

# **APPLIED THERMAL DESIGNS**

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# **GREEN MONSTER**™

## **Oil Recovery System**

(Anaerobic Indirect Heated Rotary Kiln)  
**Separating Hydrocarbons from Solids**



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### **INTRODUCTION**

**A novel and innovative approach to providing a source of fuel and solving an difficult environmental problem.**

The Applied Thermal Designs (ATD) Oil Recovery System is a proprietary process that separates organics and solids. In most cases a significant portion of the organics can be recovered for



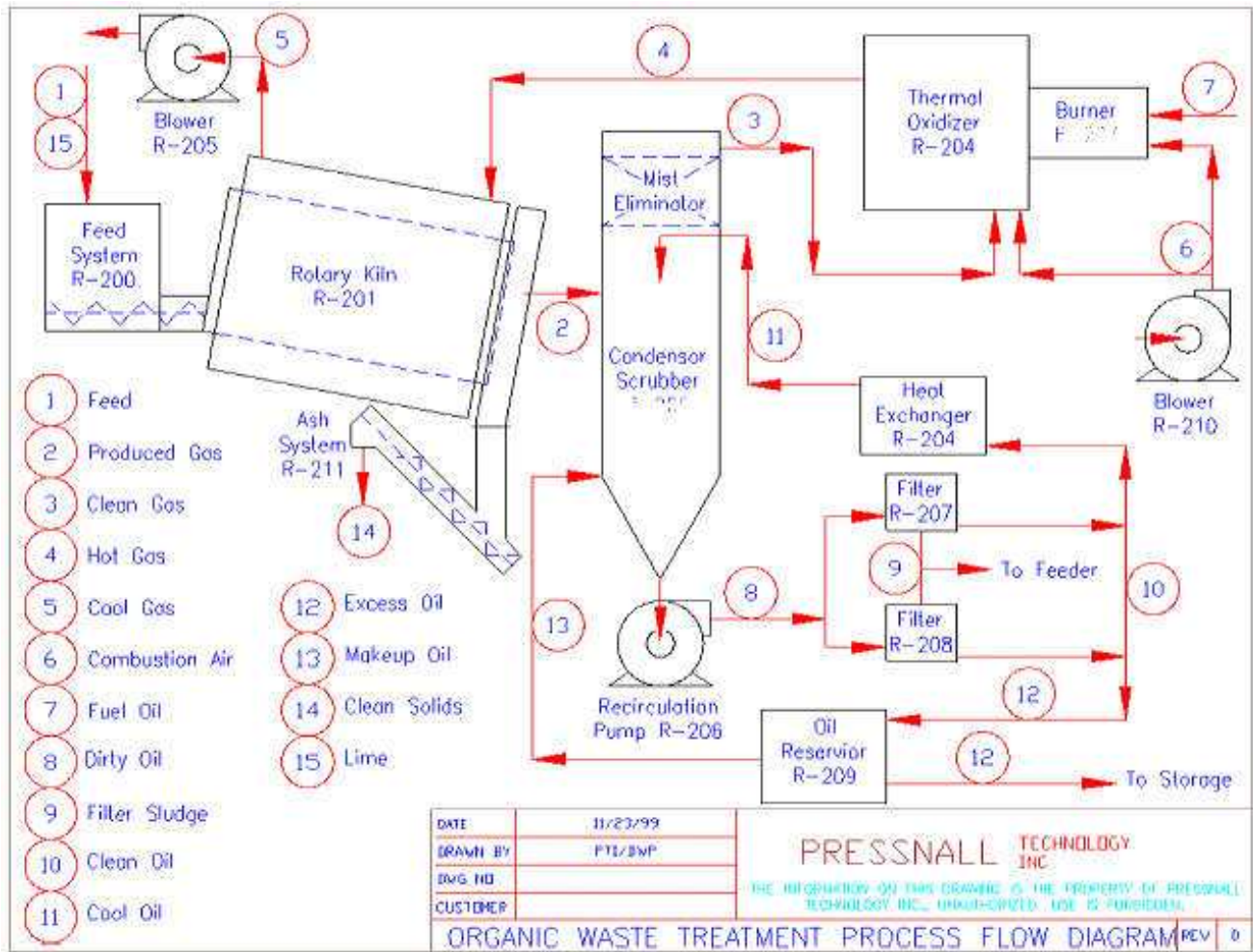
use as fuel. This is environmentally beneficial both by disposing of a serious health hazard and by replacing fossil fuels.

Pyrolysis is the “chemical decomposition of a substance by heat”. Pyrolysis of hydrocarbons is accomplished in an oxygen free atmosphere to prevent oxidation or burning of the products of decomposition.

All of the major previous technologies have had both economic and technical handicaps. The capital cost of the systems have been very high and the quality of the oil produced (if any) has been unsuited for commercial use.

A serious problem associated with some processes has been excessive gas production due to the very high temperatures required by the pyrolysis reactors. It is universally reported that with higher operating temperatures, less oil and more gas is produced. Additionally, the quality of the oil is significantly affected by the absolute pressure and temperatures of the process. These must be closely controlled to achieve high-quality valuable products.

A combustion chamber that is designed as a thermal oxidizer and a high-efficiency scrubber, assure that the exhaust emissions comply with current US EPA regulations. The solids can be easily cleaned to less than 100 ppm THC. Less than 10 ppm THC is readily achieved with most types of waste. Depending on the unit size, solids composition and the level of contamination, feed rates vary from 25 to 300 (metric) tons per



day. The process is applicable for the separation of organics from refinery wastes, coal tar wastes, wood-treating wastes, creosote-contaminated soils, hydrocarbon-contaminated soils, mixed (radioactive and hazardous) wastes, synthetic rubber processing waste, pesticides, and paint wastes.

### TECHNOLOGY

The Applied Thermal Designs Oil Recovery system provides a technology that overcomes the limitations of the previous approaches. The Oil Recovery system uses a proven indirect fired rotary kiln operating under specific vacuum, temperature and residence time parameters to optimizing the yield of oil and gas produced from the wastes. An overview of the system is shown in the adjacent figure. Similar technology is currently being used successfully in Texas to remediate sludges from refinery tank bottoms and in Russia to clean up oil field wastes.

The feedstock is waste solids with hydrocarbon contents from nil to near 100%. The primary products of this unit are a high Btu gaseous fuel and a high Btu liquid fuel that is similar to diesel fuel oil. The gaseous fuel is used as it is produced from the system in the combustion chamber. The liquid fuel produced is stored for later use or resale.

The system design incorporates an indirect fired rotary kiln system that is heated by the exhaust from the combustion chamber. Using an innovative engineering design this reactor operates under vacuum so that there are no fugitive emissions. Heat transfer from the reactor to the feedstock is maximized using turbulent flow at the interface between the waste solids and the rotating hot kiln shell.

The Oil Recovery system consists of two major components. The first is the pyrolysis system and the second is the combustion chamber coupled to it. The gas produced in the former is burned in the latter and the exhaust of the combustion system is sent to the rotary section.



The basic system provides a revenue stream from the oil produced by the process. In areas where the oil has no value, the system can be operated to produce no oil. The only waste stream to dispose of is dry ash. In most cases, this can be returned to the excavation site as clean fill.

### OPERATION

- The Applied Thermal Designs Oil Recovery System uses an externally fired rotary drum with special "Puff-Pruf" process seals to keep air out the process. The ATD Oil Recovery System is a completely preassembled portable system designed to thermally separate hydrocarbons from solids. The hydrocarbons are recovered as oil and/or fired to heat the process. The system consists of an indirectly fired rotary Oil Recovery System custom designed for each customer application. Hoods to attach the feed and ash removal systems are mounted at each end with special seals to prevent air from entering the process.
- The solids feed system consists of a live bottom hopper screw feeder system, feed transfer conveyor, and feed injection screw. These are special heavy-duty screw conveyors designed by ATD specifically for this service. This system requires that the items in excess of 2" x 2" x 2" be shredded or crushed.
- Material is placed in the Live Bottom Hopper (LBH) by a front-end loader or backhoe. The LBH has a variable speed drive and a pair of counter rotating screws that meter the material to the Feed Transfer Conveyor (FTC).
- The FTC is an inclined tubular screw conveyor that transfers the material from the LBH to the Feed Injection Screw (FIS).
- The FIS is a special tubular screw conveyor with a pair of external bearings and a cantilever drive shaft. It is designed so that the conveyed material forms seal to keep air out of the process. The FIS feeds the material into the indirect fired rotary Oil Recovery.
- The kiln shell is heated by hot gases passing over its external surface. Extended surface technology is used to ensure maximum heat transfer efficiency. The hot chrome-nickel alloy steel shell then heats the solids as they contact it. The material is conveyed through the tube by its rotation and slope. No air or fire is added inside the tube. Because air is kept out of the kiln, the water and hydrocarbons vaporize without burning. Only the products vaporized in the kiln require scrubbing. As the combustion chamber is fed only clean gas, additional scrubbing is not required for the flue gases.

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- To insure that all hydrocarbons will be separated from the soil, the kiln has a unique floating lifter system combined with a solids recirculation system. This pulverizes all solids before they exit the kiln drum. All solid particles over a specific size are returned to the front of the drum for additional processing. The floating lifters scrap the walls of the rotating drum while grinding and mixing the material. By preventing carbon deposits from accumulating on the drum walls, optimum heat transfer capacity is maintained. In addition a quantity of heat transfer media is recirculated with the oversize solids to assist in the reduction process and enhance thermodynamic efficiency. By insuring that all solids are reduced to a small size before exiting the kiln, hydrocarbon extraction efficiency is optimized.
- The gases from the kiln are sent to the quench/scrubber where heavy hydrocarbons and particulate are removed by the scrubbing oil. The remaining clean gases, are sent to the combustion chamber, and the hydrocarbons are burned. The combustion chamber is size with sufficient capacity to act as a thermal oxidizer. If insufficient hydrocarbons are present to maintain the process temperature, light fuel oil is fired by the burner.
- The products of combustion from the combustion chamber pass through the kiln plenum to heat the kiln drum and its contents.
- The process induced draft fan maintains a vacuum in the kiln drum and draws the gases generated through the system. The cooled combustion gases are then sent the atmosphere through a short vent stack.
- This system will allow the stack emissions for the system to comply with current US EPA standards.
- The liquids and particulate captured in the quench/condenser/scrubber (scrubber) are circulated to the filter system and heat exchanger to remove the solids and cool the fluid. The solids are removed and returned to the Oil Recovery feed system. The cooled and cleaned fluid is returned to the scrubber. The excess oil is collected in the oil reservoir and is drained off periodically to storage for sale or reuse.