

Dairy Waste-To-Energy
...no land disposal of manure
...zero liquid discharges

Made possible by the

OATTM

**Optimized Anaerobic
Treatment Process**

No Lagoons.

- 💧 All liquid and solid wastes are continuously treated, not stored.
- 💧 Existing lagoons may be decommissioned.
- 💧 Animal deads are processed and added to the waste feedstock rather than rendered.
- 💧 Eliminates all potential for surface runoff and groundwater pollution.

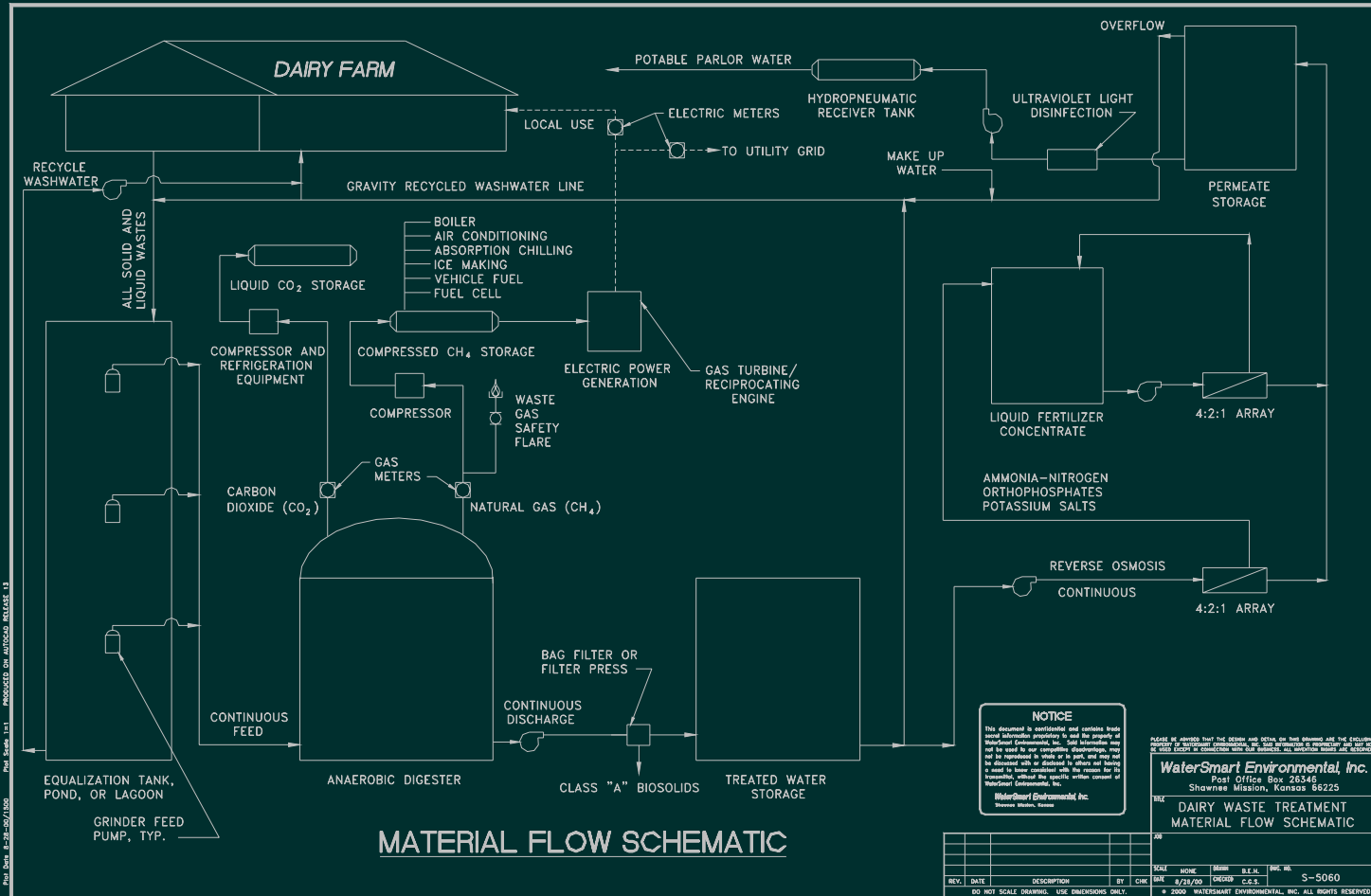
No Land Disposal of Solids or Liquid Manure.

- 💧 Dairy waste solids and liquids are continuously treated by anaerobic digestion and converted into methane gas, carbon dioxide gas, organic fertilizer, and liquid fertilizer concentrate.
- 💧 Animal deads are ground and added to the digester as organic wastes.

No Liquid Discharges.

- 💧 The digester effluent is highly purified by reverse osmosis (RO) treatment.
- 💧 The RO concentrate contains ammonia nitrogen orthophosphates, and potassium salts, the main components of liquid fertilizer.
- 💧 The RO permeate is continuously recycled for livestock drinking water.

Total Treatment Design.



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Solids (Digestate) Composition.

- 💧 Grit and sand.
- 💧 Insoluble Sulfides of Cadmium, Calcium, Copper, Iron, Lead, Manganese, Trivalent Chromium, and Zinc.
- 💧 Approximately 1-1-1 NPK (Nitrogen, Phosphorus, and Potassium)
- 💧 Qualifies as Class “A” Biosolids in compliance with 40 CFR Part 503
- 💧 Also Qualifies as Organic Fertilizer

Solids Management.

- 💧 May be used as livestock bedding material since it is pathogen free.
- 💧 May be sold to the marketplace as an organic fertilizer commodity.
- 💧 May be sold to the marketplace as a soil conditioner or soil amendment.

Liquid Streams.

- 💧 Liquid fertilizer concentrate.
- 💧 Reverse osmosis permeate.

Liquid Fertilizer Concentrate.

- 💧 Contains about 20-10-10 NPK in a concentrated water solution.
- 💧 Contains trace amounts of aluminum, magnesium, and sodium salts

Reverse Osmosis Permeate.

- 💧 Total dissolved solids < 50 mg/L
- 💧 Total coliform count < 1MPN/100 mL
- 💧 BOD < 1 mg/L
- 💧 COD < 1 mg/L
- 💧 TOC < 1 mg/L
- 💧 TSS < 1 mg/L
- 💧 NPK < 10 mg/L

Liquids Management.

- 💧 Liquid fertilizer concentrate may be directly used by the farmer for routine crop nutrient requirements.
- 💧 Liquid fertilizer may be sold to the marketplace as a commodity.
- 💧 Reverse osmosis permeate water is continuously recycled as livestock drinking water.

Other Co-Products.

- 💧 Methane gas.
- 💧 Carbon dioxide gas.

Co-Product Methane.

- 💧 Is compressed, dried, and stored at 300 psig for site use and for generation of electricity.
- 💧 Compressed methane may also be sold as CNG (compressed natural gas).
- 💧 Generated electricity may be used at with excess sold to utility grid.

Co-Product Management.

- 💧 No release of methane gas to the environment.
- 💧 No release of carbon dioxide gas to the environment.
- 💧 No gas releases accomplish a 500%+ reduction in greenhouse gas effect.

Complete Odor Control.

- 💧 No liquid or solid manures are ever land applied to create odors.
- 💧 Odors within enclosed livestock barns are controlled by continuous use as power plant combustion air thereby achieving complete thermal oxidation. Odors are therefore destroyed rather than discharged to the environment.

Co-Product Carbon Dioxide.

- 💧 Is compressed, dried, purified, and liquefied for sale to the marketplace as a commodity.
- 💧 Meets food and medical grade quality.

The OAT™ Process.

Is the *only* process that combines:

- 💧 Two-phase Anaerobic Digestion
- 💧 Thermophilic Bacteria
- 💧 Staged Phase Treatment
- 💧 Fixed Growth Media
- 💧 Flow Recirculation
- 💧 pH and Temperature Control
- 💧 Essential Nutrient Addition

Bacteria Can Produce Fuel From Liquid & Solid Wastes.

- 💧 Solid waste landfills biologically generate methane gas (called *biogas*) as clear evidence of the ability of bacteria to produce fuel.
- 💧 Biogas is a mixture of carbon dioxide and methane gas. It has a heating value of about 25,000 kJ per cubic meter.
- 💧 Biogas can be used as a primary fuel or to generate electricity.

Wastewater Treatment Plants Use Bacteria.

- 💧 Almost all wastewater treatment plants use bacteria to treat the water.
- 💧 Aerobic plants use aeration. They *consume* about 8,000 kJ per kg COD (Chemical Oxygen Demand) removed.
- 💧 WaterSmart's OAT™ anaerobic plant *generates* about 22,000 kJ/kg COD for an energy improvement of about 30,000 kJ/kg COD.

Wastes That Can Be Converted Into Biogas.

- 💧 Municipal Wastewater
- 💧 Landfill Leachate
- 💧 Chemical Manufacturing
- 💧 Pulp & Paper Mills
- 💧 Sugar Mills
- 💧 Palm Oil Mills
- 💧 Breweries & Distilleries
- 💧 Fish & Food Processing
- 💧 Agricultural Solid Wastes
- 💧 Cardboard & Sawdust
- 💧 Ethanol Plants
- 💧 Rubber Plantations

...More Eligible Wastes.

- 💧 Animal Feed Lot Wastes
- 💧 Dairy & Cheese Production
- 💧 Fruit & Vegetable Canning
- 💧 Pharmaceutical Wastes
- 💧 Rendering Plants
- 💧 Textile Manufacturing
- 💧 Municipal & Industrial Digester Sludge
- 💧 Food and Green Wastes
- 💧 Municipal Solid Wastes

A Renewable And Alternative Energy Source.

- 💧 These many wastes are generated each and every day in the normal course of living.
- 💧 The routine treatment or disposal of wastes is tremendously *expensive*.
- 💧 The OAT™ process, however, makes their treatment or disposal *profitable*, an extremely pleasant surprise.

Excess Energy Produced.

- 💧 The OAT process uses some of the methane it generates to heat the wastewater being treated.
- 💧 The excess methane can be sold, used to operate pumps, or generate electricity.
- 💧 The excess green power electricity can be used by the treatment plant, sold to the local electric utility, or even to a distant business or city through the Internet.

Positive Return On Investment.

- 💧 When one generates a profit from the treatment of wastes, a *positive return on investment* (ROI) always results.
- 💧 Rather than a burden on society, wastes may now be viewed as an **asset**--an incredible reversal of common perception.
- 💧 Wastewater treatment plants of the patented OAT™ design can now pay for themselves!

Energy Costs.

- 💧 Wastewater treatment is very expensive, particularly because of energy costs which increase at 3-5% every year.
- 💧 A typical biological wastewater treatment plant uses about 8,000 kJ per kg COD (Chemical Oxygen Demand) removed.
- 💧 WaterSmart's OAT process can produce up to 22,000 kJ/kg COD removed, for an *energy improvement* of about 30,000 kJ per kg COD.

Capital Equipment Costs.

- 💧 Are also very expensive, on the order of US\$2K+ for every kg of COD treatment capacity.
- 💧 If ammonia, nitrate, phosphorus, or heavy metal removals are required, the associated costs are much higher.
- 💧 WaterSmart's OAT™ Anaerobic Treatment Plant costs about half as much as other anaerobic systems treating the same amount of COD or Volatile Solids.

Environmentally Friendly And Sensible.

- ◆ Korea's Sudokwon Landfill, the world's largest, has the motto: *"Don't Waste Wastes."*
- ◆ We share that view and believe wastes should be converted into something useful, like fuel or electricity, if it can be done so safely and economically.
- ◆ In so doing, waste volumes are greatly reduced to better manage the environment for ourselves and the next generation.

Odors?

Absolutely None!

- 💧 All treatment is carried out in closed vessels
- 💧 Hydrogen Sulfide is removed from produced biogas.
- 💧 All gasses are captured and used or recycled. None escape.

Environmental Damage? Absolutely None!

- 💧 No emissions to atmosphere.
- 💧 Heavy metals removed as insoluble sulfides.
- 💧 Organic constituents removed to innocuous levels.
- 💧 Effluent contains nutrients which are beneficially recycled.

Beneficial Co-Products

In addition to **methane gas**, the OAT™ process generates other useful and profitable co-products.

- 💧 Carbon Dioxide
- 💧 Organic Fertilizer
- 💧 Liquid Fertilizer Concentrate
- 💧 Reverse Osmosis Permeate Water

Greenhouse Gasses

- 💧 A methane powered generator or gas turbine will discharge EPA permissible amounts of carbon dioxide when producing electricity.
- 💧 If a fuel cell is used to make electricity, no carbon dioxide is discharged.
- 💧 No methane is ever discharged to the environment.

Noise...

Practically none!

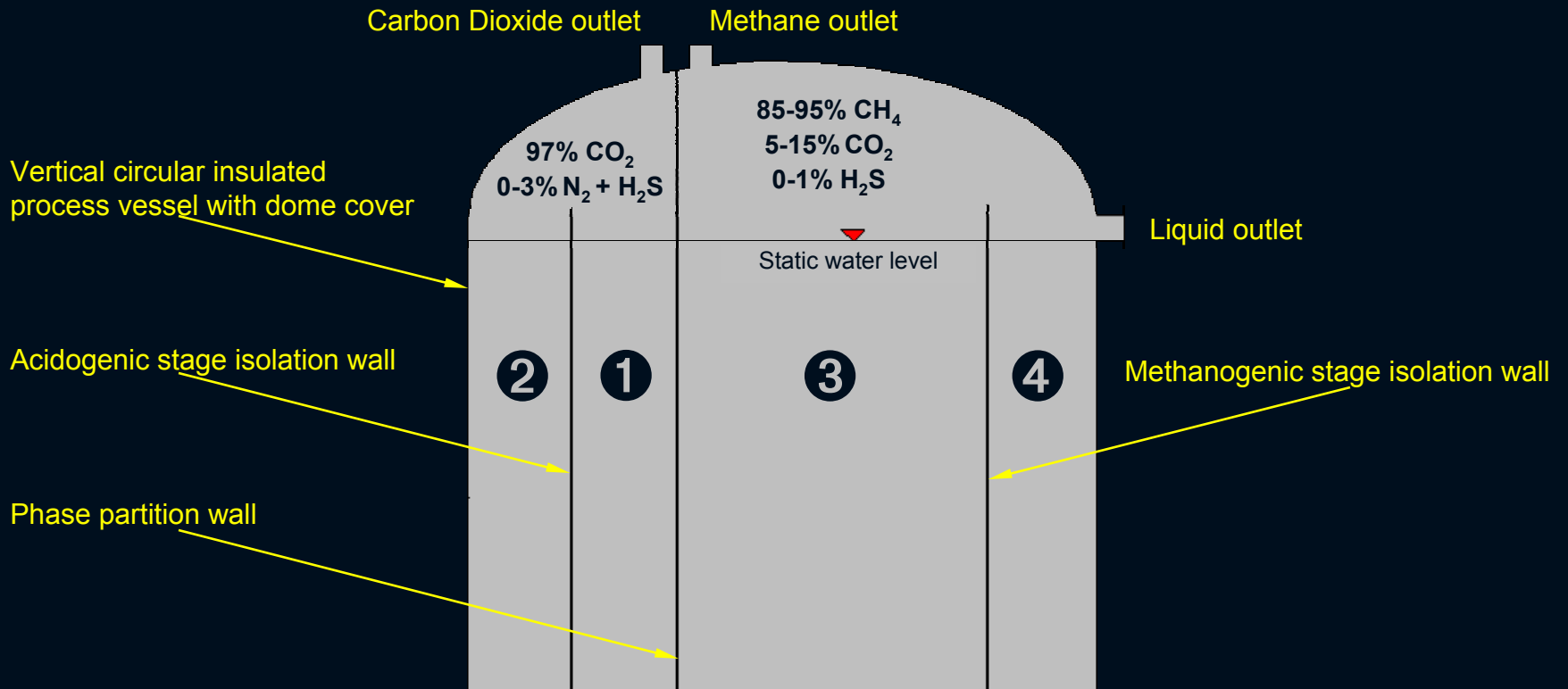
The loudest component is a biogas powered generator or turbine -- similar to a truck engine.

Noise producing equipment can easily be enclosed for noise attenuation.

Sludge

- 💧 0.01 pounds of solids produced for every pound of BOD removed—about 25% that of competitive anaerobic treatment plants!
- 💧 OAT™ process sludge qualifies as **Class “A” Biosolids** that can be sold as fully certified organic fertilizer.

Single Vessel Design.



① 1st stage acidogenic digester

② 2nd stage acidogenic digester

③ 1st stage methanogenic digester

④ 2nd stage methanogenic digester

Headworks.

- 💧 After trash removal:
- 💧 Grind or comminute the raw wastewater.
- 💧 No primary treatment required.
- 💧 Biosolids may be ground and added.
- 💧 Organic wastes may also be added.
- 💧 Liquid organic wastes may also be added.
- 💧 Green Wastes may also be added.
- 💧 Food wastes may also be added.

Sophisticated Design But Easy To Operate.

- 💧 Automatic controls simplify routine plant operations.
- 💧 Close process control translates into a high degree of treatment efficiency.
- 💧 Minimal plant operator skill required.

OAT Upgrades Available.

- Existing anaerobic digesters may usually be upgraded to the OAT process thus saving project site construction and piping costs.
- A complete upgrade to the OAT process can increase the digester capacity 10 times.
- Beneficial use or sale of the produced methane, electricity, Class A biosolids, reverse osmosis permeate water, and carbon dioxide makes the upgrade a positive ROI.

Summary.

- 💧 Wastes can be beneficially converted into fuel or electricity.
- 💧 An efficient anaerobic treatment process results in a positive return on investment.
- 💧 The OAT™ process is the **most efficient** anaerobic treatment available worldwide.
- 💧 OAT™ plants are smaller, less expensive, do not smell, and generate a profit.
- 💧 Reverse Osmosis permeate can be continuously recycled for livestock drinking water

For Project Feasibility Studies and Proposals

Contact: WaterSmart Environmental, Inc.

POC: Chuck Steiner @ 913.897.2727

Fax: 913.897.1902

email: csteiner@ix.netcom.com

Website: www.watersmart.com