Food Waste Disposal Using Anaerobic Digestion

Summary

The ever-increasing quantity and high moisture and salt content of Korean food waste cause problems with its disposal. Highly urbanised and populated towns do not have enough space for landfill sites and the high moisture content of food waste does not allow effective incineration and energy recovery.

A plant at Anyang City has demonstrated a two-phase anaerobic digestion system which successfully processes municipal solid waste containing food waste to produce compost, biogas and recovered materials.

Highlights

- Food wastes converted to a combustible gas
- Cheaper alternative to incineration for the disposal of food wastes
Project Background

In 1991, Korea disposed of 92,200 tonnes/day of municipal solid waste (MSW). By 1994, this had decreased to 58,000 tonnes/day following the enforcement, since 1991, of source-sorting of recyclable materials such as paper, plastics and bottles. However, the proportion of the food waste component in MSW is gradually increasing, from 27% in 1991 to 50% in 1995. Food waste is difficult to treat or recycle since it contains high levels of sodium salt and moisture and is mixed with other waste during collection.

In 1992, a proposal to develop a process for the disposal of food waste was submitted by the Korea Institute of Energy Research (KIER) to the Ministry of Trade, Industry and Energy (MOTIE). A basic study for the process development, investigating the biochemical methane potential (BMP) of waste food components in Korea, began in 1993, with the help of government funding.

The concept of two-phase digestion was developed using bench-scale and mini-pilot units in 1994 and 1995. In 1996, a pilot-scale plant, with a treatment capacity of 5 tonnes/day of food waste, was funded, constructed and operated by Halla Engineering and Heavy Industries Ltd, in cooperation with KIER. Details of the pilot-scale plant are described in this brochure. More recently, a full-scale 15 tonnes/day food waste treatment plant was built in Euiwang City, near Seoul, and started operation in March 1997.

The Project

The pilot-scale plant is located at the Anyang city incineration plant site and the city co-operates in the collection and supply of source-sorted food waste. The whole process consists of four different steps: pre-treatment, digestion, composting and gas utilisation.

The pre-treatment step is the removal of non-degradable waste. The waste (in plastic bags) is stored in a bunker before being fed to a shredder. The shredded material is passed to a 50 mm drum screen to remove light fractions such as plastic bags, clothes and wooden materials. A magnetic separator removes ferric components such as bottle tops.

The moist and heavy waste stream from the drum screen is fed into an acid reactor where the sedimentation of heavy objects such as bones and shells occurs together with the acidification of organic materials. The acid reactor is mildly agitated to ensure mixing and is equipped with a skimmer to remove some remaining light fractions such as pieces of plastic and light vegetables which float to the top surface of the liquid in the reactor.

In the second step, the uniformly suspended food wastes are hydrolysed and degraded to organic acids in the acid reactor. The fluid, which contains a high concentration of acid, is pumped into the methane reactor where the acids are converted to methane. The almost ‘organic-free’ alkaline overflow from the methane reactor is recycled to the acid reactor to prevent excessive acidification of the acid reactor.

Part of the slowly degrading organics and anaerobic sludges are withdrawn from the methane reactor, dehydrated in a screw press, and fed into an aerobic composter, where the humus (anaerobically-stabilised organics) is treated aerobically to produce completely stabilised organic fertiliser.

The biogas produced in the reactors contains about 70% methane and is temporarily stored in a gas holder. The gas can be used for cooling/heating of adjacent facilities, for electricity generation or as a combustion aid in an incinerator.

This anaerobic treatment process has several advantages over conventional anaerobic treatments of organic wastes:

- the process is a two-phase system with two reactors (an acid reactor and a methane reactor) in series, where the acid reactor functions as a pre-treatment tank as well as an acidification reaction tank to remove the heavy and light rejects;

- the anaerobic digester type of methane reactor is specially designed for the easy withdrawal of digested sludge, and for the easy recycling of treated methane reactor effluent to the acid reactor;
the whole system and layout of the equipment (including pretreatment, reactors, humus treatment and gas utilisation) are optimised for simple automatic operation.

Performance

There were several problems during the early stage of testing. Mechanical problems such as clogging in the conveyor line were caused by heavy rejects such as bones and pieces of metal. Almost all the problems were caused by a high proportion of foreign materials in the source-separated food wastes contained in the plastic bags. For example there was an unexpectedly large number of bottle openers, and of fresh whole fruit which is difficult to digest because of the skin. However, all the problems have been overcome and the equipment adjusted to accept and deal with the waste food input.

The two-phase anaerobic process using two reactors in series, with 15 m³ and 45 m³ effective capacities, recently started steady-state operation. In steady-state operation, the treatment of 3 tonnes of food waste produces about 100 kg of humus (70% moisture), 230 m³ of biogas (70% methane) and 2 tonnes of anaerobically-treated waste water. Around 73% of the degradable waste is estimated to be converted to biogas.

Economics

The initial investment required for this type of plant in Korea is estimated to be below $125,000 per tonne/day (where $ is the US dollar) for a plant with a capacity of over 15 tonnes/day. The operating cost of the plant is estimated to be $60/tonne. On the other hand, in Korea, the cost of incineration is estimated to be about $90/tonne and for landfill about $25/tonne of MSW. However, there are no new landfill sites available in Korea, and the use of landfill for food waste disposal is almost impossible because of the environmental impacts such as leachate and bad odour etc.

The utilisation of the biogas is dependent on the size of plant and the plant location. Several possibilities, heating or cooling of service buildings, utilisation as a fuel in incinerator or for power generation for internal utilisation and/or grid connection are available.
The shredder and drum screen for pre-treatment of the waste.

Please write to the address below if you require more information.

**Host Organisation**
Korea Institute of Energy Research
71-2 Jangdong
Yusongku, Taejon
Korea
Contact: Mr Soon Chul Park
Tel: + 82 42 860 3550
Fax: + 82 42 860 3132

**Information Organisation**
CADDET Korean National Team
RaCER
3F, 935-34 Bangbae-Dong
Socho-Ku, Seoul
137-060 Korea
Contact: Dr ChangSeob Kim
Tel: + 85 2 522 4298
Fax: + 82 2 522 8093/8094
E-mail: cskim@netra.racer.or.kr