Evaporation of waste wash water occurs during normal operation of the pressure, steam or automatic vehicle wash system. It is generally assumed that 10-30% of wash water is lost to evaporation. Accelerated evaporation can be used to dispose of excessive wastewater, highly contaminated wastewater, or to remove recycled water with high dissolved solid (TDS) build up.

General Definitions

Evaporation
The process in which a liquid dissipates or emits vapor, fumes, or invisible minute particles.

Distillation
A process that consists of driving gas or vapor from liquids or solids by heating and condensing to liquid products once again.

BTU's (British Thermal Unit)
Amount of energy required to raise a 1 lb. mass of water 1°F @ 1 atmosphere.

VOC's (Volatile Organic Compound)
Organic compound which readily dissipates into the air at room temperature, i.e., benzene, gasoline.

TDS (Total Dissolved Solids)
The amount of ionic matter dissolved in a fluid and can be measured by electric current.

Thermal Oxidation
High temperature breakdown of contaminants to carbon dioxide and water.

TSS (Total Suspended Solids)
Substances suspended in a fluid large enough to be visible by the human eye and small enough to be kept in suspension by the movement of the fluid molecules.

Condenser
An apparatus in which gas or vapor is condensed to a liquid form.

Efficiency

Water evaporation efficiency is based on some basic laws of physics:

- It takes 9,346 BTU to evaporate 1 gal. of water.
- Natural gas has a heating value of 100,000 BTU's (1 Therm=100,000 BTU)
- Approximate cost of natural gas is $0.50 per Therm
- Efficiency Equation - **Q = UADT**
  Where "Q" = efficiency of heat transfer
  "U" = heat conductance of exchanger material
  "A" = area of heat transfer surface
  "DT" = difference in temperature between heated surface of exposed material to be evaporated

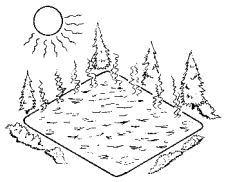
Cost Calculation Example:
Evaporators have a thermal efficiency of 60-80% (average of 70%). For calculations we'll use 70% efficiency or 14,000 BTU to evaporate one gal of wastewater at sea level.

1000 gal. of wastewater x 14,000 BTU per gal. = 14,000,000 BTU, $0.50/Therm = $70 = ***$0.70 cents per gal. evap.***

Note: An efficiency factor is present with all evaporators and must be calculated.

Methods

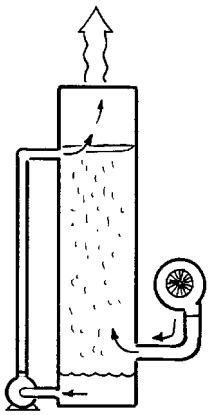
Natural Evaporation Ponds



Rely on the combination of solar heat and wind to naturally evaporate water. This method requires a great deal of area, is slow, and is subject to the weather.

Problems:
- Very slow
- Requires large land mass and pond liner

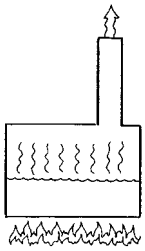
Forced Air Evaporators



Utilize blowers to force air in a counter current to a spray of water pumped to the top of a column and free falling downward. The evaporation rate is largely dependent on the water temperature and the dew point. This method is cost effective and highly efficient when the waste stream to be evaporated is preheated by another process, and the wastewater does not contain volatile compounds (VOC's) that would be readily transferred to the air, and thereby create air pollution. Not recommended for water high in dissolved or suspended solids as they will deposit on the internals and block the water air flow. This design has no method of removing dried solids. Cost estimates depend on the temperature of the waste stream.

Problems:
- Source water should be preheated by process generating waste.
- Efficiency is dependent on the relative humidity and water temperature.
- Air permitting may be required

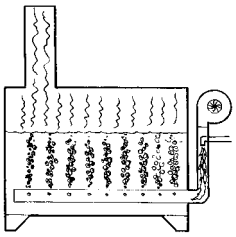
Boiling Water Evaporators



Basically heating the water to its boiling point 212°F and exhausting the steam via an exhaust pipe. This method has no way to remove dried solids other than baking the tank contents down to a cake, which insulates the heat and holds it into the steel causing early tank failure. Efficiency is usually 65-75% depending on design. With the addition of a condenser, you can distill the water for reuse.

Problems:
- Acids and salts will attack the steel

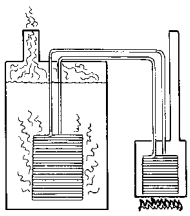
Steam Tube with Water Exhaust Evaporator



Basically the same concept as a Boiling Water Evaporator. However, the hot exhaust gases are bubbled through the wastewater to improve heat transfer efficiency. VOC's will be vaporized and air pollution will result. Dissolved and suspended solids removed periodically by draining a slurry. Efficiency is 75-85%.

Problems:
- You still have a highly concentrated liquid water slurry to dispose of
- VOC's will be exhausted as air pollution
- Acids and salts will attack the steel, shortened vessel, and steam tube life
- Air pollution permitting concerns

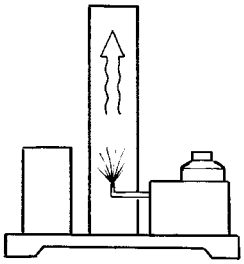
Heat Exchanger Evaporators



Heat a coil filled with a high temperature oil, which is pumped to another coil inside a tank containing the waste. The advantage to this system is that the tank can be made of non-corrosive polypropylene with no direct flame contact. The vapor can be distilled, efficiency is 70-80%.

Problems:
- Air permitting may be required
- Coil failure

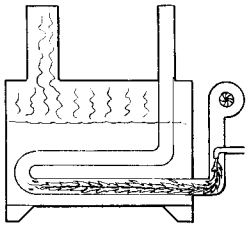
Boiler Blow-Off Evaporators



Can evaporate large volumes (2-4 gpm) at a low cost and are effective on pretreated waste streams. Have no method of collecting or removing of suspended solids. Most of the dissolved solids are vaporized in the steam at 212°F and blown off into the atmosphere. VOC will be vaporized and will create air pollution. Therefore, all VOC's and solids must be removed from this system. Efficiency is 70-85%.

Problems:
- No method of collecting solids, droplet carryover.
- VOC's will vaporize and could create air pollution
- Not suitable for distillation for water reuse

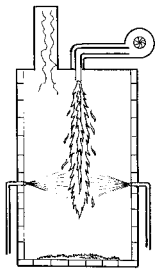
Steam Tube Evaporators



Utilize a hot tube as a heat source. The flame is directed inside a steel tube thereby saving the tank from flame impingement and early failure. The tube will fail. However, it is easily replaceable and considerably less expensive than the tank. Efficiency is 70-80%. The water is heated to 212°F. The vapor can be distilled and reused.

Problems:
- VOC will be vaporized and will create air pollution
- Dissolved solids and suspended solids are periodically drained off in a slurry solution and this highly concentrated liquid waste must be disposed of
- Acids and salts will attack steel vessel
- Low tube life expectancy

Liquid Thermal Oxidation

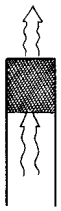


A method of liquid destruction. The liquid waste atomized and sprayed under pressure directly into a 2100° flame. At 1250°F all VOC's and organics are oxidized, and dissolved and suspended solids are thermally oxidized to ash. Efficiency is 70-85%. Solid contaminants are reduced to a powdered inorganic ash.

Problems:
- Air permits may be required

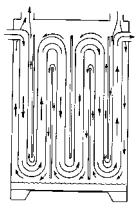
Add-On Systems

Vapor Destruction System



Utilize ozone to oxidize remaining exhausting volatile organics followed by activated carbon to neutralize the ozone.

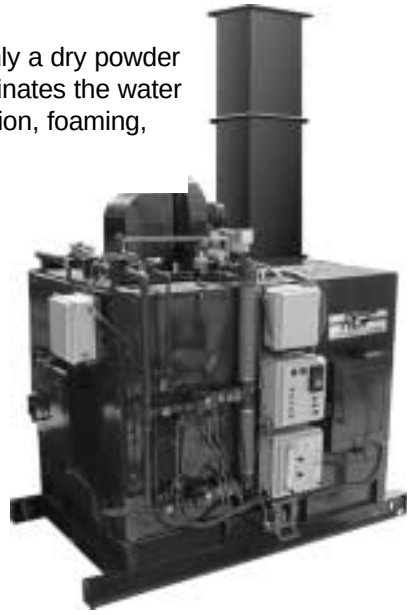
Condensers



A heat exchanger that converts the vapor back to pure distilled water.

RGF Thermo Oxidizer
Wastewater Combustors

The Thermo Oxidizer System completely oxidizes water borne waste streams, leaving only a dry powder as the residual waste material. Unlike evaporators, the Thermo Oxidizer completely eliminates the water content of the liquid waste. The unit eliminates the typical evaporator problems of corrosion, foaming, residual slurry, V.O.C. emissions, and difficult to clean evaporator chambers.



THE CONCEPT

The ***RGF*** **Thermo Oxidizer** is designed to completely oxidize liquid waste, leaving only a dry ash residue. By automatically controlling the fuel modulation and the waste flow, maximum efficiency is achieved resulting in a fuel cost as low as $0.03 per gallon. ***RGF*** utilizes a cast ceramic refractory for all interior combustion surfaces to eliminate corrosion and metal failure. By utilizing an optional waste oil burner, the system can eliminate both waste oil and wastewater.

- *Fuel*: L.P.G., N.G., (diesel optional)
- *Typical Operating Temp.:* 1200 - 1400 °F
- *Primary Burner:* Down Fired 1,250,000 BTU Eclipse Burner
- *Controls:* PLC Programmable Controller
- *Dimensions:* 80"W x 72"D x 108"H
- *Construction:* A-36 carbon steel, ceramic refractory
- *Weight:* 11,000 lbs.

ADVANTAGES OF THERMO OXIDATION

Lower Cost Of Fuel
Traditional evaporators utilize a wastewater reservoir of 50-200 gallons, which must be heated and maintained to 212° F, requiring a lot of wasted energy. *RGF's* Thermo Oxidation Process sprays a high pressure controlled atomized flow directly into the flame, thereby eliminating the 50-200 gallon heated water mass, which results in a cost as low as $0.03 per gallon. *RGF* is so confident of their cost per gallon figures that they will give you a written guarantee for your particular application. With the waste oil burner option, fuel cost is virtually eliminated. Additional savings can be realized with the complete elimination of both waste oil and water.

Reduced Air Emissions
Traditional evaporators simply heat water to 212° F, or boiling point, which produces steam to evaporate the waste away. However, V.O.C. - Volatile Organic Compounds are also driven off with the steam producing air pollution problems that could far exceed your wastewater problems. *RGF's* Thermo Oxidation Process will combust any V.O.C. as the waste stream is atomized and sprayed under pressure directly into the open flame of the burner. With a retention time exceeding two seconds. This is more than enough temperature and time to oxidize most contaminants. A high fire setting is available with secondary chamber temperature of 1,400-1,600° F., 1,250° F is generally accepted as a total oxidation temperature for hydrocarbons.

No Residual Slurry
Traditional evaporators require a periodic removal of the concentrated slurry, which can consist of highly concentrated hazardous wastes presenting a disposal problem. *RGF's* Thermo Oxidation Process totally oxidizes the waste to ash, which may be disposed of as non-hazardous. In cases of highly contaminated waste streams, the oxidizer is set for 1,400° F, which will render almost any waste harmless.

Residue from 2,000 gal. of parts washer waste

No Corrosion
Traditional Evaporators utilize a waste stream reservoir where the water is heated to 212° F, or boiling, to produce steam which is vented off as air emissions. The problem is heat, water and steel do not mix well and, when added to the water chlorides and sodium, create a real corrosion problem. Even expensive stainless steel will develop stress corrosion, cracking, carbide precipitation, and inter granular corrosion, resulting in early failure. *RGF*, therefore, developed a high temperature ceramic liner for the wet combustion chamber thereby eliminating corrosion problems.

Item #	*Description*	*Waste Oxidation Rate*	*Ship Wt.*
TO-30	RGF Thermo Oxidizer TO-30 Wastewater Combustor	Up to 30 g.p.h.	11,000 lbs.
TO-60	RGF Thermo Oxidizer TO-60 Wastewater Combustor	Up to 60 g.p.h.	14,000 lbs.
TO-150	RGF Thermo Oxidizer TO-150 Wastewater Combustor	Up to 150 g.p.h.	16,000 lbs.