AGRICULTURAL BIOGAS PLANTS – WORLDWIDE

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Summary

There are biogas plants all over the world. But the technical development level varies greatly. In Asia there have been millions of low-tech, hand-made biogas plants in operation for decades. In Europe there have been high-tech, turn-key biogas plants in operation for no more than 10 or 15 years – if at all. The developmental state of the biogas plants in the rest of the world lies between these limits.

More advanced treatment options are being developed in order to deliver total solutions for the further treatment of digested manure that result in provision of drinking-water quality and fertilizer/compost. Here, too, Europe provides the state-of-the-art technology that will also influence densely populated countries, like Japan and Korea, in the near future.

Although there are many sophisticated solutions in the meantime, we should be aware that we still treat a digester more or less as a black box and that no one really knows what happens in this box at any given moment. Measurements are made – if at all – only on a very limited scale and are generally not published. Some operators have a great deal of experience with their own biogas plant but no scientific background. Some scientists have masses of measured data but cannot transfer their technology to practical applications.

Keywords: biogas, biogas plant, worldwide, state of the art

1. INTRODUCTION

The microbiological production of a methane-rich gas has been occurring on earth for billions of years. We have to be aware of the fact human beings have only recently begun use bacteria in more or less optimised plants to produce biogas for their own use.

Although biogas is a well-known word worldwide, its definition varies greatly from one region to another. In this context – as it is the general definition worldwide – biogas is the gas produced microbiologically from organic waste treatment. The wastes utilised can be manure, kitchen waste, biowaste, brewery residues, organic sludges, but in general they are solid wastes. In most cases biogas plants are fed with animal manure and/or dung and, additionally, with some other organics like market waste, fruit, etc.

Just as there are many definitions for the term “biogas”, there are also many different reasons for constructing a biogas plant. In China and India the main reason has been to produce energy and use it for cooking and lighting. Obviously, in Arabia there is no need for energy production. The main reason there is to reduce olfactory pollution and to obtain good fertiliser for soil conditioning. In Western Europe there is political pressure for developing renewable energy, and the farmers – most of the financers and operators are farmers – do it because they can earn money with it.

2. BIOGAS PLANTS IN ASIA

In China there are many millions of biogas plants. Nobody knows exactly how many but most people guess between six and seven million. It is very uncertain whether they are still all in operation. In India there is a similar situation with about one million biogas plants.

Those plants are hand-made with underground, non-insulated digesters. The design is very simple design, but the plants are cheap and effective. They are feded with animal dung and organice residues from the house in a fed-batch mode. Once a year they are emptied and the digested substrate is given to the fields as a fertiliser. The biogas is collected and used for cooking and lighting.

Although reports written by non-Asians usually only mention developments in China and India, there are also biogas plants in operation in many other countries, for example: Vietnam, Thailand, etc. Asians have a great deal of experience in operating low-budget biogas. In addition, there are many universities and institutes devoting part of their research effort to improving biogas technology. Against this background, it becomes obvious that Asians are among the most knowledgable about the biology and chemistry of biogas production from agricultural residues. It is just the lack of money which prevents the countries from producing more regenerative energy from organic solid waste.

In only two countries in Asia is this general description inaccurate: Japan and Korea. In the past three or four years Japan has developed a biogas market with state-of-the-art agricultural biogas plants. In this context, I use the term state-of-the-art in the European sense: Many German, Danish and Austrian companies have entered the Japanese market and have sold licences to several Japanese general contractors.

For this reason, meanwhile, there are some biogas plants in operation in Japan. On the one hand, these have been constructed for biowaste treatment (source-separated organic waste from households and restaurants) and on the other hand, for manure treatment. Similar to the situation in Denmark and Germany there are some large, centralised biogas plants and some small farm-scale plants.

In Korea the situation is similar, but at a stage which existed in Japan about two or three years ago.

3. BIOGAS PLANTS IN AUSTRALIA / NEW ZEELAND

In both countries there are just a few pilot plants for treating animal residues. At some universities such plants have been in operation for some time.

In Australia one large biogas plant for treating source-sparated waste is to be built with a licence from Germany.

4. BIOGAS PLANTS IN NORTH AND SOUTH AMERICA

There are many anaerobic waste water treatment plants in operation in South America but thus far hardly any information on anaerobic solid waste treatment is available. Although there have been some efforts to implement such plants, they have been unsuccessful to date, mainly because of a lack of money.

In North America the situation is similar but changing. Although the USA did not sign the Kyoto protocol, there is a strong movement towards use of renewable energy. There is a similar development in Canada.

Originally, there were many investigations on anaerobic solid waste treatment being conducted at North American universities. Evidence of this can still be found in many written reports from the sixties and seventies. But in the mid-seventies a major failure occurred in a biogas plant being constructed in Florida. This setback had a bad influence on all further developments.

Today, there is again great interest in the planning and construction of biogas plants in North America. But developments are still the planning phase. First contacts have been established with more experienced European companies but there are nearly no plants in operation at present.

5. BIOGAS PLANTS IN EUROPE

In the mid-eighties the first steps were taken in Denmark and the former East Germany to develop large centralised biogas plants. At about the same time in the fomer West Germany the main interest was in farm-scale biogas plant development. Today, in both countries – Denmark and Germany – there is a large variety of small-, medium- and large sized biogas plants in operation. Although the construction of new plants in Denmark is much slower than it is in Germany, the technological standard is still about the same and the most highly developed worldwide. Another report with the title „Planning and Construction of agricultural Biogas Plants“, which will also be presented here, will provide more technical details about this topic. In a few other countries, such as Austria and Switzerland, the development is just a little bit behind the developmental situation mentioned above. This is mainly due to the national agricultural structure, as both of these countries have primarily small and very small farms. In Sweden there are also quite a few large plants.

In another few countries, for example Spain, Italy, Belgium and the Netherlands the first biogas plants are under construction or in operation. It will just take a few years and the development will have reached a state similar to that existing in Germany and Denmark now. But, especially in Spain and in the Netherlands, there are some very specific developments which possibly will change the state of the art of all biogas plants.

Although the funding for every electrical kWh delivered to the public power grid in the Netherlands is similar to the funding in Germany – just a little bit lower – there is no incentive for a Dutch farmer to construct a biogas plant. Because of the rigid laws for environmental protection the Dutch farmer has a nitrogen and phosphorus problem with his manure, which has to be solved. In the Netherlands there is just not enough free space to enable all the farmers to get rid of their manure. The Dutch farmer does not need a biogas plant – he just wants somebody to take away the manure. Right now a common price for 1 m³ of manure disposal is between 10,- and 15,- Euros.

Since standard biogas plants do not alter the quantities of nitrogen and phosphorus present in the original waste, another treatment of the digested substrate is required in order to reduce the quantities of these substances. This is called a total or complete solution and can be, for example,

- A biogas plant + membrane technology,
- A biogas plant + evaporation treatment,
- A biogas plant + MAP-treatment.

In each case there will be a concentration of the nutrients, which can be then transported easily. The main part of the manure, water, will be treated to such an extent that the direct input into a river or lake will be possible. Depending on the process, more or less potable water will be produced from manure.

In Spain the situation is different. Although in some parts of the country the situation is similar to the one in the Netherlands, the reason for total treatment has another background: the funding. The regulations in Spain are such that they construct large natural gas power stations and use the thermal energy to evaporate manure. At present, there are several projects based on electrical power production by natural gas of about 15 MW per year. Additionally, one or two MW per year will be produced from about 100,000 m³ of manure. The digested manure is to be

evaporated by use of the thermal energy from the electrical production from natural gas and biogas.

As a result of this policy, biogas plants have a bad reputation in Spain. No one wants to live near a plant that emits the odor resulting from the evaporation of 100,000 or even more cubic meters of manure per year.

There are several other countries in Europe that are interested in biogas plant development, for example Poland, Hungary, Lithuania, England, Ireland. In some of these countries, especially in Poland, political decisions have been made to fund regenerative energies. Others will follow.

According to this experience of biogas plant development in Europe in the past 15 years it can be said that it is just a matter of time until there are political decisions for funding renewable energies. Each country has got its own developmental rate, and this shows that it is not possible to develop these energies without political activity – as was the case in the development of coal and nuclear power many years ago.

6. SUMMARY

There seems to be a rule that civilised countries need more and more meat to feed their populations. This has an impact on the environment. To reduce this impact, some more or less developed technology has to be implemented. The smaller and more densely populated a country is, the more sophisticated its solutions for the treatment of animal excrements will be, as a rule.

There is no real technical standard for biogas plants that is applicable worldwide. The differences in biogas plants are simply too large and the reasons for constructing them are just too different to allow a single definition. In principle, the process is so easy that it can be performed worldwide: heat some manure and you cannot avoid to gaining biogas. But, ultimately, there are as many solutions as there are countries in the world.

Even today we have no real insight in the biological and chemical processes within a biogas digester. Of course, in theory we do know quite a lot. But in reality we have a kind of black box. Measurements are made – if at all – only at a very limited scale and are generally not published. Some operators have a great deal of experience with their own biogas plant but no scientific background. Some scientists have masses of measured data but cannot transfer their technology to feasable applications. The contents of digester is mixed and heated, and then biogas comes out of the digester. This is state-of-the-art biogas plant operation – worldwide.