

## PYROLYSIS FACILITY

Wednesday, October 13, 2004

**Facility Name:** Müllpyrolyseanlage (MPA) MSW Pyrolysis Plant

**Location:** The (MPA) MSW Pyrolysis Plant is located two miles outside the City of Burgau, Germany. This plant process refuse for about 120,000 residents, 34,000TPY, which all the county of Günzburg (294 square miles). The plant is located on a three (3) acres lot and it is adjacent to the county council's landfill (closed landfill). Farmland surrounds the site within a one-mile radius. The plant started operating in 1984 and in 1987 the facility was taken over by the county of Günzburg, and presently the plant is operating to its full capacity.

**Start-up Date:**

- Beginning of trial run in 1983
- Commissioning in mid-1984
- One year test run by plant supplier in 1986
- Takeover by county in 1987

**Conversion Technology:** Thermal: Pyrolysis (kiln)

**Conversion Technology Supplier:** WasteGen UK Ltd. Technology is designed by TechTrade.

**Definition: Pyrolysis** – The thermal degradation of carbon-based materials through the use of an indirect, external source of heat, typically at temperatures of 750 to 1,650°F, in the absence or almost complete absence of free oxygen. This thermally decomposes and drives off the volatile portions of the organic materials, resulting in synthetic gases (syngas) composed primarily of hydrogen (H<sub>2</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Some of the volatile components can be formed into tars and oils to be used as fuel. Air emission control systems remove almost all air pollutants. After cooling and cleaning in emission control systems, the syngas can be utilized in boilers, gas turbines or internal combustion engines to generate electricity or used to make chemicals. The organic materials that are not volatile or liquid are left as a char material that can be further processed or used for its absorption properties (activated carbon). Inorganic materials form a bottom ash that requires disposal.



**Technical Meeting and Facility Tour with:** Colin Hygate, WasteGen, Ltd., and Dr. Rüdiger Schmidt (designer of the original facility and now a consultant to WasteGen)



**Owner/Operator:** Müllpyrolyseanlage (MPA) MSW Pyrolysis Plant, which is owned by County of Günzburg.

**Feedstock:** The plant process about 38,580 tons/year of municipal solid waste (MSW), which include; residual domestic waste, commercial waste, bulky waste, and sewage sludge (feedstock is 25% moisture, 45% organic, 30% inorganic). No pre-segregation of the MSW feedstock is provided, however, all material must be shredded into a 12-inch maximum size. Heating value of feedstock is:

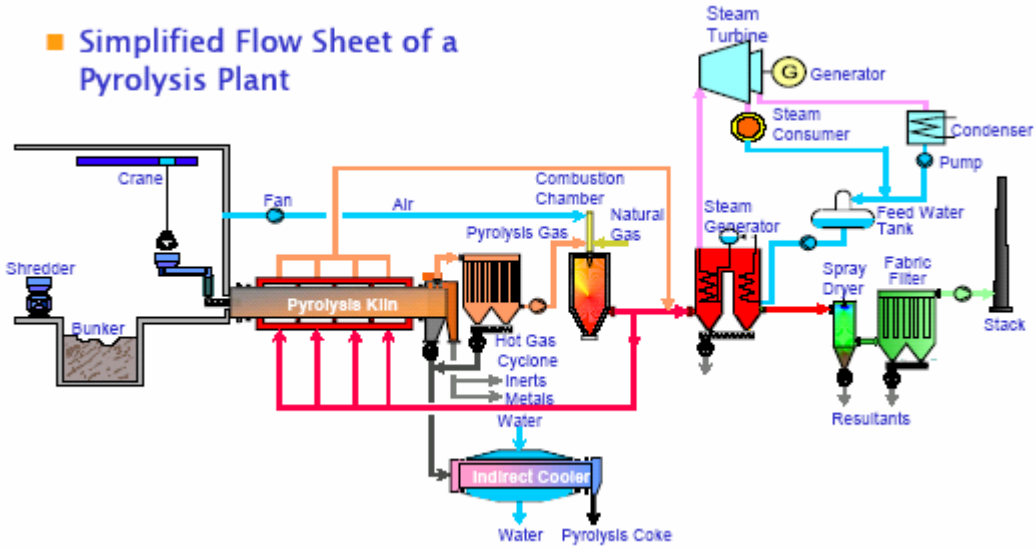
- average 3,662 Btu/lb
- max 6,033 Btu/lb
- min 2,155 Btu/lb

**Technology Description:**

The two-unit plant consists of:

- Refuse treatment
- Two rotary kilns
- Dust separation
- Combustion chamber for pyrolysis gas incineration
- Waste heat boiler and steam turbine generator
- Bag house filter with addition of sodium bicarbonate and activated carbon
- Induced draft fan and stack

■ Simplified Flow Sheet of a Pyrolysis Plant



Raw MSW is delivered to the facility by the county's sanitation department.



Private citizens can also bring household waste (white goods, large furniture, and recyclables) to the facility.



The garbage trucks dump their waste into the below grade bunker, which has up to a week's storage capacity. Sewage sludge is brought in by tanker truck every 2-3 weeks, and dumped into the waste bunker.



The waste is picked up by a grappling hook and dropped into the shredder feed bunker. There are two 33-ton/hour shredders (one operating/one standby). The shredder cuts the waste into a 12-inch maximum size (300mm size). The shredded waste is then dumped into below grade storage area adjacent to the delivered MSW storage area.

The grappling hook is then used to feed the shredded waste into the pyrolysis feed chutes. Lime is added (16 lbs/ton MSW) for removal of  $\text{SO}_2$  in the syngas.



A slide gate is used to feed the waste into the screw feeder, and to keep incoming air out of the oxygen out of the feed system. This provides a seal from outside air and a constant feed to the kiln.



A spare feed screw is kept on site.



The screw feeder moves the waste into the kiln inlet (but stays out of the hot gas stream).



The waste enters the two 2.64 tons/hr (TPH) rotary pyrolysis kilns, which turn at 1.5 RPM. Each kiln measures 7.2' diameter x 72' long, with a wall thickness of 1 inch. The material of construction is AC66.

The steel kiln rotates inside an insulated jacket clad in metal. Part of the hot flue gas from the combustion chamber (at about 2,300 °F) flows through the jacketed portion of the kiln. The outside walls of the kilns are then heated indirectly from the hot flue gas in the combustion chamber. The outside of the kiln reaches 1,292°F, and the inside of the kiln reaches 925 °F, resulting in pyrolysis of the organic portion of the MSW and producing the syngas. The residence time in the kiln is 1 hour.



The cooled flue gas exits at the top of the kiln through insulated pipes, and is returned to the top of the boiler, where it is mixed with the hot flue gas from the combustion chamber.



Solids from the kiln (carbon char, minerals, glass) are discharged through a water bath, which provides a seal against air entering the kiln and a quench for the hot residues.



A ram is used to push the char mixture down into the water bath.



The char and ash are removed by a wet slag remover.



The char mixture is dumped onto the conveyor belt.



The ferrous metal contained in the solid residue is extracted with a magnetic separator and conveyed into a small bin.



The metals are stored onsite for pickup by the users.



After the metal removal, the conveyor with the remaining solids discharges into a bin.

Several bins are kept ready on site. This material is landfilled as inert waste at the county council's adjacent landfill. The main characteristics and inert material of the pyrolysis residue (char/ash) are as follows:

**Main Characteristics**

- Appearance/color: black
- Odor: odorless
- Density: 37.5 lb/ft<sup>3</sup>
- Caloric value: 3,706 Btu/lb
- Quantity: 600 lbs/ton MSW

**Inert Materials:**

- Aluminum oxide
- Silicic acid
- Calcium oxide
- Iron oxide
- Carbon
- Anions (sulfates, carbonates, etc.)



The pyrolysis gas also contains 40-60% steam and approximately 15% organic condensation products (tars and oil).



The hot, dirty syngas passes through a hot gas cyclone, which removes most of the particulate matter (PM).

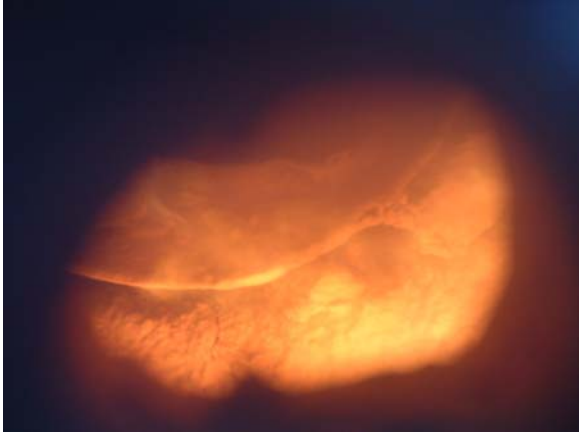


The solids are removed through a double valve arrangement, to assure that hot syngas is not released.



The PM collected in the hot gas cyclone is discharged onto the solid residue conveyor for disposal in the landfill.





The combustion chamber burns the syngas, along with the landfill gas, using air drawn from the tipping hall (for odor control), at temperatures in excess of 2,282°F.



At the top of the combustion chamber, some cooler flue gases from the pyrolysis kiln outlets is used to help control the flue gas temperature



Typically, 80% of the hot flue gas goes to the boiler.



20% of the hot flue gas exits the combustion chamber and flows back to the pyrolysis kilns to provide indirect heat for pyrolysis.



The flue gas passes through a bag-house filter that removes the remaining PM. Sodium bicarbonate and activated carbon are injected into the flue gas stream, absorbing gaseous pollutants ( $\text{SO}_2$  and  $\text{HCl}$ ) and mercury.



The ash falls into a small bucket and the ash material is very grainy. It is taken to a salt mine for disposal.



The fan creates an induced draft in the system and moves the flue gas to the stack.



The flue gas is discharged through a 93' high stack.  
In the flue gas monitored pollutants include (actual measured emission values achieved are lower than the permitted values):

- Particular Matter (PM)
- Hydrochloric Acid (HCl)
- Sulfur dioxide (SO<sub>2</sub>)
- C total
- Cadmium / Thallium
- Mercury
- Dioxins / Furans



The system is managed from a control room, housed in a 2-story building that also contains the power generation equipment.



Steam is generated in the boiler, and drives a 2.2 MW steam turbine generator for power generation. Over the last 18 years, the heating value of the MSW has increased from 2,600 Btu/lb to about 4,400 Btu/lb (more plastics, etc). As a result, more, high heating value syngas was being produced. The boiler did not have enough heat transfer surface, and was limiting gas throughput. A new boiler was retrofitted last year, solving the problem.



Residual steam/condensate is piped to a nearby greenhouse. In the greenhouse, four crops of cucumbers and tomatoes are grown each year.

**Products:** The combustion chamber burns the syngas and the landfill gas, using air drawn from the tipping hall (for odor control), at temperatures in excess of 2,282°F generating steam. The steam is used to drive a steam turbine with an electrical generator to produce 2.2 MW. The steam residual is used in an adjoining greenhouse that grows tomatoes and cucumbers. Approximately 22,473 ft<sup>3</sup>/ton MSW of syngas is produced annually.

The syngas produced by pyrolysis of the MSW in the kiln contains the following gases:

- Hydrogen (H<sub>2</sub>)
- Carbon monoxide (CO)
- Carbon Dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Hydrocarbons

The heating value is 268-376 Btu/ ft<sup>3</sup>, depending on the quality of the feedstock.

**Byproducts:** Pyrolysis char and ash, mixed together, recovered ferrous metals. Since an eddy current separator is used, aluminum is not recovered.