



PURAC Sludge Anaerobic Digestion & Co-digestion Solution



Company Introduction

PURAC, as an environmental protection company with advanced technologies and rich experience in project management, was established in Sweden in 1956, and provides products, engineering and services to the fields of wastewater & water treatment and biogas production. The company has completed more than 5,000 contracts in over 70 countries, covering areas of sewage sludge treatment, organic waste treatment, drinking water & municipal sewage treatment, industrial wastewater treatment and biogas utilization etc.

PURAC has been in the Chinese market since 1993, and has served for more than 170 projects, including: 12 sewage sludge treatment contracts, with total daily capacity of 9,000 tons; 62 organic waste treatment contracts, with total daily capacity of 26,000 tons; 14 municipal drinking water contracts, with total capacity of 2540MLD; 19 municipal sewage treatment contracts, with total capacity of 2330MLD; 54 industrial wastewater treatment contracts, with total capacity of 1960MLD. These projects cover a variety of contract type, such as Engineering Procurement Contract (EPC), design & equipment supply, consulting service, etc., and have established the company's strength position in above mentioned areas.

In the sludge treatment field, PURAC has many successful cases, such as the Sludge Digestion Project of Pantai Sewage Treatment Plant in Malaysia, 5 Sludge Treatment Projects in Beijing (the Gaobeidian, the Huaifang, the Gaoantun, the Xiaohongmen and the Qinghe Project), the Xi'an Sewage Sludge Centralized Disposal Project, and the Ulaanbaatar Sludge Treatment Project in Mongolia, etc. In addition to the digestion treatment with single substrate of sewage sludge, PURAC also recommends co-digestion treatment with multiple substrates, to mixing the restaurant waste / household waste with the sewage sludge. The successful operation of the Chongqing Luoqi co-digestion project (capacity 2,500 tons/day) and the Beijing Tongzhou organic resources ecological treatment project (capacity 600 tons/day) provides a new direction for this field.

Business Scope

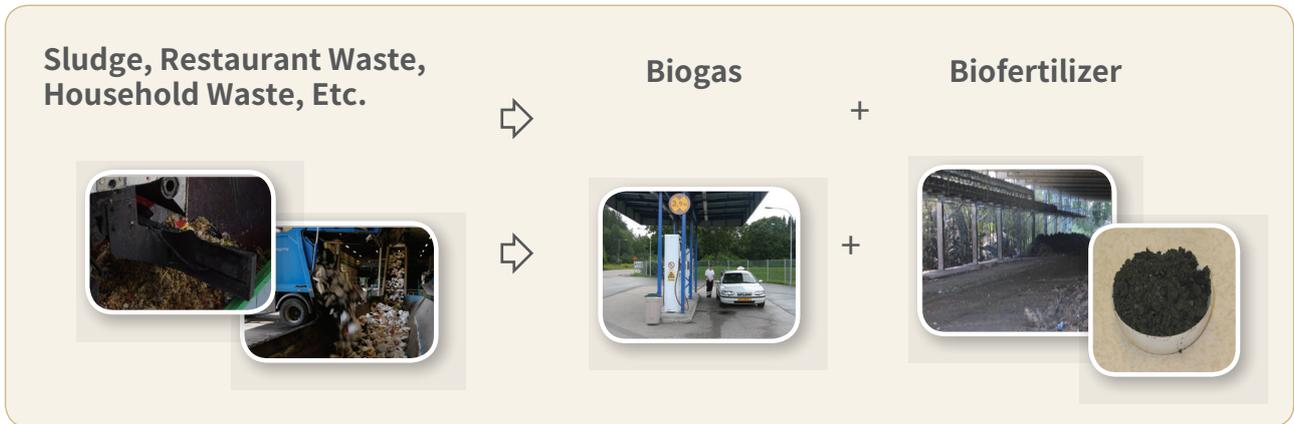
Restaurant waste, household waste and other biodegradable organic waste

Sewage Sludge

Municipal Sewage

Industrial Wastewater

PURAC: Market Leader in Sludge and Organic Waste Treatment



Core Competitiveness

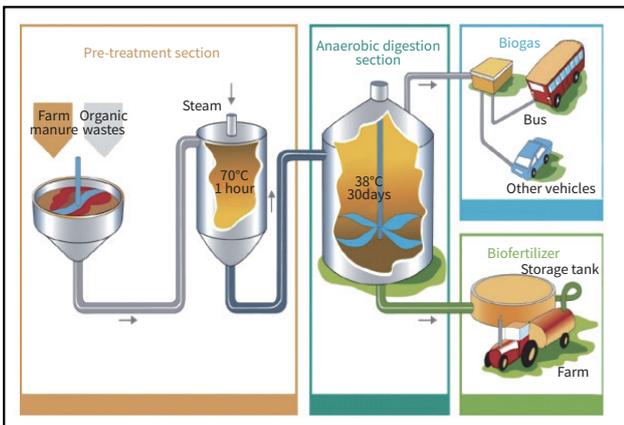
History of 68 years, always pursuit of perfection.

Technologies originated in Sweden, with projects all over the world, and achieved successful localization practice and experience for decades in China.

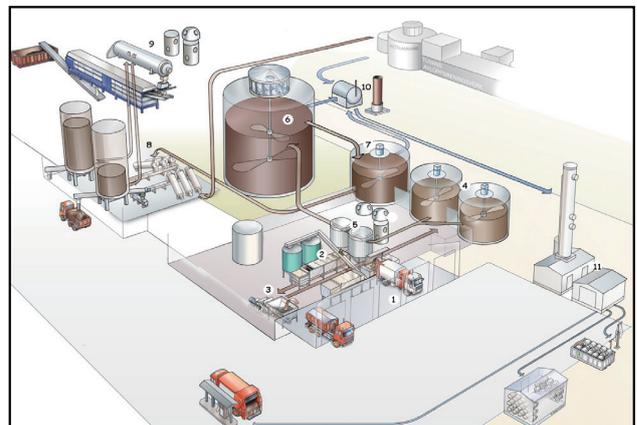
To offer integrated solution for customers in organic waste treatment area, with comprehensive technologies in pre-treatment, digestion, post-treatment and the wastewater treatment process.

To provide overall optimal scheme for customer, in view of the project whole life cycle, with comprehensive consideration of energy saving, consumption reduction, land saving, emission reduction, and stability etc.

Adhere to the value concept, and to provide customers with brand quality assurance.



Process Flow Diagram of Biogas Plant



Overview of Biogas Plant

PURAC Sludge Anaerobic Treatment Technology

The primary sludge (PS) and the activated sludge (WAS) from the sewage treatment plant are degraded in the anaerobic digestion tank after pre-thickening, to generate biogas with methane concentration of 50% to 85%, which can be used as fuel for power generation or be upgraded to natural gas. The anaerobic digestion treatment technology can be combined with drying, incineration and composting processes, to achieve the final disposal of sludge.

ANAMET® Anaerobic Process

ANAMET® is an improved completely mixed anaerobic digestion process developed by PURAC, which is used for treatment of sewage sludge and other biodegradable organic wastes. This process enhances the mixing performance and improves heat transfer efficiency of anaerobic system, and realizes the fully mixing and homogenous contact of microorganisms and substrate, thus improving the stability and efficiency of anaerobic reaction, achieving more thoroughly organic matter degradation, producing more biogas. The ANAMET® is a green and low-carbon process with very low energy consumption and chemical consumption.

ANAMET® Features and Benefits

Steel reactor:
shorter construction period, longer service life

Volume of single reactor can be up to 13000m³ for sludge and organic waste digestion treatment

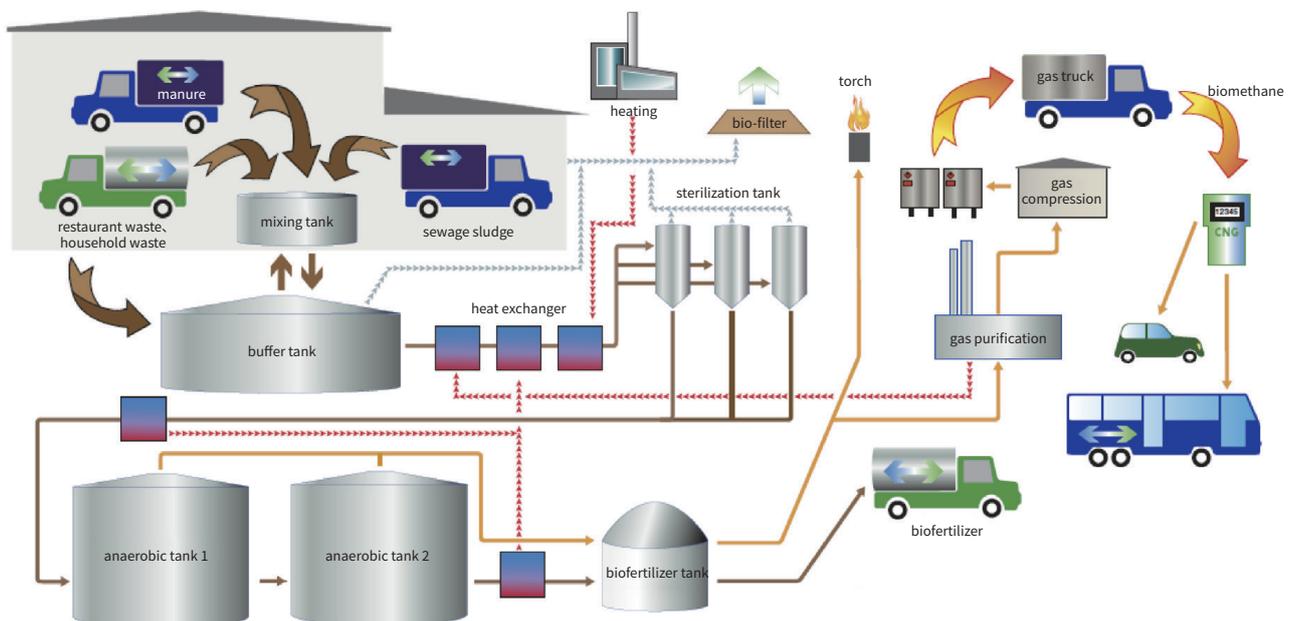
Efficient mechanical agitator:
homogenous mixing, low energy consumption

Stable operation, resistant to shock load

External heat exchanger:
high efficiency, easy maintenance

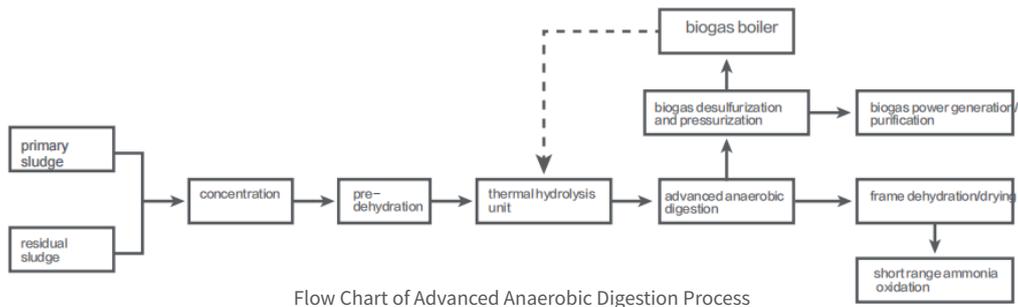
Higher degradation rate and more biogas production

Less system equipment:
maintenance and control simple, land saving



Sludge Advanced Anaerobic Digestion Technology

The advanced anaerobic digestion technology is to add a thermal hydrolysis unit as the pretreatment of digestion. Thermal hydrolysis disintegrates the cellular structure of bacteria in the sludge and solubilizes exopolymers to yield an easily digestible product. This results in a more complete sludge decomposition in digestion, more biogas production, and obtain a more stable end product.



Flow Chart of Advanced Anaerobic Digestion Process

Sludge Anaerobic Co-digestion Technology

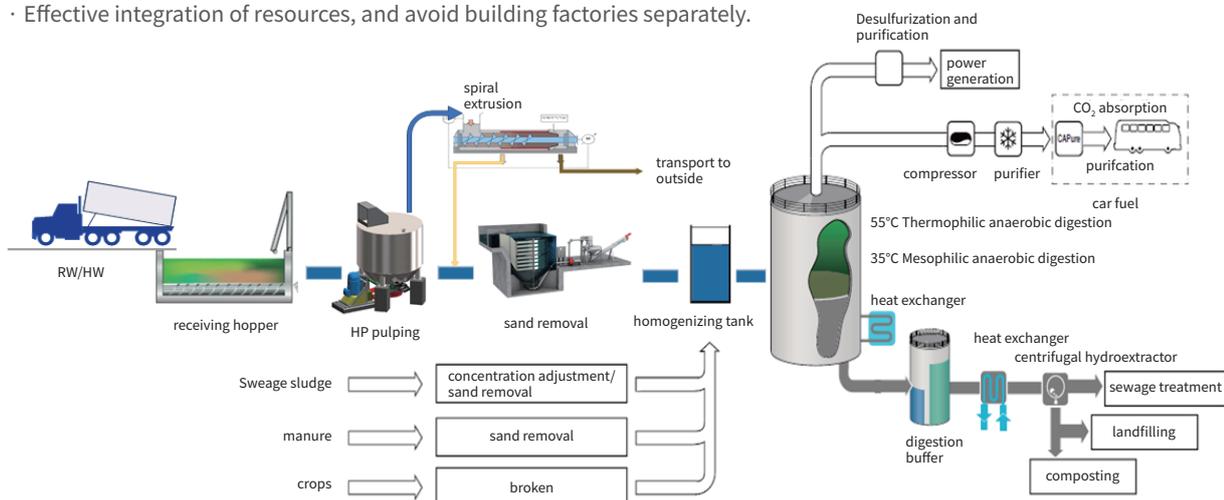
With the implementation of the garbage classification policy, more and more cities are separating large amount of wet garbage, mainly restaurant waste & household waste with high organic matter and water content, which are particularly suitable for anaerobic digestion treatment.

Based on years of engineering experience, PURAC proposed a technical solution of co-digestion, that is, the sewage sludge, the restaurant & household waste, the food passed its sell-by dates, and other organic wastes are mixed and treated together.

Co-digestion technology can not only play the scale merit of the treatment facilities, but also help to achieve the balance of fermentation substrate nutrition, and increase biogas production. At the same time, this technology will reduce power consumption, save wastewater treatment cost, and lower the overall operating cost of the whole sewage plant.

Advantages of Co-digestion:

- Optimize the ratio of nutrients and elements, and adjust the raw material composition.
- Effectively increase biogas production and reduce operating cost.
- More stable anaerobic reaction, and resistant to shock load.
- Effective integration of resources, and avoid building factories separately.



DeAmmon[®] Efficient Nitrogen Removal Process

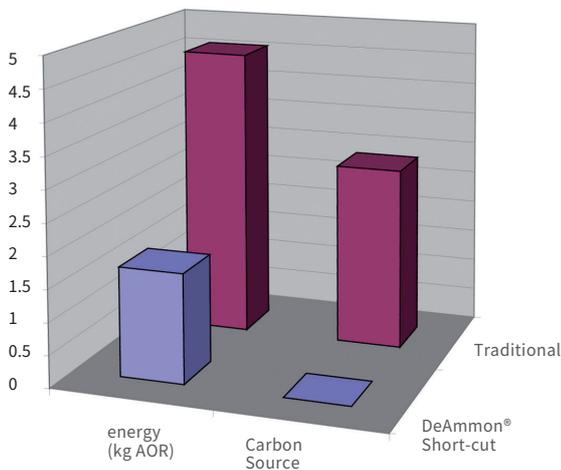
DeAmmon[®] is an anaerobic ammonia oxidation (Anammox) denitrification process specially developed for wastewater with high nitrogen concentration, such as the rejected water from digestion, and industrial waste water with nitrogen rich stream. Compared to traditional nitrogen removal processes, the significant advantage of DeAmmon[®] is the extremely low oxygen consumption, and no need for additional carbon sources.

This process can easily be retrofitted into existing treatment plants.

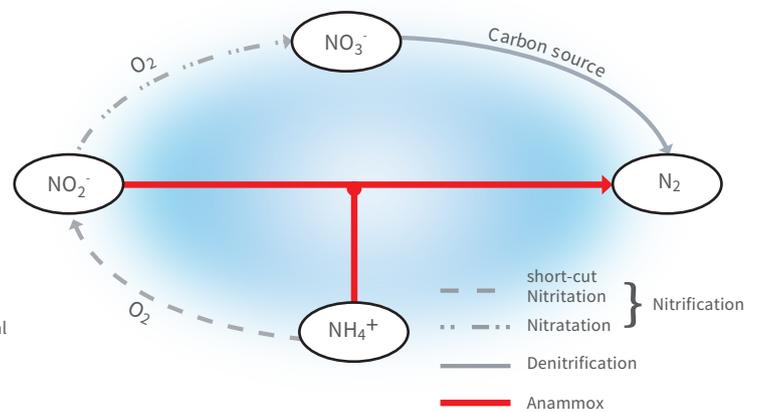
DeAmmon[®] Features and Benefits:

- Low operation cost
- No carbon source needed, such as methanol or ethanol
- Reliable performance
- High nitrogen removal rate
- Less sludge production

Process comparison



The DeAmmonification process



Himmerfjärden WWTP, Sweden

Scandinavia's first full-scale plant for deammonification started in 2007. The plant is designed to handle 480 kg N per day with a 70% removal rate. The DeAmmon[®] technology has been fitted in existing primary settling tanks with 32% filling degree of carriers. The plant has proven to be very stable to varying process conditions such as high loads of suspended solids and scaling of calcium carbonate, as well as other common disturbances related to the reject from the digestors handling sewage sludge and garbage.



Bekkelaget WWTP, Oslo, Norway

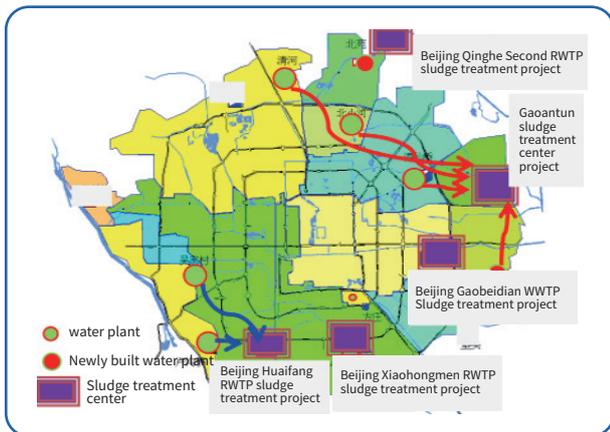
The Bekkelaget WWTP serves 350,000 people in the capital of Norwegian, Oslo. All sludge streams from sewage treatment are being proposed at this plant. Thickening takes place by use of centrifuges, the sludge is further treated by thermophilic digestion and dewatered by centrifuges. Energy is recovered by use of heat pumps to minimize usage of external energy. The biogas is upgraded to natural gas quality and used as vehicle fuel for city buses.

The DeAmmon[®] plant with the capacity of 1000kg N/d was commissioned during 2014 and started without seeding carriers. The total load is >1kg N/m³ total.

Cases of Anaerobic Digestion Treatment of Sludge

Beijing Main Urban Area Sludge Treatment Projects

During 2014 to 2015, PURAC signed 5 sludge treatment contracts, including: Beijing Gaobeidian WWTP Sludge treatment project (1,358 tons/day, based on 20% solid content), Beijing Xiaohongmen RWTP sludge treatment project (900 tons/day, based on 20% solid content), Beijing Qinghe Second RWTP sludge treatment project (814 tons/day, based on 20% solid content), Beijing Huaifang RWTP sludge treatment project (1,220 tons/day, based on 20% solid content), and Gaoantun sludge treatment center project (1,836 tons/day, based on 20% solid content). The total daily treatment capacity is up to 6,128 tons, and all these projects have been put into operation and in stable operation at present.



Location Map of 5 Sludge Projects

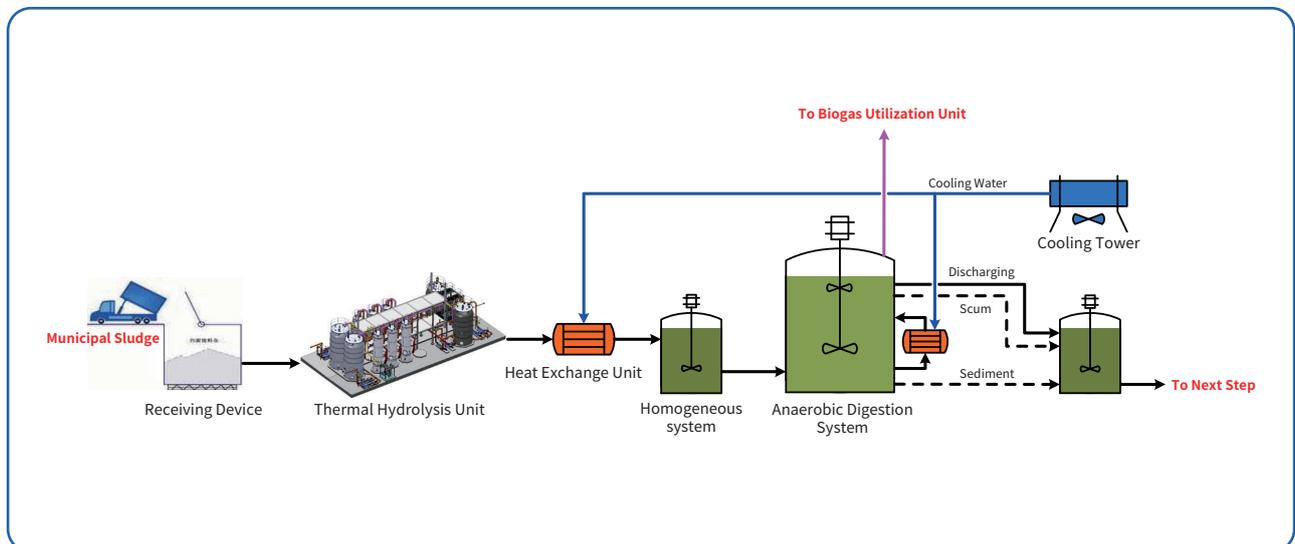


Aerial View of Digesters in Gaoantun Sludge Center

All the five sludge treatment projects adopt the advanced anaerobic digestion technology, that is, thermal hydrolysis pretreatment + anaerobic digestion process, and Anammox process for rejected water, which can reduce the sludge volume by 60%. The daily biogas production can reach 300,000 m³, equivalent to 212 tons of standard coal.

Since the greenhouse effect caused by methane is more than 20 times that of carbon dioxide, the reduction effect is significant.

The dewatered digestate can be used for landscaping and land restoration, to realize the resourceful utilization of the sludge.



Cases of Anaerobic Digestion Treatment of Sludge



Ulaanbaatar Central Sewage Plant Sludge Digestion Project,

Raw materials and capacity:
Sludge of WWTP with capacity 250MLD
Biogas production: 34,000 m³ / day
EPC project of sludge treatment



Pantai, Malaysia 320MLD WWTP Sludge Digestion Project

Raw materials and capacity:
Sewage sludge 224 tons/day (20% solid
content)
Biogas production: 18,000 m³ / day



Xi'an Sewage Sludge Centralized Disposal Project

Raw materials and capacity:
Sewage sludge 1,000 tons/day (20% of
solid content)
Biogas production: 45,000 m³ / day
Biogas usage: Power generation



Beijing Gaoantun Sludge Treatment Center Project

Raw materials and capacity:
Sewage sludge 1,836 tons/day
(20% solid content)
Biogas production: 110,000 m³ / day
Biogas usage: Power generation



Beijing Qinghe 2nd RWTP Sludge Treatment Project

Raw materials and capacity:
Sewage sludge 814 tons/day
(20% solid content)
Biogas production:
51,000 m³ / day



Beijing Huaifang RWTP Sludge Treatment Project

Raw materials and capacity:
Sewage sludge 1,220 tons/day
(20% solid content)
Biogas production: 79,200 m³ / day
Biogas usage: Power generation



Beijing Gaobeidian WWTP Sludge Treatment Project

Raw materials and capacity:
Sewage sludge 1,358 tons/day
(20% solid content)
Biogas production: 65,000 m³ / day



Beijing Xiaohongmen RWTP Sludge Treatment Project

Raw materials and capacity
Sewage sludge 900 tons/day
(20% solid content)
Biogas production: 48,000 m³ / day



Oslo, Norway BEKKELAGET WWTP Sludge Anaerobic Treatment Project

Raw materials and capacity:
Sludge of WWTP with
capacity of 120MLD

Cases of Co-digestion Treatment of Mixed Sludge & Organic Waste

Chongqing Luoqi Anaerobic Co-digestion Treatment Project



Raw materials and capacity:
Restaurant waste 2,100 tons/day + Sewage sludge 400 tons/day
Biogas production: 180,000 m³ / day
Biogas usage: Power generation
Production time: phase 1 2020, phase 2 2021.

This project is located in the Luoqi National Resource recycling industrial park, which undertakes the disposing of restaurant waste and sewage sludge of the main urban area and some counties of Chongqing. This project produces 180,000m³ biogas per day, and generate 360,000 KWH electricity per day.

The completion of this project, on the one hand, reflects the effect of people's livelihood effect, and at the same time produces huge economic benefits, and realizes the waste recycling to the greatest extent.

Project summarize:

1. Thermophilic anaerobic process adopted for restaurant waste treatment mixed with sewage sludge, to explore experience for co-digestion of municipal organic wastes.
2. Six large steel digestion reactors with volume 13000m³ each are built, saving the area and operating costs.
3. The overall process is compact, the system configuration is simple and efficient, and the operation management is easy.
4. Maximize energy recovery and reduce operating costs.

Tongzhou Organic Resources Ecological Treatment Project, Beijing



Raw materials and capacity:
Restaurant waste 200 tons/day + Manure 300tons/day + Sewage sludge 100 tons/day
Biogas production: 24,000 m³ / day
Biogas usage: Power generation
Production time: 2018

This project is located in Zhangjiawan area, Tongzhou District, Beijing, is one of Beijing Municipal government "Twelfth Five-Year Plans" and key projects of Tongzhou District.

The project adopts advanced co-digestion treatment technology with a variety of organic waste. The pretreated substrates (restaurant wastes, manure, sludge, etc.) are mixed and pumped into the anaerobic system for digestion. The biogas generated is upgraded to natural gas quality, and used as clean energy vehicle fuel in Tongzhou District.

After the completion of this project, 220,000 tons of restaurant waste, manure and sludge are treated annually in Tongzhou and surrounding areas, contributing to the green ecological sustainable development of Beijing.

Cases of Co-digestion Treatment of Mixed Sludge & Organic Waste

Haikou Mixed Organic Waste Co-digestion Project

A total of 500 tons of organic waste including sewage sludge, pig manure, banana straw and municipal organic waste are processed daily by ANAMET® anaerobic treatment process, biogas generated is then upgraded to natural gas for use as vehicle fuel, with a daily capacity of 20,000m³, which can meet the fuel needs of 250 city buses or 1,000 taxis. The residue sludge is reduced after drying and can be used as fertilizer.

The project was completed and put into operation in 2014 for supplying gas to city buses and taxis in Haikou City, and is the first demonstration project of new energy for vehicle gas in Hainan. The implementation of the project not only promotes the development and implementation of waste classification in Haikou City, but also provides a practical model for the establishment of a recycling system, the development of renewable resources industry, and the realization of harmless waste resourceful treatment. It is one of the key projects of Hainan Island to become an international and ecological tourism island.

Capacity:	500 t/d
Sewage sludge	100 t/d
Pig manure	160 t/d
Restaurant/household waste	60 t/d
Rotten fruit	180 t/d
Biogas production:	34,000 m ³ /d
Natural gas production CNG:	20,000 m ³ /d



Linköping biogas plant, Sweden

This biogas plant is located at Linköping WWTP to receive slaughter wastes and manure. There are two receiving hoppers in this plant, one for receiving slaughter wastes and the other for receiving livestock manure. The hopper for organic slaughter wastes is equipped with four bottom screw conveyors to break down and homogenize feed substrates and unload them onto conveyors to two mixing tanks. In the mixing tanks, the substrates are diluted to a suitable dry solid concentration and then transported to a biological separator to separate the indigestible inorganic material. The organic material passes through the pulping machine for further pulping and reaches the buffer tank. The livestock manure is transported by a bottom screw conveyor to the pulping machine for further pulping to the buffer tank, and then is pumped into two sanitizing tanks, where it is thermally sterilized at 70 °C before being pumped into an anaerobic digestion tank. The biogas is then purified into vehicle fuel, which can meet the fuel needs of 70 city buses and 500 private cars.

Input	Organic slaughter wastes 96 tons/day Livestock manure 96 tons/day TS removal rate 50%
Output	Total biogas production: 9600 m ³ / day The installed power generation capacity: 4.5 MW Methane content 97-98%



References

PURAC Group Sewage Sludge Anaerobic Treatment References

No.	Project Nam	Capacity (Solid Content 20%)	Location	Completion
1	Chengdu No.6 Reclaimed Water Plant Second Phase Project Sludge Digestion System	162.5t/d	China	2026
2	Ulaanbaatar Central Sewage Treatment Plant Sludge Digestion Project	738.5 t/d	Mongolia	2025
3	Xi'an Sewage Treatment Plant Sludge Centralized Disposal Project	1000 t/d	China	2020
4	Beijing Qinghe 500,000t/d Second Reclaimed Water Plant Sludge Treatment Project	814 t/d	China	2020
5	Beijing Gao'antun Sludge Treatment Center Project	1836 t/d	China	2018
6	Beijing Huaifang 600,000 t/d Reclaimed Water Plant Sludge Treatment Project	1220 t/d	China	2018
7	Beijing Xiaohongmen 600,000t/d Sewage Treatment Plant Sludge Treatment Project	900 t/d	China	2016
8	Beijing Gaobeidian 1M t/d Sewage Treatment Plant Sludge Anaerobic Project	1358 t/d	China	2016
9	Pantai 320,000t/d sewage treatment plant sludge digestion project, Malaysia	224 t/d	Malaysia	2014
10	Shandong Qufu Sewage Treatment Plant Sludge Treatment Project	30 t/d	China	2004
11	Shandong Yanzhou Sewage Treatment Plant Sludge Treatment Project	30 t/d	China	2004
12	Beijing Gaobeidian Sewage Treatment Plant Phase II Sludge Treatment Project	662 t/d	China	1999
13	Flen wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2023
14	Rimbo wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2021
15	Arvidstorp slam avvattning wwtp Sludge Treatment Project	28 t/d	Sweden	2021
16	Trollhättan Arvidstorp Slam wwtp Sludge Treatment Project	28 t/d	Sweden	2021
17	Rosenholm Röt-kammare wwtp Sludge Treatment Project	24 t/d	Sweden	2021
18	Borås Rötning-anläggning wwtp Sludge Treatment Project	115 t/d	Sweden	2021
19	Källby Rötning wwtp Sludge Treatment Project	44 t/d	Sweden	2020
20	Lindholmen wwtp Sludge Treatment Project	22.5 t/d	Sweden	2020
21	Halden Remmen wwtp Sludge Treatment Project	18.5 t/d	Norway	2018
22	Brandholmen wwtp Sludge Treatment Project	31.5 t/d	Sweden	2017
23	Bårlidalen wwtp Sludge Treatment Project	11.3 t/d	Norway	2016
24	Lillehammer wwtp Sludge Treatment Project	123 t/d	Norway	2016
25	Bergen wwtp Sludge Treatment Project	Supporting facility for wwtp	Norway	2014
26	Lindum, Drammen wwtp Sludge Treatment Project	82 t/d	Norway	2012
27	Karlstad wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2010
28	Borgholm wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2009
29	Bromma wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2008
30	Kapusciska Bydgoszcz wwtp Sludge Treatment Project	Supporting facility for wwtp	Poland	2006
31	Narva wwtp Sludge Treatment Project	Supporting facility for wwtp	Estonia	2005
32	Bekkelaget wwtp Sludge Treatment Project	Supporting facility for wwtp	Norway	2004
33	Malmö VA-verk, Sjölanda wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	2002
34	Lowestoft wwtp Sludge Treatment Project	Supporting facility for wwtp	UK	2002
35	Brom borough wwtp Sludge Treatment Project	Supporting facility for wwtp	UK	2001
36	Monserud wwtp Sludge Treatment Project	Supporting facility for wwtp	Norway	2001
37	Glogow wwtp Sludge Treatment Project	Supporting facility for wwtp	Poland	2000
38	Pyewipe wwtp Sludge Treatment Project	Supporting facility for wwtp	UK	1999
39	Millbrook wwtp Sludge Treatment Project	Supporting facility for wwtp	UK	1999
40	Lillevik wwtp Sludge Treatment Project	Supporting facility for wwtp	Norway	1999
41	Värnamo wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1998
42	Falkenberg wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1997
43	Deje wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1997
44	Tjustvik, Värmdö wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1996
45	Karlshamn, Sternö wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1996
46	Hudiksvall, Reffel mansverket wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1995
47	Nowy Sacz wwtp Sludge Treatment Project	Supporting facility for wwtp	Poland	1995
48	Smedjeholm wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1994
49	Sundsvall, Fillan wwtp Sludge Treatment Project	Supporting facility for wwtp	Sweden	1994
50	Jastrzebie -Zdroj wwtp Sludge Treatment Project	Supporting facility for wwtp	Poland	1993
51	Oswiecim wwtp Sludge Treatment Project	Supporting facility for wwtp	Poland	1992
52	Esbjerg W. wwtp Sludge Treatment Project	Supporting facility for wwtp	Denmark	1991
53	Oskarshamn wwtp Sludge Treatment Projec	Supporting facility for wwtp	Sweden	1987

PURAC Organic Waste and Sludge Co-Digestion References

No.	Project Name	Capacity (Solid Content 20%)	Location	Completion
1	Anhui Fuyang Sludge and Restaurant Waste Co-Digestion Project	200t/d of restaurant waste + 100t/d sludge + waste oil	China	2026
2	Chongqing Luoqi restaurant Waste and Sludge Co - anaerobic Treatment Project	2100 t/d of restaurant waste + 400 t/d of sewage sludge	China	2021
3	Tongzhou organic waste ecological treatment project	200 t/d of restaurant waste+300 t/d of manure + 100 t/d of sewage sludge	China	2018
4	Haikou mixed waste treatment project	sludge+manure+banana stalks+household waste+expired fruits	China	2013
5	Kalmar biogas plant	sludge +organic waste	Sweden	2011



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