HOW PYROLYSIS WASTE TO ENERGY WORKS

The use of pyrolysis in the thermal processing of municipal solid waste is becoming more widespread in application due to the overall flexibility of the pyrolysis process. Compared with existing incineration or gasification techniques, pyrolysis is more effective in reducing the mass bulk, and putrescibility of the solid waste and is more effective for increasing the overall resource recovery while reducing air pollution dramatically versus incineration and gasification. Pyrolysis is the term used for an irreversible chemical change brought about by the action of heat in an atmosphere devoid of oxygen. Synonymous terms are thermal decomposition, destructive distillation, and carbonization.

The pyrolysis of organic compounds yields:

- Char
- Organic liquids (Heavy Fuel Oils)
- Fuel gas – used for the process fuel gas
- Waste heat – used to dry the wet MSW to be processed.

The char contains any mineral ash or other non-combustible material present in the waste plus what is termed the "fixed carbon," which represents the carbonaceous fraction of the original material that did not volatilize on heating. The char also usually contains small quantities of hydrogen and oxygen, and nitrogen is sometimes present and can be used to produce charcoal briquettes and sold into the local charcoal mark.

The liquids are a complex mixture of chemicals and are often called "Heavy Fuel Oils", because they are mixture of short and long carbon chains and were first produced by the destructive distillation of the raw MSW. The fuel gas consists of a number of combustible gases, and is used as fuel gas for the pyrolysis process.[1]

Municipal solid waste (MSW) management is an intensifying challenge on a global level. Even though reliable data are difficult to obtain in this field and large variations occur, current trends show that MSW generation is growing worldwide. This growth is observed not only on the total MSW generation but also on the per capita generation. Trends for the EU 25 show a constant increase for the last decade. For comparison, the USA was producing about 740 kg/year per capita (highest generation rate in the world) and India (representative of developing countries) 150-200 kg/year. It is obvious that MSW is a complex and heterogeneous mixture, made of materials with very different chemical structures and physical properties.

2.0 PYROLYSIS (CDP) OF MSW

Pyrolysis (CDP) systems thermally degrade solid waste without the addition of any oxygen. The process is optimized for the production of fuel gases and liquids or pyrolysis oils (sometimes called bio-oils if biomass feedstock is used). Pyrolysis also produces vapour gases and a solid char product, whereby the vapour gases produced are cooled into non-condensable gases and condensed liquids. Pyrolysis liquids can be used directly (e.g. as boiler fuel and in some stationary engines) or refined for higher quality uses such as motor fuels, chemicals, adhesives, and other products. Direct pyrolysis liquids may be toxic or corrosive unless catalytic reformed in the vapour gas phase.

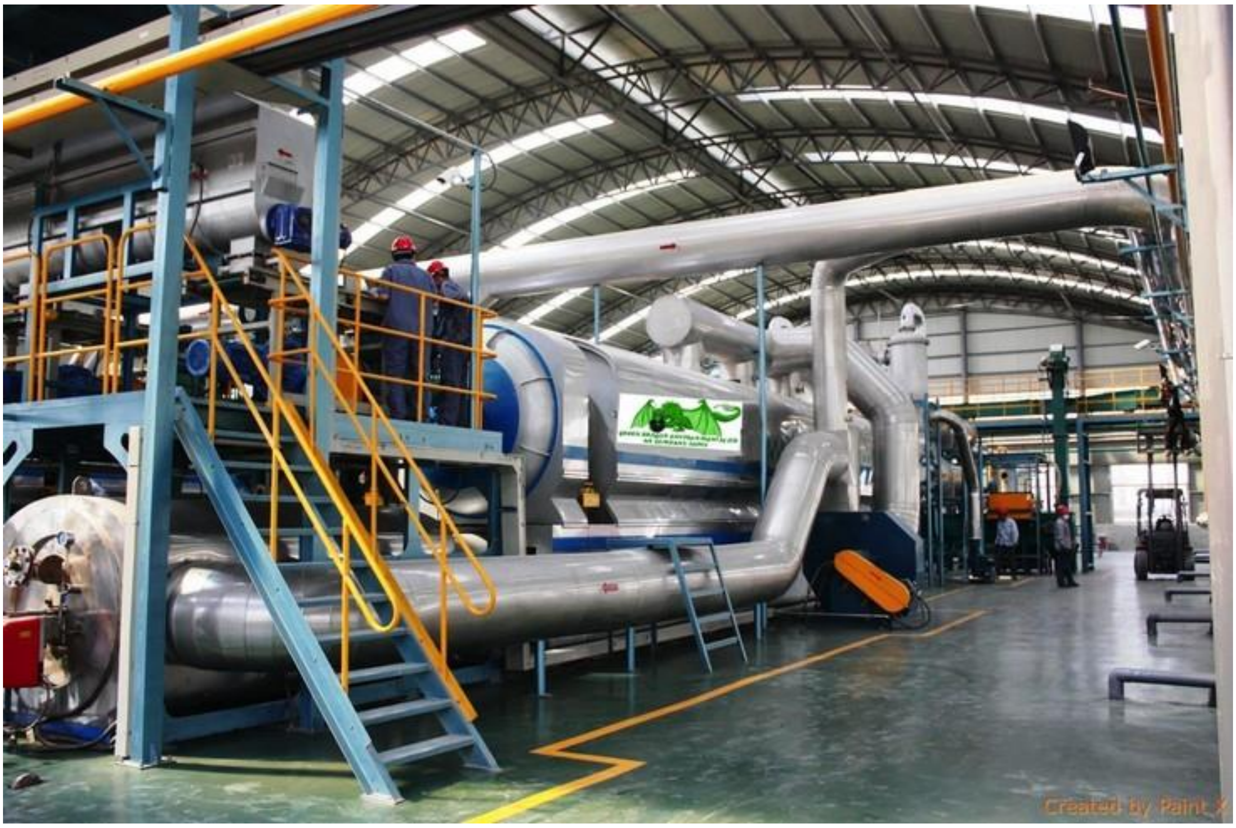
In the process of pyrolysis of MSW, there are four main operational points to not only maximize the respective product outputs, but also to minimize toxic or harmful influences:

1) An effective front-end sorting process that diverts, batteries, fluorescent light bulbs, etc to a hazard collection point, along with glass and ferrous and non-ferrous metals
2) Size reduction to 6-12 mm
3) Reducing moisture content to 10% or less
4) Consistent thermal heat rate = reduced retention time

3.0 INPUTS & OUTPUTS

Depending on the mix of the MSW feedstock, the pyrolysis chambers produce a feedstock-to-oil conversion rate o f approximately 45% of input values. Each pyrolysis line, comprising a pair of chambers, processes 10,000 MT per annum including maintenance downtime, an average of 30MT a day, when operated according to warranty conditions. With this production each line on a daily basis is capable of producing 2.6 Mw, therefore to achieve 14 Mw output and produce +/- 70 Mt of viable fuels per day, the plant will require 10 lines each processing 30 Mt dry (<10% moisture) or 300 Mt/day of dried MSW. Oil produced per line per day = 13.5 MT (45% of 30MT) per line (baseline liquid fuel output figure)

Based on a wet MSW delivery value of 500 MT per day for the plant, sorted and dried to a daily available input of 298 MT, and producing 45% oil production, we would have available on a daily basis 146 Mt. The daily consumption of the oil for 14 MW production is 72 Mt. The balance 74 Mt would be run through a distillation module to produce liquid fuels. (examples of fuel production based on a 32 tray distillation column would be D1, D2, Kerosene, gasoline etc).



4.0 ADVANTAGES MSW PYROLYSIS

- It is safer and more environmentally friendly than incineration and land filling and many other gasification processes.
- It takes trash and converts it into valuable new products, oil, carbon and gas.
- It allows for the recovery of metals and glass either before the process.
- It is suitable for a mixed (heterogeneous) waste stream.
- It complements traditional recycling efforts.
- It preserves land for agricultural or other uses that would be taken up by land fills.
- It creates jobs.
- It has the potential to reduce the carbon footprint by reducing the distances that trash is hauled, by reducing the machinery that is used to handle the trash at the land fill, and by sequestering carbon in products which would otherwise be used for fuel or released as landfill gases.
- It's sustainable by reusing products that are thrown away. Unsorted MSW is a source of sustainable energy. Typically for 120 tons daily capacity plant treating MSW with a calorific value of 8-9 MJ/kg and moisture <10%, the pyrolysis process generates ~10-13 MWh of electricity via with liquid biofuels utilized in a HFO engine.

Additionally, waste heat is utilized for the drying system of the MSW. Each particular design of the MSW pyrolysis plant can be adjusted in accordance with the design specifications to optimize the power and heat, supplied, e.g. ratio between generated electricity and heat.

5.0 EMISSIONS

In respect to emissions of a MSW pyrolysis, firstly there are no stack emissions[2] from the actual process, as the heating medium, i.e. recovered syn gas is catalytically cleaned prior to burning, and the captured heat exhaust from the burner chamber is utilized for the drying process of the MSW, with the final exhaust passing through a catalytic converter prior to be emitted, thereby producing emissions below EPA & EU limits.

Therefore, pyrolysis indirect emissions are lower in quantities than those coming from incinerators or gasification. The application of lower temperatures for pyrolysis treatment vs incineration & gasification; results to the avoidance of formation of dioxins and furans and reduce NOx emissions. Pyrolysis also achieves emissions reduction by the detention of alkali, sulphur, heavy metals and chlorine in its residue via the application of organic catalytic influences.

6.0 THE SYSTEM MODULES

a) Pre-processing and feeding system:

The waste materials initially pass a pre-processing line comprising a sorting line, a shredder, a dryer and a bunker for pre-processed waste. The sorting line filters out recyclable goods which cannot be pyrolized: metals, glass and inerts like concrete, stones, sand, ceramics, etc. These materials, usually making for 15-20% of the initial amount, can be sold to the recyclables' market as an additional source of income for the project. The remaining waste will go into a shredder, where it is chipped and ground to a material size of 6-12 mm in diameter and then sent off to the dryer. The dryers are used to lower moisture content in the feedstock to 10% in order to produce higher power generating results.

b) Pyrolysis reactor

Passing the storage silos the waste materials are then conveyed into the pyrolytic chamber through a specifically designed loading unit with a series of valves and gates being synchronized to prevent unwanted oxygen or air from entering the chamber. The production capacity of a single module is 30 TPD with waste moisture content <10% .A pyrolytic process which applies indirect heat in an environment free of flame and oxygen is the most important stage. Subjected to temperatures between 400-450°C the waste is reduced to a carbon char residue and a raw gaseous vapour product and HFO oil to be used to generate electrical power. The amount of carbon residue is 2-10% of the initial feedstock mass, depending on its composition. Specific temperatures are continuously maintained in the process chamber, eliminates any dioxins or furans in the carbon char residue, allowing further use of this by-product. Waste heat from the reactor is recovered and reused in order to minimize outside energy sources used in the operation of the system.

c) Thermal Raw Vapour Reformer

The raw gaseous vapours from the chamber modules are passed through specialized catalytic beds, to remove sulphurs, inherent oxygen, acids etc, and reform the free carbons into both short and long chain carbons.

d) Energy generation

Thermal energy captured from the pyrolytic chambers and HFO cogen units are converted into steam supplying energy to the drying system. In colder climates the waste heat can also be utilized for green house operations Alternatively, the system can produce hot water. We are able maintain a consistency in power generation due to system design.

e) Off-gas depuration system

The oxidized off-gasses are dealt with using our gas cleaning system comprising a bag house and a wet scrubber with De-NOx system ensuring control of the off-gas composition and compliance with strictest world's air quality standards.

f) The total plant system is controlled through a Logic Control System with a PLC control room.

We note that the EPA assessment cited concludes that there is a net greenhouse gas emission benefit from the combustion of municipal solid waste in waste-to-energy units. However, the EPA's methodology incorrectly assumes that electricity from waste combustion would offset only fossil-fueled power stations. The EPA study entitled *Solid Waste Management and Greenhouse Gases—A Life-Cycle Assessment of Emissions and Sinks* states: "Estimates of GHG emission reductions attributable to utility emissions avoided from waste management practices, however, are based solely on the reduction of fossil fuel use. We adopted this approach based on suggestions from several reviewers who argued that fossil fuels should be regarded as the marginal fuel displaced by waste-to-energy and landfill gas recovery systems." (Executive Summary, page E-7 and footnote 15) This is a fatal flaw. *Solid Waste Management and Green House Gases: A Life-Cycle Assessment of Emissions and Sinks*, Second Edition, EPA530-R-02-006, May 2002, downloaded February 3, 2009

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