IEA Bioenergy
Technology Collaboration Programme

Biogas production from kitchen wastes in Jinhua, China

Case Story

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Figure 1. An overview of the Jinhua Kitchen Waste Biogas Plant

Production of valuable products from kitchen wastes

In China, especially in urban areas, a significant quantity of kitchen waste is generated annually. Jinhua is a city of c. 7 million people located in Zhejiang Province, China. The city has an ambition to improve the quality of the urban environment and achieve the UN sustainable development goals such as SDG 6 (Clean Health and Water), SDG 7 (Affordable and Clean Energy), and SDG 11 (Sustainable Cities and Communities). A commercial project entitled Jinhua Kitchen Waste Biogas Plant was launched on June 27, 2016, with the primary goal of treating kitchen wastes and producing biogas in the process.

The project uses single-stage anaerobic digestion technology, including two parallel continuous stirred tank reactors (CSTR), each with a working volume of 1200 m^3 (Figure 1). The raw materials are kitchen wastes from c. 1700 restaurants and canteens in Jinhua City. The biogas

project processes 100 t of kitchen wastes per day at a total solids (TS) concentration in the range 6.79% to 8.92%. Volatile solids (VS) account for 79.79% to 83.63% of the total solids. The average daily biogas production has been recorded as 3944 ± 566 m^3/d. After the biogas is desulfurized, around a quarter of the produced biogas is used onsite to provide energy for the industrial process and in doing so substitute for fossil fuel. The remaining biogas is sold directly for electricity generation at a rate of 0.35 RMB/m^3.

To optimize the process and to gain a competitive market advantage, the project uses filtered non-water-soluble (non-biodegradable) kitchen waste fines (typically 15 to 20% of the yield of kitchen wastes) for breeding Black Horsefly (which is a nutritious animal feed); this creates a revenue of the order of 3 million RMB/y. The crude oil extracted from kitchen wastes (about 1825 t/y) is sold directly, generating further revenues of 9 million RMB/y.

An outline of process implementation

The main process units and routes of the project are shown in Figure 2 & 3. Before entering the anaerobic fermentation tank, kitchen wastes undergo several processes, including compression and filtration, de-sanding and crushing, boiling, and oil separation. Filtered kitchen wastes mainly contain carbohydrates, proteins, and fats, with a C/N of 17 ~ 18. Oil accounts for 5.5% of the fresh weight. The biogas tank adopts a high-temperature anaerobic fermentation process (about 55°C), with an organic load of 1.65 ~ 2.76 gVS/(L·d), and a hydraulic retention time (HRT) of 20 ~ 30 days. The average concentration of volatile fatty acids (VFAs) and total alkalinity (TA) in the biogas slurry is 2217 ± 704 and 12607 ± 826 mg/L, respectively. The average ammonium nitrogen concentration reaches 2478 ± 126 mg/L. The biogas slurry is further treated in wastewater facilities, with a treatment capacity of about 100 m^3/d (Figure 3).

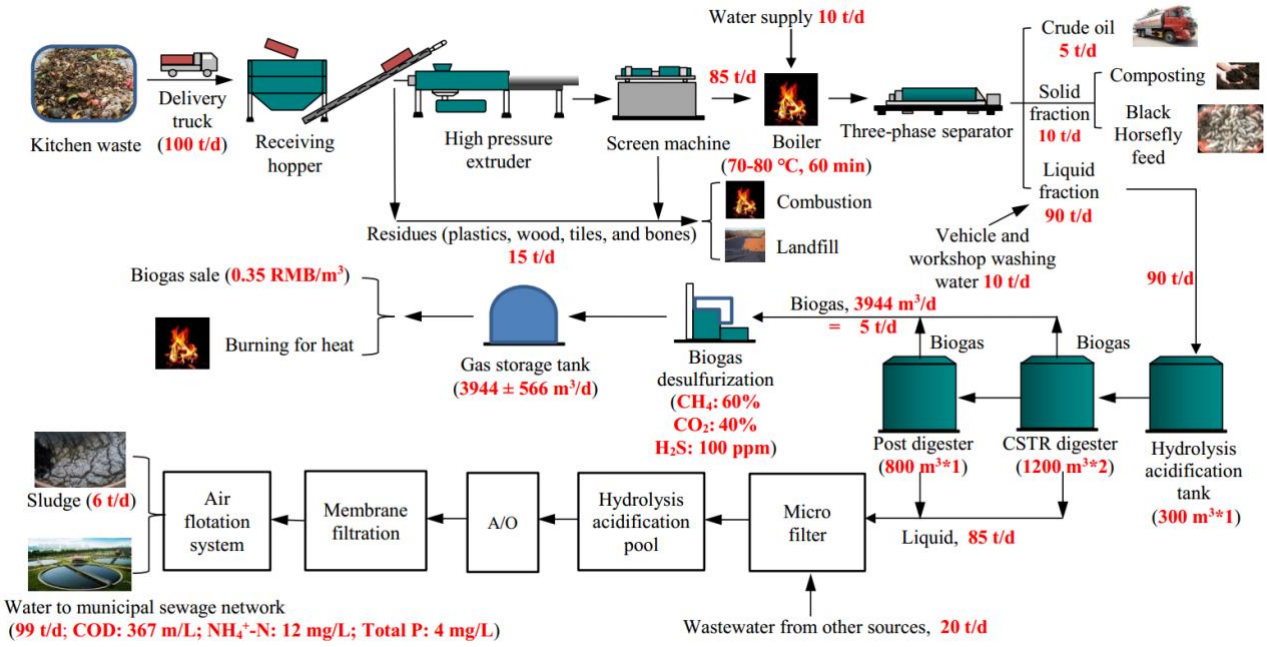
(A) Anaerobic digestion tank

(B) Biogas desulfuration unit

(C) Biogas storage tank

Figure 2. Main biogas process units

(A) Detailed description



(B) General description

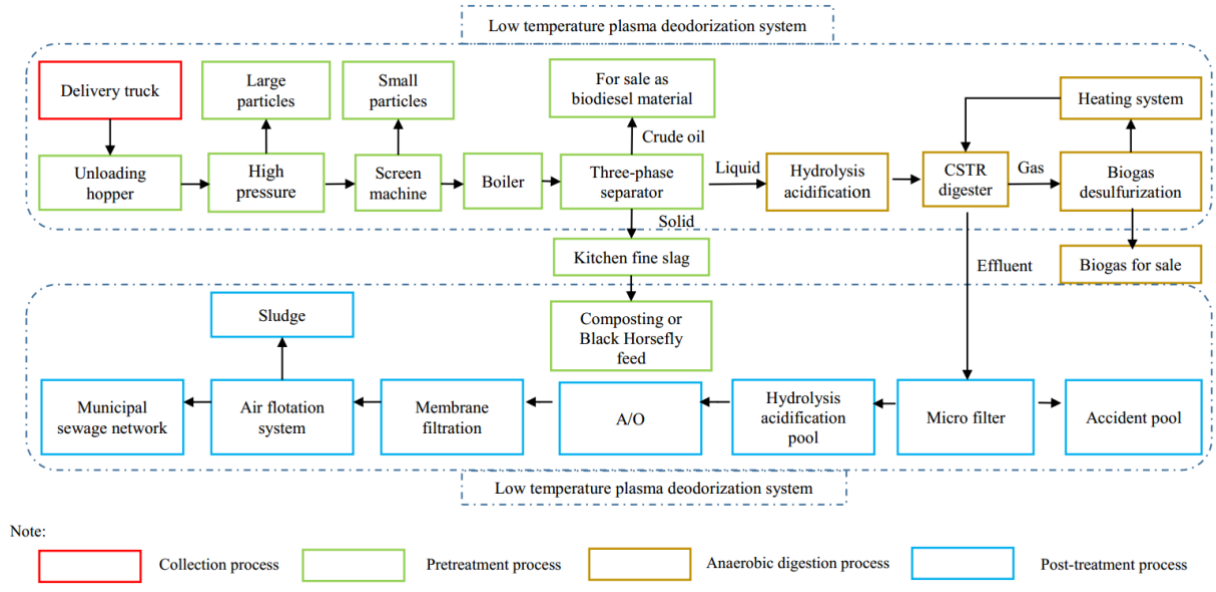


Figure 3. The flowchart of the Jinhua Biogas Project

Challenges and outlook

In the past 5 years, the biogas facilities have been operating stably. The removal rate of total chemical oxygen demand (TCOD) and VS has reached 82±3%, but the TCOD of biogas slurry and residue remains as high as 24 ± 4 g/L. The total salt content (in Cl^-) is 7108 ~ 7365 mg/L. The project is currently searching for feasible economic and technological paths to improve the biodegradability of source-sorted kitchen wastes and the disposal of high-salt-rich biogas slurry. Accordingly, a hydrolytic acidification tank is installed for source-sorted kitchen wastes before the anaerobic digestion tank. Meanwhile, a trial experiment has been established for lotus cultivation using high-salt-rich biogas slurry.

IEA Bioenergy Task 37 "Energy from Biogas" http://task37.ieabioenergy.com

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