Division of McNish Corporation

INSTALLATION PROFILE

Hot Water Boiler and Heat Exchangers

Water-to-Sludge and Sludge-to-Sludge Exchangers

GREEN MEADOW FARMS, INC.

Elsie, Michigan

The Methane digester at Green Meadow Farms handles the manure from farms 2 and 3. When the cows are in the parlor being milked, the alleys in the barns are scraped into a holding pit at the end of the pen. The barns are bedded with sand so the manure is full of sand when it enters the pit. Sand is considered the ultimate bedding from the standpoint of dairy cow health by providing a healthy environment for the udder, keeps cows cleaner, and aids in cow traction on slick concrete.

Once the manure is in the pit at the end of the barn, the sand needs to be taken out of it. For this process Sand-Manure Separators, from the McLanahan Corporation (http://agricultural.mclanahan.com/overview), and a hydrocyclone are used. The sand used for bedding has a gradation, that is, not all the sand particles are the same size. The Sand-Manure Separators remove the coarser sand and the hydrocyclone removes the finer particles. At this point the manure is almost sand free. The separated sand that comes out of this process is stacked to drain and dry. Within a couple months it will be ready to be reused under the heifers.

The manure is at about 12% dry solids concentration, and is pumped by a US Farm Systems (www.usfarmsystems.com) pit pump/agitator through a cutter and flows to the influent equalization pit at the Methane digester.

Three conventional mesophilic primary digesters, approximately 85' diameter by 24' deep, at a temperature of 102 degrees F are used to produce methane from the manure. Each digester has a volume of approximately 970,000 gallons. At the design manure influent flow of approximately 150,000 gallons per day, this is a hydraulic retention time in the digesters of approximately 20 days. Gravity transfer lines from digesters #1 and #2 to digester #3 allow digester #3 to function as a secondary digester, if desired. The hot mesophilically digested sludge flows from the digesters to the outlet equalization pit.

A concentric tube, sludge-to-sludge heat exchanger furnished by **Walker Process Equipment** (**WPE**) has a minimum 1,900,000 BTU/hr rating, and initially provided direct solids-solids heat recovery. The manure influent was pumped from the influent equalization pit by an inverter-driven lobe pump through the 5" diameter inner sludge tubes in a once-through operation and warmed by heat exchange with 107 gallons per minute of digested sludge pumped by an inverter-driven lobe pump from the outlet equalization pit in a once-through operation through the annular passages of the heat exchanger. The Walker Process® **sludge-to-sludge heat exchanger** cooled the digested sludge from 102 degrees F to approximately 70 degrees F. This flow scheme was abandoned after about two years of operation due to struvite accumulation in the annular passages of the heat exchanger, apparently caused by contact of the digested sludge with air as it discharged into the outlet equalization pit, and it has been converted into a hot water-to-manure influent heat exchanger. The warm manure influent now, as before, flows to a concentric tube, Type E **hot water-to-manure influent heat exchanger** furnished by **WPE**, which has a minimum 1,900,000 BTU/hr rating, and increases the warm manure influent temperature to approximately 102 degrees F.

The digested sludge flows to the open-top, post digester storage tank, and is subsequently hauled away for land application. The digested sludge is well stabilized and has the typical odor of mesophilically-digested solids.

A dual fuel **Type B boiler** furnished by **WPE** has a minimum 2,000,000 BTU/hr rating, and provides hot water at approximately 150 degrees F for the original (and converted) hot water-to-manure influent heat exchanger, the heating pipes embedded in the concrete walls and floors of the digesters, and building heating. The burner is a forced draft type, and burns digester gas as the primary fuel. Upon depletion of the digester gas, the burner automatically switches over to the auxiliary fuel, LPG. When the digester gas supply is restored, the burner automatically switches back to digester gas. A selector switch on the boiler control panel also allows for the manual selection of either fuel.

The digester gas produced in excess of that used in the boiler, approximately 325 cubic feet per minute at the manure influent design flow of approximately 150,000 gallons per day, has a heating value of approximately 600 BTU per cubic foot and is sold to North American Biofuels L.L.C. (http://www.northamericanbiofuels.net/blank.html), who fire it in a Caterpillar Gas Generator Set (http://www.cat.com/cda/layout?m=206981&x=7), rated 1025 kVA, 820 eKW, 60 Hz, continuous, and convert it to electricity. Heat is captured from the engine with a water jacket and from the exhaust, and recovered heat is used for the same heating purposes as the boiler above.

An ExTox Gasmess-Systeme GmbH (www.extox.de) ET-8D series control unit detects concentrations of oxygen, carbon dioxide, methane, and hydrogen sulfide in the digester gas going to the generator set. The presence of appreciable concentrations of oxygen in the digester gas, in conjunction with the gas indicators mounted on the digesters, could be indicative of leaks in the inflatable digester roofs.

Any digester gas in excess of that used in the boiler and generator set is wasted to three flares. This would usually occur only if the generator set was down for one reason or another.

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