UDC

GB

NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

P **GB/T 51063-2014**

Technical code for large and medium-scale biogas engineering

大中型沼气工程技术规范

Issued on: December 02, 2014 **Implemented on: August 01, 2015**

Issued by: Ministry of Housing and Urban-Rural Development of PRC;

General Administration of Quality Supervision, Inspection and Quarantine of PRC.

Table of Contents

Technical code for large and medium-scale biogas engineering

1 General provisions

1.0.1 In order to standardize the design, construction, installation, acceptance, operation, maintenance of large and medium-scale biogas engineering, AND to ensure project quality and safe production, this Code is hereby formulated.

1.0.2 This Code applies to the design, construction and installation, acceptance, operation and maintenance of the newly-built, expanded, rebuilt biogas engineering, which uses anaerobic digestion technology to process the agricultural organic waste, industrial high-concentration organic wastewater, industrial organic waste residue, sludge, is mainly for gas supply, has a biogas output of not less than 500 m^3/d.

1.0.3 Large and medium-sized biogas projects shall actively adopt new technologies, new processes, new materials, new equipment, on the basis of constantly summarizing practical experience in production and construction, so as to achieve stable operation, reliable equipment, advanced technology, economic feasibility.

1.0.4 The design, installation, acceptance, operation and maintenance of large and medium-sized biogas projects shall not only comply with this Code, but also comply with the current relevant national standards.

2 Terms and abbreviations

2.1 Terms

2.1.1 Biogas

A combustible mixed gas, which is mainly composed of methane, has a low-level calorific value not less than 17 MJ/m^3 as produced by the digestion of organic matter, under anaerobic conditions, by microorganisms.

2.1.2 Biogas station

A place which uses anaerobic digestion technology to produce, purity, store biogas.

2.1.3 Large and medium-scale biogas engineering

A biogas project, which adopts the anaerobic digestion process to process agricultural organic waste, industrial high-concentration organic wastewater, industrial organic waste residue, sludge, has the biogas output of not less than 500 m^3/d; can be used for civil, power generation, purification and compression. It includes biogas stations, transmission and distribution pipeline network, user engineering, referred to as "biogas engineering".

2.1.4 Agricultural organic waste

Organic substances, such as crop straws, which are produced in the process of agricultural production AND livestock and poultry manure produced in the whole process of aquaculture production.

2.1.5 High concentration industrial organic wastewater

Liquid organic waste, which has a COD_{cr} content greater than 2000 mg/L, is discharged from industrial production, such as brewing, papermaking, food processing.

2.1.6 Industrial organic residue

Solid organic waste, which is discharged from industrial production, such as brewing, sugar refining, starch processing, biopharmaceuticals, paper making, food processing.

2.1.7 Sludge

The sludge, which is produced in primary settling tanks and secondary settling tanks, in the process of urban sewage treatment. It does not include: screen slag, scum, sand settling in grit chambers.

2.1.8 Volume organic loading rate

The amount of organic matter, that can be digested per unit volume of anaerobic digester per day, expressed in $kgCOD_{cr}/(m^3 \cdot d)$.

2.1.9 Cryochem

A method to condense and precipitate saturated water in biogas, by lowering the temperature.

2.1.10 Bio-desulfurization

A method for removing hydrogen sulfide in biogas, under microaerobic conditions after the desulfurization bacteria group is cultivated.

2.1.11 Space velocity

The capacity of a unit volume of desulfurizer to treat biogas per hour.

2.1.12 Sulfur sludge

The mixture containing elemental sulfur, sulfite, sulfate and biological metabolites, which is produced in the process of biological desulfurization.

2.1.13 Anaerobic activated sludge

Suspended matter and colloidal matter, which are formed by the combination of anaerobic digestion bacteria and flocs and particles, with a strong ability to adsorb and decompose organic matter; it can also be used as the inoculum for the initial raw materials of anaerobic digesters.

2.2 Abbreviations

CSTR - Complete stirred tank reactor

USR - Upflow solid reactor

UASB - Upflow anaerobic sludge blanket reactor

IC - Internal circulation anaerobic reactor

EGSB - Expanded granular sludge blanket reactor

HCPF - High concentrations of plug-flow reactor

TS - Total solids

SS - Suspended solids

VS - Volatile solids

4 Biogas station

4.1 Site selection and general layout

4.1.1 The site selection shall conform to the overall planning of urban and rural construction. It shall meet the following requirements:

1 It should be on the downwind side of the dominant wind direction in the residential area throughout the year; it shall be far away from the residential area; it shall meet the requirements of sanitation and epidemic prevention;

2 It should be close to the production area of biogas fermentation raw materials. For civil biogas projects, a reasonable site shall be selected, according to the distribution characteristics of gas consumption areas. Biogas projects for power generation and grid connection shall be close to transmission and power lines;

3 It should choose the natural foundation with solid rock and soil and good anti-seepage performance; it shall avoid unfavorable geological areas, such as mountain torrents and landslides;

4 It should have water supply and drainage, power supply conditions, convenient external transportation;

5 It shall not be selected in the area, which is crossed by overhead power lines;

6 The fire separation distance -- between the open-air process installations inside the station and the buildings (structures) outside the station -- shall comply with the relevant provisions of the current national standard 5 "Code of design on building fire protection and prevention" GB 50016.

4.1.2 The overall layout of the station area shall be divided according to the production area and production auxiliary area. It shall meet the following requirements:

1 Pretreatment facilities, anaerobic digesters, purification facilities, gas storage facilities, booster rooms, generator rooms, pump rooms, etc. shall be arranged in the production area;

2 Auxiliary production facilities such as monitoring room, power distribution room, laboratory, maintenance room, etc., as well as rooms for management and living facilities shall be arranged, in the auxiliary production area.

4.1.3 The overall layout of the station area shall be reasonably designed, according to the functions and technological requirements of various facilities in the station, combined with terrain, wind direction and other factors. Meanwhile it shall meet the following requirements:

or near the biogas station; the area of the straw stockyard should be determined according to the amount of straw purchased and consumed.

4.2.2 Industrial high-concentration organic wastewater, industrial organic waste residue, sludge raw materials shall not contain toxic substances or inhibitors, that can inhibit anaerobic fermentation; the BOD_5/COD_{cr} shall not be less than 0.3.

4.2.3 Anaerobic fermentation raw materials shall be pretreated; corresponding pretreatment facilities shall be set up, according to the characteristics of raw materials.

4.2.4 The pretreatment of agricultural organic waste and industrial high-concentration organic wastewater shall meet the following requirements:

1 For raw materials with a lot of floating debris, grilles shall be installed; the gap between the grid bars shall be determined, according to the type of raw materials, flow rate, size of debris, water pump requirements;

2 For raw materials with a lot of sand, grit chambers and de-sanding devices shall be installed; the minimum effective volume of grit chambers shall be calculated and determined, based on raw material flow, velocity, viscosity, density, residence time;

3 For raw materials with large fluctuations in water quality, water quantity, temperature, a regulating tank shall be installed; the minimum effective volume shall be able to meet the total amount of raw materials, which are discharged in one cycle of raw material change;

4 The design of grilles, grit chambers, regulating tanks shall comply with the provisions of Appendix A of this Code.

4.2.5 The pretreatment of straw shall meet the following requirements:

1 Dry straw shall be crushed in the crushing room; the particle size after crushing should be less than 10 mm;

2 The fresh straw shall be crushed and put into the fresh silo for storage; the crushed particle size shall be 20 mm ~ 30 mm;

3 Straw raw materials should be uniformly tempered in the blending pool, then enter the anaerobic digester.

4.2.6 The pretreatment of industrial organic waste residue and sludge shall meet the following requirements:

1 For industrial organic waste residue or sludge cake, it should set up a collection tank before entering the anaerobic digester; the minimum effective volume shall be determined, according to the collection cycle of raw materials or the feeding cycle of the anaerobic digester;

2 The moisture content of wet sludge after thickening should be 96%.

4.2.7 After various raw materials are pretreated, the temperature and solid concentration shall be adjusted uniformly; it should not contain suspended solids with a diameter or length greater than 40 mm.

4.2.8 Reinforced concrete anti-seepage structure should be adopted for the pretreatment structure, which shall comply with the relevant provisions of the current national standard "Code for design of concrete structures" GB 50010.

4.3 Anaerobic digestion process and equipments

4.3.1 The anaerobic digestion process and anaerobic digester shall be determined, after technical and economic comparisons, based on raw material characteristics, fermentation time, feeding method, feeding conditions.

4.3.2 The temperature of anaerobic digestion process shall be determined according to the raw material temperature, heat source form and other factors. It shall meet the following requirements:

1 When the medium-temperature anaerobic digestion process is adopted, the temperature shall be 35 °C ± 2 °C;

2 When the raw material temperature is higher than 50 °C, the high-temperature anaerobic digestion process should be selected. The high-temperature anaerobic digestion temperature should be 55 °C ± 2 °C; it should not exceed 58 °C;

3 After stable operation, the fluctuation range of daily fermentation temperature should be ±2 °C.

4.3.3 The anaerobic digestion process can be designed as one-stage digestion process or two-stage digestion process, according to the requirements of the digestion stage. When a two-stage digestion process is used, the one-stage anaerobic digester shall be switched with the two-stage anaerobic digester, meanwhile it can be used independently.

4.3.4 For biogas projects with uninterrupted gas supply, the number of anaerobic digesters shall not be less than 2.

4.3.5 The feeding method of the anaerobic digester can be continuous feeding or batch feeding. The diameter of the inlet and outlet pipes, the parameters of the feeding equipment, the heating required to heat the feed liquid to the design temperature shall be calculated according to the hourly feed amount.

4.3.6 When waste with high solid content is used as raw material, it should use a completely mixed anaerobic reactor (CSTR), an upflow solid reactor (USR) or a high-concentration plug-flow reactor (HCPF). When wastewater with high dissolved organic

4.3.18 A pressure stabilizing device should be installed on the gas collecting pipeline of the anaerobic digester. When a water-sealed pressure stabilizing device is used, the effective height shall be determined, according to the maximum working pressure of the anaerobic digester and the gas storage pressure at the back end.

4.3.19 The treatment of anaerobic digested sludge shall meet the following requirements:

1 The anaerobic digested sludge shall be stored in a sludge storage tank. The volume of the sludge storage tank shall be determined, according to factors such as the amount of sludge, the amount of digestion, the digestion cycle;

2 For mechanical dehydration of anaerobic digested sludge, it may select centrifuges, plate and frame filter presses, screw filter presses or belt filter presses, according to sludge properties, sludge output, dehydration requirements; the moisture content of dehydrated sludge shall be less than 80%;

3 The dehydrated sludge shall not be stacked in the open air; it shall be disposed of in time;

4 The size of the sludge storage yard shall be determined according to the sludge output and transportation conditions; the ground of the sludge storage yard shall have anti-seepage and anti-leakage measures.

4.3.20 The disposal and utilization of anaerobic digestion liquid shall comply with the following requirements:

1 Anaerobic digestion solution should be given priority to agricultural use;

2 The storage pool shall be able to meet the requirements of balanced fertilization of the crops; its volume shall be determined, according to the amount of anaerobic digestion liquid, storage time, utilization method, utilization cycle, local rainfall, evaporation.

4.4 Biogas purification

4.4.1 The biogas produced by the anaerobic digester shall be desulfurized, dehydrated, purified. The selection of purification process shall be determined, after technical and economic comparison, based on the different uses of biogas, processing capacity, biogas quality indicators, in combination with local environmental temperature and other factors.

4.4.2 Biogas desulfurization should adopt biological desulfurization, dry desulfurization or wet desulfurization.

4.4.3 When the quality of biogas after first-stage desulfurization cannot meet the

requirements, two-stage desulfurization shall be adopted; dry desulfurization should be used for the second stage.

4.4.4 The design of desulfurization process shall meet the following requirements:

1 Biological desulfurization shall be installed at the front of the dehydration device;

2 The dry desulfurization shall be installed at the back end of the dehydration device;

3 The desulfurization device shall be equipped with backup equipment;

4 Valves shall be installed before and after the desulfurization device;

5 Detection ports shall be reserved before and after the desulfurization device;

6 The disposal of waste desulfurizer and sulfur sludge shall meet the requirements of environmental protection.

4.4.5 The process design of biological desulfurization shall meet the following requirements:

1 The biological desulfurization system should be equipped with biological desulfurization tower, circulating water tank, circulating pump, blower, slag discharge pump, dosing pump, etc.;

2 The desulfurization tower shall be easy to clean, maintain, overhaul; it shall be equipped with observation windows and manholes;

3 A temperature sensor and a heating device shall be installed in the circulating water tank;

4 The biogas pipeline behind the biological desulfurization should be equipped with an online oxygen content monitoring system, which shall be linked with the fan; the residual oxygen content in the biogas shall be less than 1%;

5 The nutrient solution required for biological desulfurization shall meet the requirements for the survival of desulfurization bacteria;

6 The desulfurization effect of the biological desulfurization device shall meet the process requirements.

4.4.6 The process design of dry desulfurization shall meet the following requirements:

1 Iron oxide should be used as the desulfurizer; the space velocity of the desulfurizer should be 200 h^{-1} ~ 400 h^{-1};

2 The pressure drop when the biogas passes through the bed of desulfurizer for the first time shall be less than 100 Pa;

time;

3 When used for purification and compression, the gas storage volume should be determined, according to 10% ~ 30% of the daily gas consumption;

4 When determining the volume of a single gas cabinet, the scheduling balance of the gas supply system during the maintenance of the gas cabinet shall be considered. For users with uninterrupted gas supply, the number of gas cabinets should not be less than 2.

4.5.3 The gas cabinet shall be equipped with an automatic overpressure release device and a low-pressure alarm device.

4.5.4 The process design of membrane gas cabinets shall meet the following requirements:

1 Membrane gas cabinet shall be composed of gas cabinet body, gas cabinet pressure stabilization system, leak detection system, gas volume detection system, overpressure release device, etc.;

2 The outer membrane should be anti-static, high-strength flame-retardant material, which has good reflective effect, anti-ultraviolet, aging resistance, low temperature resistance;

3 The inner membrane and the bottom membrane shall be made of high-strength flame-retardant materials, that are anti-biogas penetration, wear-resistant, wrinkle-resistant, hydrogen sulfide-resistant;

4 The pressure stabilization system of the gas cabinet shall include blown-membrane explosion-proof fans, flexible gas ducts, butterfly valves, pressure regulating devices and air ducts; blown-membrane explosion-proof fans shall be equipped with spare equipment;

5 The methane concentration sensor in the leak detection system should be installed on the inner top of the outer membrane, which shall transmit the alarm signal to the control room;

6 The gas volume detection system shall be able to instantly display the biogas storage in the gas cabinet;

7 The outer membrane shall be equipped with observation windows; the position of the observation windows shall be convenient for observing the condition of the inner membrane;

8 The independent membrane gas cabinet shall be provided with a foundation, which shall be dense and flat, with a slope not less than 0.02, sloping to the drain pipe;

9 The shape of the independent membrane gas cabinet should be 3/4 spherical or

This is an excerpt of the PDF (Some pages are marked off intentionally)

------ The End ------