

BIOGAS TECHNOLOGY AND ECOLOGICAL ENVIRONMENT DEVELOPMENT IN RURAL AREAS OF CHINA

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China is a country rich in renewable energy sources. Biogas technology has developed very fast in China. However, inadequate utilization of energy has resulted in the deterioration of the environment and in serious pollution. The development of renewable energy will help in reducing the ever-increasing consumption of petrochemical energy and the resulting pollution. As forecasted by experts, renewable energy will become the main part of energy supply after the middle of the 21st century. 30 years practice has proved that biogas digesters not only produce clean energy but have also made important contributions to the protection of the rural environment.

Biogas development has gone through 20 years in China. More than 8 million family biogas digesters and 800 large biogas plants had been built all around our country by the end of 2000. "Energy environment projects" and "ecological garden projects" are combined with biogas technology, agricultural production and environmental protection. By doing so, a particular model of crop production and animal husbandry has taken shape in rural areas. The biogas project has greatly promoted ecological agriculture and the environment.

1. Biogas technology development in rural areas

Biogas projects aim at providing a complete set of equipment that can turn organic wastes into clean biogas and efficient fertilizer by anaerobic processes. The equipment may be a simple device for family use or large size plant to treat agricultural waste. It can provide clean energy for our everyday life, produce forage and fertilizer for agriculture, soak seeds, prevent insect pest, increase output of plants and fruits, and improve the soil. With the popularization of biogas technology, the hygiene of pigsty and toilet have been notably improved and the breeding of mosquitoes, flies and harmful germs prevented. As a result, the development of biogas has benefited the environment, the standard of living and economic development. It has brought about great changes in China's rural areas.

During the past years of biogas development different models have emerged in different areas of China according to the requirements of the local situation. There is no doubt that biogas technology can keep advancing and bring even more benefits to us.

2. The ecological courtyard model in northern China

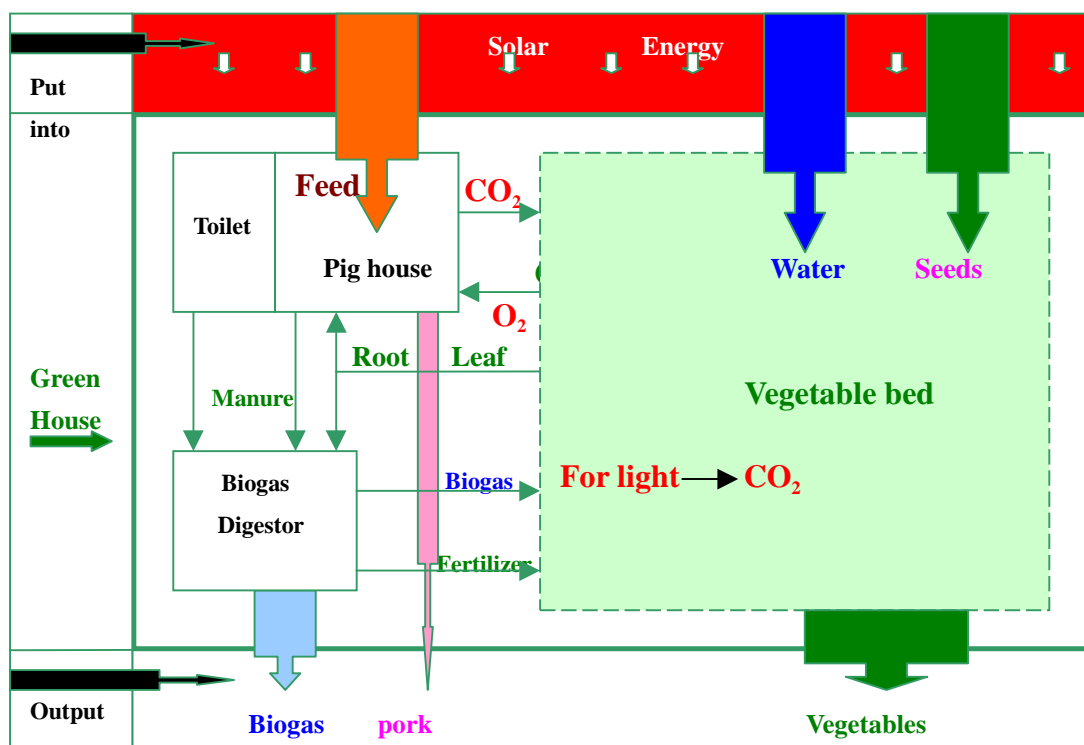
The development of ecological courtyard models in northern rural areas began in 1980s. This model optimizes and combines greenhouse, pigsty, biogas digester and toilet in the farmer's courtyard, and forms a "quaternity" system of solar energy, biogas, planting and animal husbandry. All these interact and complement each other to form a virtually perfect mini-ecological system. At the same time it improves the environment and the economy.

The typical structure is like this: a greenhouse is built in the yard, underground is a biogas digester, on which a solar pigsty and toilet are built. Thus human and animal excreta drop

directly into the biogas digester. The greenhouse is using solar energy, biogas lighting, biogas fertilizer and CO₂ from the digester. Farmers can get clean energy and safe agriculture products and byproducts thus increasing their income several times. They now all live in a cleaner environment.

With the development of intensive farming, large scale planting has been advocated. Since the early 90s, the ecological courtyard model has gradually expanded from farmers' yard to large fields. The typical unit is like this: the area of a greenhouse is about 0.5-1.0 mu (1 mu=667m²), the volume of a biogas digester is 8-12 m³, and a solar pigsty covers an area of 20 m². Its scientific and effective management ensures high benefit. In this system, human and animal excreta go directly into the digester where they are sanitized; biogas is used as a source of light and as fuel, also providing CO₂ for the vegetables in the greenhouse; biogas liquid is used as a fertilizer for vegetables and fruit; biogas residues are used as base fertilizer to improve the soil.

Because pigsty and biogas digester are built in the greenhouse, the warm environment is good for pig growth. Thus pigs grow quickly and a lot of feed is saved. Moreover, the biogas digester can easily operate throughout winter in cold areas. Pigsty and greenhouse are built together, oxygen and CO₂ from planting and pig industry can complement each other, output of crops increases and quality of vegetables and fruits improves. The rural courtyard ecological system provides an effective, practical, and scientific model for the development of ecological agriculture in China.



Courtyard biology System

This system has distinct economic, social and environmental benefits. Compared with the old method, more pigs can be raised in this system. Vegetables do not need any chemical fertilizer, and their output increases by 20-30 %. More than RMB5,000 can be earned from a courtyard of “quaternity” (greenhouse, biogas, pigsty and toilet) every year. For example, there are 5,560 courtyards of “quaternity” in Dawa County of Liaoning Province. Annual average income is RMB 6,260. Net income from field of “quaternity”

amounts to RMB 10,000-28,000 per year. In Feitun Village of Pulandian District there are 213 fields of “quaternity” – they can produce more than RMB 14,000 per mu. By the end of 1999 there are 172,000 “quaternity” only in Liaoning Province.

From the perspective of financial analysis or national economic analysis, investment of “quaternity” can gain profit.

The social benefits of this model are notable. “Quaternity” can provide safe vegetables and fruit. Each unit can contribute RMB 17,000 and RMB 590 of tax annually. Besides, it can stimulate development of related industries. Each unit can provide jobs for two labourers. On the other hand, “quaternity” has changed production and living habits of farmers in cold northern areas, keeping them busy also in winter and earning money all year round.

The environment has been greatly improved. In the past, farmers’ courtyard s tended to be dirty and disorderly. Now they are tidy, clean and hygienic. Each family has a clean pigsty and toilet. Organic wastes are processed in the biogas digester, environment pollution is prevented and disease is reduced. According to statistics, the rate of intestinal infectious disease in “quaternity” villags has decreased by 29-33% compared to “non-quaternity” village. Enteritis has also decreased notably. For example, the rate of enteritis in pigs, chicken and ducks has decreased by 72%, 52% and 82% respectively. All these are typical achievements of the system.

The soil in greenhouses can be improved and sanitized. According to tests, the porosity of the soil has increased by 15% within three years after biogas sludge was being used as a fertilizer. Soil pH has hardly changed (when chemical fertilizer is used pH will decrease every year). Organic matter has increased by 0.98% within three years. When biogas sludge is used as fertilizer soil fertility increases every year. It can also prevent soil from becoming acid, and provide a good environment for greenhouse crop growth.

3. The ecological “pig-biogas-fruit” model in southern China

The ecological “pig-biogas-fruit” model in southern China is formed by combining biogas with agricultural and ecological environmental development. The “pig-biogas-fruit” model is a project of ecological agriculture and environmental protection, which aims at developing related areas, such as animal husbandry, fruit and agriculture production and environment together. Concretely, “every family builds a biogas digester, sells two pigs per capita per year, plants one-mu fruits per capita”, which results in “a greatly improved ecological environment”. Take Ganzhou for an example. The “pig-biogas-fruit” project has improved rural environment and accelerated development in the countryside. Farmers use biogas as fuel; excreta go into the biogas digester and are fermented through anaerobic digestion; mosquitoes and flies cannot breed, and parasites and pathogen are killed in the digester. As a result infectious diseases have decreased, and farmers’ health improved. The whole village takes on a different look. Because farmers do not use firewood as fuel, they will not cut down trees randomly. In Ganzhou a 6m³ biogas digester can save 25 ton firewood every year. The “pig-biogas-fruit” project has been developed on a large scale in this area, so the rate of vegetation has increased from 436% in 1982 to 853% in 1995.

4. Biogas project for greywater sanitization

Biogas digesters for greywater sanitization can be used in small towns suburban areas without adequate drainage system. Greywater treatment by biogas digesters has its own distinct features: separate investment; easy to raise money; local treatment; low transport cost; no need for special management; no need for energy; built underground and thus no

need for land. Pilot projects in various places have achieved satisfactory hygienic and environment standards. Based on our national situation, biogas project is an effective approach to separate treatment of greywater in urban areas.

“Resolution of problems on environment protection” issued by State Department states: In cities of less than 500,000 people greywater treatment is by separate approach since quite a long time. There are 500 such cities. Biogas technology as a practical system for greywater sanitization has been approved by the authorities. It will be of great importance in treating water pollution and improving ecological environment.

Since the 90s, the pace of urban growth has increased in our country. Till 2000 drainage of greywater has amounted to $223 \times 10^8 \text{m}^3$ per year, while in 1995 biogas digesters in cities could only handle $1 \times 10^8 \text{m}^3$ greywater per year.

It costs less to treat greywater in biogas digesters. Also biogas digster is of notable help to prevent environment pollution, especially to control infectious disease. So it applies to developing countries. Chinese biogas digester for greywater sanitization in towns has drawn attention of other developing countries. Besides, we have begun international assistance and cooperation in this field.

The development of biogas digester for greywater sanitization should be correspondent with city planning. More than 95% greywater can reach the discharge standard after treatment. This treated water can be used to irrigate greenbelt, clean streets, and wash cars to ease serious lack of water in our country.