

Complete Mix Digesters: Technical Details

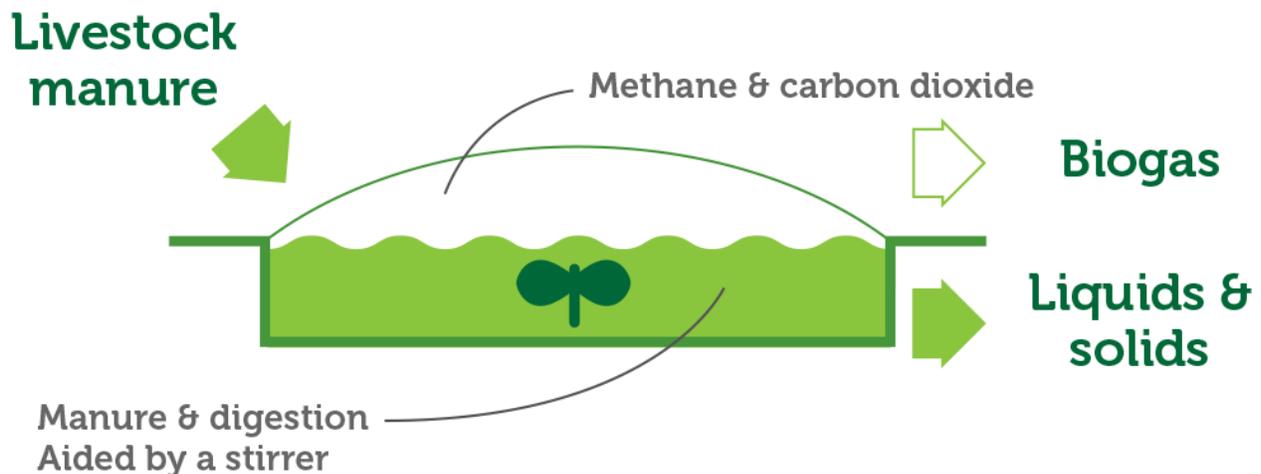
Information excerpted from: Biomethane from Dairy Waste: A Sourcebook for the Production and Use of Renewable Natural Gas in California

Description of Complete-Mix Digester

A complete-mix digester is a controlled temperature, constant volume, mechanically mixed, biological treatment unit that anaerobically decomposes medium concentration (3% to 10% solids) animal manures and produces biogas (60% methane and 40% carbon dioxide) and biologically stabilized effluent.

A complete-mix digester is designed to maximize biogas production as an energy source. The optimized anaerobic process results in biological stabilization of the effluent and odor control. The process is part of manure management system and supplemental effluent storage is usually required. Manure contaminated rainfall runoff or excess process water should not be introduced into the complete-mix digester.

Complete Mix Digester: How it Works



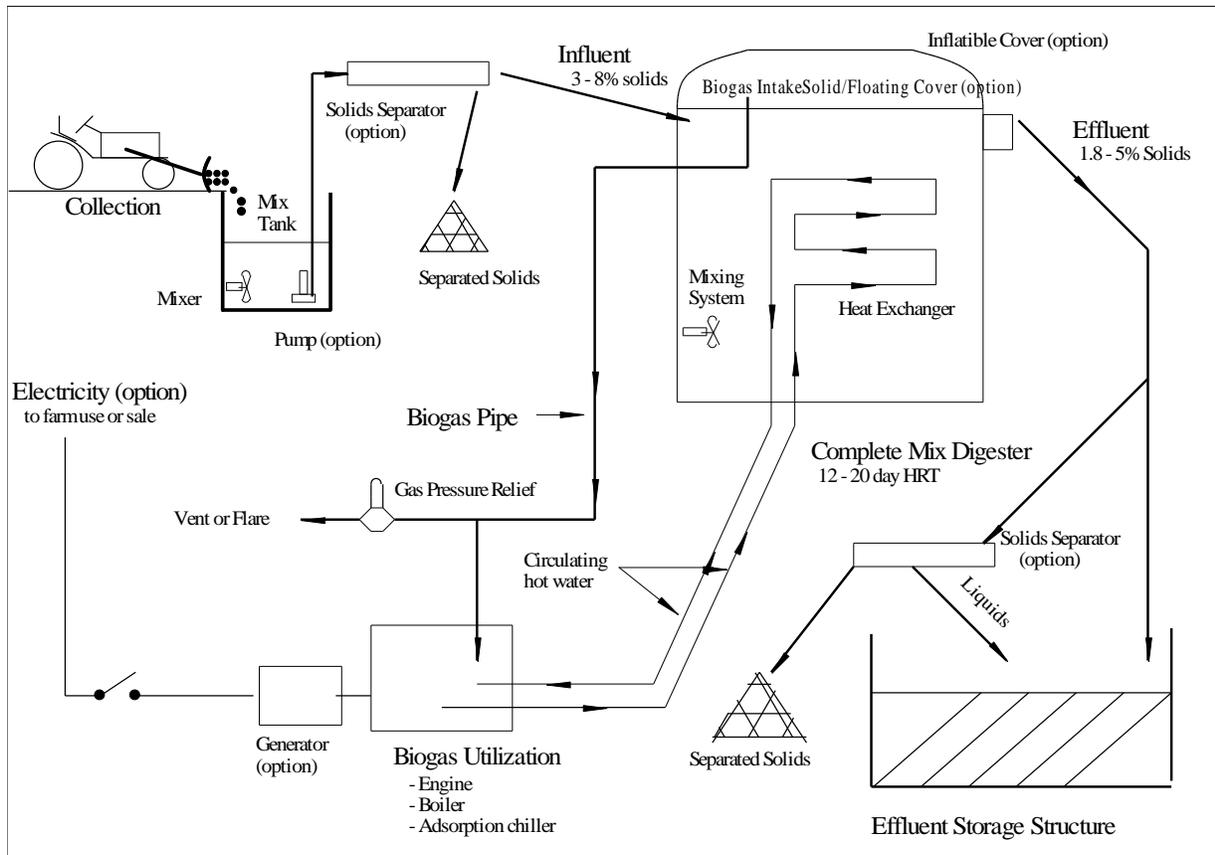
Components of Complete-Mix Digester

The components of a complete-mix digester system generally include a mix tank, a digester tank with mixing, heating and biogas recovery systems, an effluent storage structure, and a biogas utilization system. Pre- or post-digester solids separation is optional.

- *Mix tank.* The mix tank is a concrete or metal structure where manure is deposited by a manure collection system. It serves as a control point where water can be added to dry manure or dry manure can be added to dilute manure.
- *Pretreatment.* A solids separator may be used to separate solids from influent manure to reduce solids buildup in the digester.

- *Complete-mix digester.* A complete-mix digester is a heated, insulated above ground or in-ground circular, square or rectangular tank with a mixing system. The tank is covered by a fixed solid top, a flexible inflatable top, or a floating cover to collect and direct biogas to the gas utilization system. All covers are gas tight.
- *Biogas use.* The recovered biogas can be used to produce space heat, hot water, cooling, or electricity.
- *Solids separator (optional):* A mechanical separator may be installed after a complete-mix digester to capture fibrous materials fed as roughage to ruminants.

Complete Mix Digester System with Biogas Utilization



Complete-Mix Digester Design Criteria

- *Location:* A complete-mix digester can be located within a 600 ft radius of the mix tank at a convenient location with good access.
- *Optimum solids concentration.* The operating range for influent solids concentration in a complete-mix digester is 3% to 10% solids. However, 6% to 8% solids is the preferred concentration.
- *Mix tank.* The mix tank can be round, square, or rectangular. A pump may be required to move manure to the digester.
- *Hydraulic retention time and sizing of complete-mix digester.* A complete-mix digester will function with an HRT from 10 to 80 days. However, an HRT between 12 and 20 days is most commonly used to economically produce 60% to 75% of the ultimate methane yield.

- *Operating temperature.* A heat exchange system should maintain the daily temperature fluctuation at less than 0.55 °C (1 °F). Most complete-mix digesters operate in the mesophilic range between 35 to 41 °C (95 to 105 °F). It is possible for this type of digester to operate in the thermophilic range between (135 to 145 °F) but the digestion process is subject to upset if not closely monitored.
- *Insulation.* A complete-mix digester tank may require insulation to control heat loss.
- *Heat exchanger.* An external heat exchanger or an internal heat exchanger is used to heat and maintain the digesting mixture at the design temperature. Hot water or steam circulated through the heat exchanger is heated using a biogas-fueled boiler or waste heat from a biogas fueled engine-generator.
- *Construction materials.* The digester tanks can be concrete or metal.
- *Mixing.* Gas or mechanical mixing is used to stir the digester.
- *Dimensions.* The depth can be between 8 and 40 ft depending upon soil conditions and the required tank volume.
- *Methane recovery system.* A complete-mix digester is covered by a gas tight fixed solid top, a flexible top, or a floating cover to collect and direct biogas to the gas utilization system.
- *Solid cover.* A solid cover is constructed to avoid cracking and leaks. Solid covers should resist corrosion. A solid cover allows for minimal gas storage.
- *Inflatable Cover.* A coated fabric is generally used for inflatable covers. An inflatable cover can be designed for some gas storage. Wind protection may be necessary. The cover must have a gas tight seal. These materials are described in the covered lagoon discussion, above.
- *Floating cover.* A floating cover is designed to lie flat on the digester surface.

Operation and Maintenance of Complete-Mix Digesters

Operation and maintenance of complete-mix and plug-flow digesters is very similar and therefore will be discussed together in this section. Proper operation and maintenance of plug-flow and complete-mix digesters is necessary for successful operation.

- *Mix tank — operation.* On a daily or every other day basis, collectible manure is pushed, dragged or dumped into the mix tank. If necessary, dilution water or drier manure is added to the collected manure and mixed to achieve the design total solids mixture. The mixed manure is released via gravity gate or pumped into the digester.
- *Mix tank — maintenance.* Mix tank maintenance consists of normal maintenance of pumps and mixers per manufacturers recommendations. The mix tank will require occasional cleaning to remove accumulated sand, gravel, steel and wood.
- *Complete-mix— operation.* A complete-mix digester is fed hourly to daily, displacing an equal amount of manure from the outlet. The digester heating and mixing system should be checked daily to verify operation.
- *Complete-mix— maintenance.* The digester temperature should be checked daily. The effluent outlet and digester gas pressure relief should be checked weekly to be sure that they are operating properly. The heat exchanger pump should be lubricated per the manufacturer's recommendations. The mixer in a complete mix digester should be lubricated per the manufacturer's recommendations. Sludge accumulation may require sludge removal every 8 to 10 years.
- *Cover — maintenance.* The cover should be visually inspected weekly for rainwater accumulation, cracks, tearing, wear, and tensioning.

