NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ANAEROBIC DIGESTER – AMBIENT TEMPERATURE

(no.)
CODE 365

DEFINITION

An unheated waste treatment impoundment.

PURPOSE

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

Produce and capture biogas for summer season energy use;

Improve air quality;

Reduce greenhouse gas emissions.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

Biogas production and capture are components of a planned animal waste management system. South Dakota is generally considered to be too far north for reliable energy production using this practice (Figure 1).

Existing waste impoundment(s) can be modified to the requirements of this standard or new construction will be used.

The digester is in conjunction with a separate waste storage facility or where the digester and storage are congruent.

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

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 collected fresh, generally less than seven days old. Manure shall be essentially free of soil, sand, stones, or fibrous bedding material (including clumps of straw), or shall be processed to remove such material.

Solids must be removed from ruminant's manure before entering the digester.

Frozen manure must not be added to the digester when digester contents are not frozen. Manure added to the digester should be near or warmer than the digester contents.

Rainfall Runoff. Rainfall runoff from outside the digester shall not enter the digester.

Anaerobic Digester. The digester shall meet the General Criteria for All Lagoons given in Practice Standard Waste Treatment Lagoon (359), as appropriate, and the following:

Minimum Treatment (Design Operating) Volume. The design operating volume shall be based either on the daily volatile solids (VS) loading rate per 1,000 ft^3 or the minimum hydraulic retention time (HRT) adequate for methane production, whichever is greater. The maximum daily VS loading rate shall be selected from the values listed on the map in Figure 2. The minimum HRT shall be selected from values listed on the map in Figure 3.

Required Total Volume. The required total volume of the digester shall be equal to the minimum treatment volume except where waste storage is included in the design, in which case the volume shall meet the additional criteria for Design Storage Volume in Practice Standard Waste Storage Facility (313), as appropriate.

Rainfall must be included in the digester storage volume only to the extent the design allows rainfall to enter the digester.

A minimum of two feet of freeboard above the digester design water surface shall be provided where rainfall will be trapped within the digester containment structure.

A minimum of one foot of freeboard above digester design water surface shall be provided where rainfall is freely drained from atop the digester cover or where the digester is sheltered from rainfall.

Length to Width Ratio of the digester is limited to 4:1 or less.

Operating Depth. The operating depth of the digester shall be at least 12 feet over 50 percent or more of the bottom area.

Interior Slopes. Digesters will function best with steep or vertical interior slopes.

Waste Inlet and Outlet. The inlet and outlet devices shall be located as far apart as practical to minimize "short circuiting."

The inlet shall discharge a minimum of 12 inches below the digester water surface.

Outlet. Except where the digester is designed to include storage, an outflow device shall be provided that maintains the digester water surface at its operating level and releases overflows directly to the waste storage facility without release of trapped gas.

Digester Cover. The digester 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 Waste Facility Cover (367).

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.

Separate Waste Storage Facility. Separate waste storage facilities shall meet the requirements of Practice Standard Waste Storage Facility (313). Where the digester will not be emptied each time the storage facility is emptied, no storage credit shall be attributed to the digester in meeting the minimum storage requirements in Practice Standard 313 except for sludge volume reduction based on expected total solids (TS) removed/destroyed.

Gas Collection, Transfer, and Control System. The biogas collection, transfer, and control system shall be designed to convey captured gas from under the digester cover to gas utilization equipment or device (flare, boiler, engine, etc.).

Gas Collection and Transfer:

Perforated pipe and other components under the digester cover shall be designed to exclude floating debris and waste residue and shall have a service life consistent with the expected cover life, but not less than 10 years.

Pipe and components under the cover shall be securely anchored to prevent displacement from normal cover forces.

The collection and transfer pipe shall be designed for wet biogas. The pipe shall be protected as necessary to prevent frost buildup. In no case shall the pipe size be less than three-inch diameter.

Pipe used for transfer of gas can be buried or installed above ground and must include provisions for cleanout, condensate drainage, pressure and vacuum relief, and flame traps.

Gas Control

Gas control equipment and components shall be conveniently located and sheltered from the elements.

Gas control 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.

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 recommendations. As a minimum, the installation will include a flare to burn off collected gas.

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.

Monitoring. When the purpose is to produce and capture biogas for energy, equipment needed to properly monitor the digester and gas production shall be installed as part of the system.

As a minimum, the equipment shall include a temperature sensor and readout device to measure internal temperature of the digester and a gas meter to measure 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 pipe shall be marked with signs to prevent accidental disturbance or rupture. Mark exposed pipe to indicate whether gas line or other.

CONSIDERATIONS

Using available gas to heat the digester can improve total solids destruction and further reduce greenhouse gas emissions. In geographic areas north of the 40th parallel (Figure 1), heat is required to maintain year around anaerobic digestion.

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.

Waste Transfer Pipe. The standard practice is to locate a cleanout immediately upstream of the digester. Influent from the waste collection pit discharges below the digester operating level, and depending on the installation, solids tend to build up in the inlet pipe. The cleanout

is also a good location for venting any gas that builds up in the transfer pipe.

Depth of Digester. Deeper digesters have improved performance.

Rainfall. Rainfall on the digester cover can result in increased effluent discharge into the storage facility. For normal rainfall events, this is probably not a problem. For high rainfall events, a ported riser on the outflow pipe should be considered to provide temporary storage and reduce the outflow rate.

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 purpose.

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.

Warranties. The cover manufacturer and/or installer shall warrant the cover for the intended use and design life, provide maintenance instructions, and certify that the cover is properly installed.

OPERATION AND MAINTENANCE (O&M)

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:

Proper loading rate of the digester and total solids content of influent.

Proper operating level of the digester.

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

A description of the planned startup procedures, normal operation, winterization and spring restart procedures, safety issues, and normal maintenance items.

Alternative operation procedures in the event of equipment failure.

Instructions for safe use and/or flaring of biogas.

Cover and gas collection system maintenance.

Daily inspection of the following:

Cover material – check for cracks, tears, or points of distress around perimeter.

Check for excessive ballooning of cover or presence of odor.

Check for excess rainwater on cover.

Check gas control panel, regulators, pressure gages, electrical power, flow meter, flare igniter, and flare operation.

Frequency of measuring and recording digester inflow, operating temperatures, biogas yield, and/or other information as appropriate.

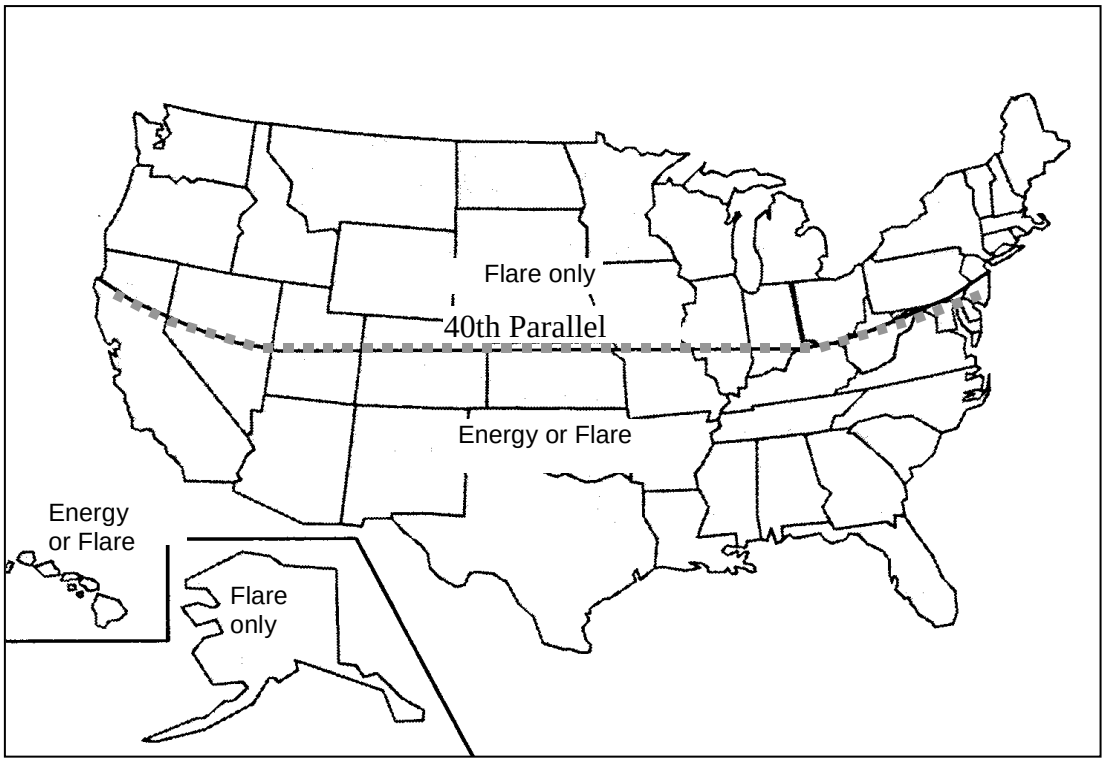

Figure 1. Ambient temperature digester. Locations suitable for energy production generally fall below the 40th parallel.

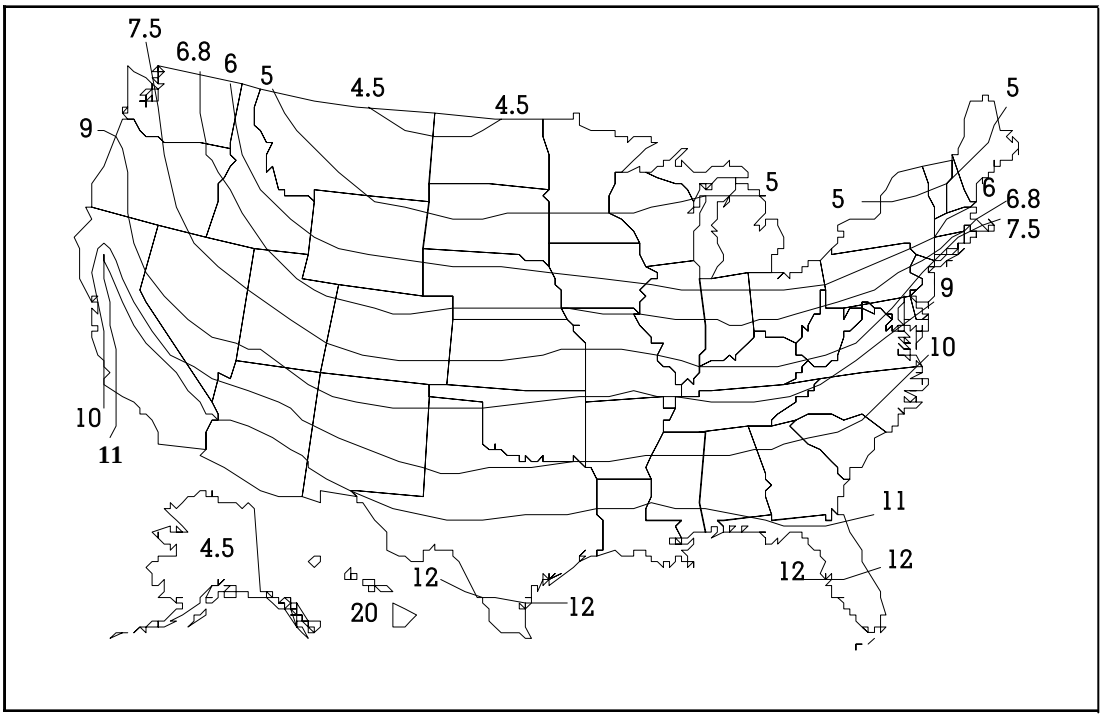

Figure 2. Covered anaerobic digester maximum loading rate (lb. VS/1,000 ft^3/day)

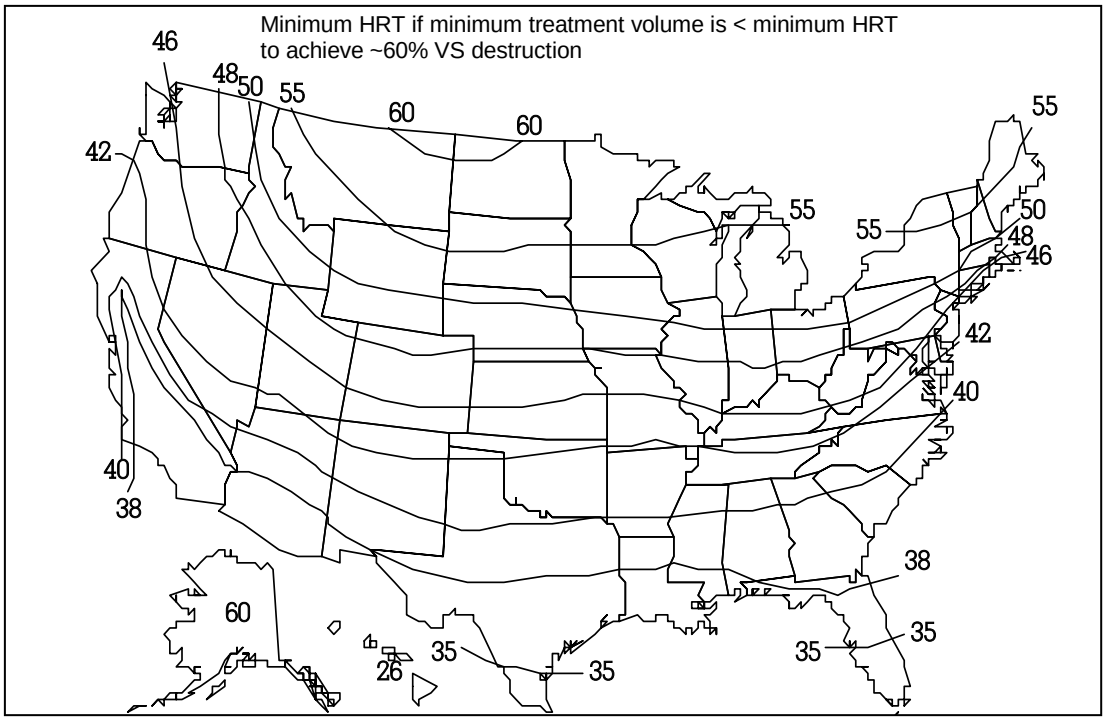

Figure 3. Covered anaerobic digester minimum hydraulic retention times (HRT) in days