation. Renewable energy resources should be dedicated for the social and economic welfare of the rural people.

d. Environmental Issues

Every nation in the world is now understand, that bio energy technologies are friendlier to the environment than conventional energy technologies, which rely on fossil fuels. We also deeply understood that fossil fuels contribute significantly to many of the environmental problems we face to day – greenhouse gases, air pollution, and water and soil contamination. Development of science and technology provide us understanding and knowledge, that bio-energy could help us break our conventional pattern of energy use to improve the quality of our environment.

2. Development at Agribusiness Region

In India and China, biogas technology development has been running fastly. In 1998, India had 12 million units biogas processing instalation for generating 17000 MW electricity. While China had 9 million units processing instalation with estimation gas production of 62000 – 145000 million m^3. Indonesia has potential of biogas energy 684.83 MW with installed capacity of 0.06 MW or only $8.76 \cdot 10^3$ % was utilized [2, 9].

Biogas technology development (cow dung) in Indonesia has a good prospect because of development of animal husbandry at several agribusiness regions [3,4], such as:

a. Special region for animal husbandry

Cow milk region (Jest Java and East Java Province) and beef cattle (Nangroe Aceh Darussalam, West Sumatra, South Sumatra); Java (Central Java, East Java and Yogyakarta); and East Indonesia region (South Sulawesi, Nusa Tenggara Timur, Nusa Tenggara Barat and Bali).

b. Integration region

Integration region of palm oil and cattle: Bengkulu Province.

c. Agropolitan

West Sumatra Province (Agam District) and South Sulawesi Province (Barru District), each region has main commodity of animal husbandry.

Biogas technology development in Indonesia could be conducted by strategy ways with consideration and analysis of Strength, Weakness, Opportunity and Threat (SWOT), as shown in Table 1.

3. Tripartite Cooperation

Many sides that competences realize that the huge potency of biomass of agricultural waste could be utilized as a solution on energy crises. Therefore, it is needed a synergic cooperation among governmental body, researcher and businessman in renewable energy field. This tripartite cooperation should answer (1) database to identify the real potency of biomass and its distribution at all over Indonesia region, (2) expertise sharing for stabilizing an applicable biomass processing technology, (3) governmental policy on development and utilization of renewable energy, including an incentive reward for increasing invest on renewable energy business (Figure 6)[5].

Conclusions

1. Wastes of cattle farm enable environmental pollution (soil, water, air and biology). These polutions have been implicated as a cause of decrease quality of life for neighboring communities, with additional possible negative consequences on human health and welfare.

2. Development regions could be used as target of zero waste concept application on agricultural farming practices by sustainable and environmental friendly ways. Development of biogas technology should follow government policies and development strategies to apply this concept.

3. It was identified that biogas technology development had several constrains such as: lack of technical expertise, misfunction of digester (leak, miscontruction,etc.), design was not user friendly, need manually handling (when feeding/ taking out effluent from digester), and cost for construction was expensive. Therefore, for supporting development of biogas technology, it is needed a strategy and strong comitment from every component, e.g. society, government and stake holders.

Tablel 1. Strategy for development of biogas technology by SWOT analysis [9].

INTERNAL FACTOR EXTERNAL FACTOR	**STRENGTH** ▪ Potential for regional development ▪ Excellent genetic of local cow ▪ Adequate number of manpower ▪ Rising prosperity of community, it become a potential market ▪ Awareness for using energy alternatives that environmentally friendly and sustainable, also Clean Development Mechanism (CDM)	**WEAKNESS** • Construction cost is expensive • Lack of skilled labor • Other utilization of waste
OPPORTUNITY o Free from foot-and-mouth desease and mad cow o Government policy on animal husbandy development o No subsidy of fossil fuel o Rising of electricity tariff o Environmental issues	**SO STRATEGY** • Biogas technology introduction in the region for animal husbandry development • Make use of existed institution	**WO STRATEGY** ❖ Green labeling product for production process using green energy and organic farming to increase the product price
THREAT o Bank interest of loan is high o Construction material is expensive o Illegal import of meat	**ST STRATEGY** • Make use of group/ cooperation of advanced breeder as a center of model at the region	**WT STRATEGY** o Development program by mutual cooperation and rolling capital

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