NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ANAEROBIC DIGESTER – CONTROLLED TEMPERATURE

(no.)
CODE 366

DEFINITIONS

A managed temperature waste treatment facility.

PURPOSE

To biologically treat waste as a component of a waste management system to:

Produce and capture biogas for energy;

Improve air quality;

Reduce greenhouse gas emissions;

Reduce pathogens;

Improve nutrient management.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

Biogas production and capture are components of a planned animal waste management system.

Existing facilities can be modified to the requirements of this standard or new construction will be used.

Manure can be collected fresh (or maintained frozen until digestion) and delivered to the digester with a total solids (TS) concentration of 14 percent or less.

The operator has the interest and training to monitor and maintain processes or will contract with a consultant to provide these services.

CRITERIA

Laws and Regulations. Waste treatment facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations.

Laws and regulations of particular concern include those involving zoning, water rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Where South Dakota Department of Environment and Natural Resources (SD DENR) approval is to be obtained, SD DENR requirements must be met.

South Dakota dam safety requirements shall be met for construction of facilities utilizing embankments.

Location. Digesters shall not be located within the 100-year frequency flood plain unless the structure is protected from inundation and damage that may occur during the 100-year frequency flood event.

Digesters cannot be located closer than 1,000 feet from an existing public water well or drinking water source nor 250 feet from a well or drinking water source not owned by the producer.

Digesters shall not be located closer than 150 feet from a water well or drinking water source that is owned by the producer.

Digesters shall be located so the potential impacts from breach of embankment, accidental release, and/or liner failure are minimized.

Manure Characteristics. This practice is applicable to manure that is fresh, or reconstituted to meet digester design total solids content. Manure shall be essentially free of soil, sand, stones, or fibrous bedding material (including clumps of straw), or shall be processed to remove or reduce such material.

Large quantities of frozen manure must be thawed before it is added to the digester. Manure added to the digester should be near or warmer than the digester contents.

Total Solids Concentration. The total solids of manure influent to the digester shall be as

required by the digester type and process design. Except for any supplemental feedstocks and non-manure wastewater as described in following sections, water or wastewater, other than that needed for dilution to achieve the design total solids concentration, shall be excluded from the digester.

Treatment of Supplemental Feedstocks. Food waste and wastewater from food processing operations may be added as supplemental feedstocks to a digester when the following conditions are satisfied:

The digester is designed to treat such wastes, as documented in the Plans and Specifications.

The digester Operation and Maintenance (O&M) Plan includes the handling and treatment of such wastes.

The farm's nutrient management plan accounts for the nutrient impact of such wastes.

The treatment of such wastes meets all state and local regulations.

Treatment of Non-manure Wastewater. Wastewater from farm operations, such as milking parlor wastewater, barn floor wash water, and runoff from silage bunkers, may be added to a digester provided:

The digester design has accounted for the use and treatment of such wastewater.

The farm's nutrient management plan accounts for the nutrient impact.

DIGESTER TYPES

Plug Flow Digester. For ruminant manure the total solids concentration of influent shall be 11 to 14 percent. For other manure the total solids concentration shall be 8 to 14 percent.

Digester retention time shall be >20 days.

Operational temperature shall be mesophilic (95°F to 104ºF).

The length to width ratio of digester flow path shall be between 3.5:1 and 5:1.

The ratio of flow path width to fluid depth shall be less than 2.5:1.

The shape of the floor and walls shall be uniform to minimize mixing.

Complete Mix Digester. Total solids concentration of manure influent shall be from 2.5 to 10 percent.

Digester retention time shall be >17 days.

Operational temperature shall be mesophilic (95ºF to 104ºF).

Appropriate mixing devices shall be provided to assure a complete mix process.

Fixed Film Digester. Total solids concentration of influent shall be <5 percent. For total solids concentration >2.5 percent, the influent particle size shall be <0.25 inch.

Digester retention time shall range from one to six days, depending on waste biodegradability.

Operational temperature shall range from 59˚F to 104˚F.

Microbial support material with >3 inch openings will be included.

Alternative Digesters. Design of digesters not meeting the above design and operational criteria or other nonstructural parts of this standard (solids content, etc.,) shall be based on the documented design and performance of such existing animal waste digester and certified as such by an engineer licensed in South Dakota.

DIGESTER DESIGN

Digesters shall be designed to facilitate anaerobic digestion of animal manure and meet the minimum design and operational requirements below. The design documentation shall specify the type of digester and include a process diagram with the following minimum information:

Flow rates, influent, and effluent;

Design total and volatile solids content of influent and effluent;

Digester volume;

Retention time;

Heating system, control and monitoring;

Methane yield;

12-month energy budget (when applicable);

Process control and monitoring.

Digester vessels (tanks) shall be constructed from concrete or other corrosion-protected materials. Tanks and internal components

shall be designed to facilitate periodic removal of accumulated solids.

Digester vessels shall meet the structural criteria for “Fabricated Structures” in Practice Standard (313).

Digester Cover. The tank shall be equipped with a suitable cover designed for accumulation and collection of biogas. The cover system must exclude the entrance of air under all operating conditions. Covers shall meet Practice Standard (367), Waste Facility Cover.

Inlets and Outlets. Inlet and outlet devices shall be designed to facilitate process flow.

Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and prevent gas loss.

The digester shall be equipped with an outflow device, such as an underflow weir, that will maintain the operating level, maintain a gas seal under the cover, prevent gas loss, and release effluent directly to separation, storage, or other treatment facility.

Digester Vessel Characteristics. The digester shall be sized to retain the volume of manure and water at the design total solids concentration for the digester design retention time (days).

The configuration of the digester tank is specific to the type of digester chosen to most effectively meet this standard. Tank dividers or flow separators can be used to increase efficiency.

Operating Temperature. The design shall include heat loss calculations to determine insulation, heat exchanger capacity, and energy requirements for maintaining the digester operating temperature within acceptable limits.

Mesophilic Digesters - The digester shall be maintained between 95ºF-104ºF with an optimum of 100ºF and daily fluctuation of digester temperature limited to less than 1ºF.

Operating Level. The operating level of digesters shall be designed with appropriate freeboard and overflow or automatic shutdown devices to prevent accidental spillage of effluent or discharge into the gas collection system.

GAS COLLECTION AND TRANSFER

The biogas collection, transfer, and control system shall be designed to convey captured gas from within the digester to gas utilization equipment or devices (flare, boiler, engine, etc.).

The gas collection system within the digester shall be designed to facilitate exclusion of floating debris.

Pipe and components within the digester shall be securely anchored to prevent displacement from normal forces including loads from accumulated scum.

Pipe shall be designed for wet biogas. Insulate the pipes as needed to prevent frost buildup.

Pipes shall be constructed to enable all sections to be safely isolated and cleaned as part of routine maintenance.

Transfer pipe can be buried or installed above ground and must include provisions for drainage of condensate.

Gas Control: Equipment and components shall be conveniently located and sheltered from the elements.

Equipment and components shall have a service life of not less than two years and shall be readily accessible for replacement or repair.

The size of equipment and connecting pipe shall be based on head loss, cost of energy, cost of components, and manufacturers' recommendations.

Gas pipe installed within buildings shall be a type approved for combustible gas.

Electrical installations shall meet the National Electrical Code and local and state requirements.

Gas Utilization. Gas utilization equipment shall be designed and installed in accordance with standard engineering practice and the manufacturer's recommendations. As a minimum, the installation will include a flare to burn off collected gas and a means of maintaining the digester within acceptable operating temperature limits.

The flare shall be equipped with automatic ignition and powered by battery/solar or direct connection to electrical service. The flare shall have a minimum capacity equal to the anticipated maximum biogas production.

Included flares, gas-fired boilers, fuel cells, turbines, internal combustion engines and other gas usage equipment shall be designed for burning biogas directly, in a mix with other fuel, or shall include equipment for removing H_2S and other contaminants from the biogas.

OTHER DESIGN REQUIREMENTS

Monitoring. Equipment needed to properly monitor the digester and gas production shall be installed as part of the system. Provide temperature sensors and readout devices to measure the internal temperature of the digester and inflow and outflow temperatures of the digester heat exchanger. Provide a gas meter for measuring biogas volumes.

Safety. If the digester will create a safety hazard, it shall be fenced and warning signs posted to prevent children and others from using it for purposes other than intended.

Biogas is flammable and highly toxic. The design of the digester and gas components must consider the hazards associated with normal operation and maintenance and provide adequate safety measures including:

"Warning Flammable Gas" and "No Smoking" signs shall be posted.

Flares shall be grounded or otherwise protected to minimize lightening damage.

A flame trap device shall be provided in the gas line between the digester and sources of ignition or as recommended by the flame arrester manufacturer.

The location of underground gas lines shall be marked with signs to prevent accidental disturbance or rupture. Mark exposed pipe to indicate whether gas line or other.

Waste Storage Facility. A waste storage facility must be provided and must meet the requirements of Practice Standard, 313, Waste Storage Facility. The volume of the digester shall not be considered in determining the storage requirement of the waste storage facility except that the sludge volume can be reduced by the anticipated percent destruction of total solids.

CONSIDERATIONS

Location. In determining the location of the waste storage facility, consider elevation and distance from the digester to take advantage of gravity flow.

The digester should be located as near the source of manure as practicable and at least 300 feet from neighboring dwellings or public areas. Proper location should consider slope, distance of manure transmission, vehicle access, wind direction, proximity of streams and flood plains, and visibility.

The digester should be located near a suitable site for use of the gas. Short distances for the transmission of methane through buried pipe are preferable.

Manure Characteristics. Aged manure can be fed to the digester if properly reconstituted to the digester design total solids content. The biogas yield from aged manure (generally less than six months old) is dependent on the biodegradation that has taken place during the storage period. Little biodegradation will have occurred in frozen manure, whereas manure in a warm, moist state may significantly degrade.

Collection/Mix Tank. A collection/mix tank may be included to accumulate manure, settle foreign material, and pre-treat influent waste to the appropriate temperature and total solids concentration. A volume equal to two days of manure collection is recommended.

Digester Design. A digester operating fluid depth of eight feet or greater is generally considered more economical for tank design.

Cover Design. A secured, flexible membrane cover can be designed for significant storage of biogas whereas a rigid cover generally has limited storage.

Appropriate structures may be necessary to protect inflatable and floating digester covers from wind, ice, and snow damage.

Gas Utilization. The most beneficial use of the biogas energy must be investigated and selected. Digesters may require 50 percent or more of the biogas heat to maintain design temperatures in the winter. Digesters can be heated by hot water from boilers burning biogas or by heat recovery from engines burning biogas for power generation.

Effluent Tank. An effluent tank to hold digester effluent for solids separation treatment should be considered.

Gas Transfer Pipe. Exposed pipe conveying flammable gas is generally painted orange.

Visual Screening. Analyze the visual impact of the digester within the landscape. Screening with vegetative plantings, landforms, or other measures may alleviate a negative impact.

PLANS AND SPECIFICATIONS

Plans and specifications shall meet this standard, follow sound engineering practice, and shall describe the requirements needed to achieve its use.

Plans and specifications must include:

Layout and location of livestock facilities, waste collection points, waste transfer pipe, digester, biogas utilization facilities, and digester effluent storage.

Grading plan showing excavation, fill, and drainage, as appropriate.

Materials and structural details of the digester, including all premixing tanks, covers, inlets, outlets, pipes, pumps, valves, and appurtenances.

Details of gas collection, control, and utilization system including type of materials for pipe, valves, regulators, pressure gages, electrical power, flow meters, flare, utilization equipment, and associated appurtenances.

A process flow diagram.

OPERATION AND MAINTENANCE

An O&M Plan shall be developed and reviewed with the owner/operator. The plan must be consistent with the purposes of the practice, its safety requirements, and the design. Include:

Description of the planned startup procedures, safety issues including instructions for safe use or flaring of biogas.

Proper operating procedures for the digester including interization, loading rates and total solids content of the influent.

Estimates of biogas production, methane content, and potential energy recovery. Methods of measuring digester performance and operational effectiveness.

Estimates of biogas production, methane content, and potential energy recovery.

Alternative operation procedures in the event of equipment failure.

Digester and other component maintenance.

Troubleshooting guide.

Monitoring plan with frequency of measuring and recording digester inflow, operating temperatures, biogas yield, and other information as appropriate.