WASTAGE FROM PLASTIC TO DIESEL FUEL - THERMOFUEL

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ABSTRACT

*Plastics, an indispensable material in our daily walk of life have now become a threat for our survival. As it is non biodegradable, the process of recycling is a better way of its disposal. The process can handle a wide variety of the plastics that is currently being sent to landfills. The process consists of continuous plastics in feed system, pyrolysis gasification chamber,catalytic converter, condensers, gas scrubbers, and centrifuge and oil recovery line, off gas cleaning. Here is one such process titled "**THERMOFUEL",** a process whereby scrap and waste plastics are converted into diesel fuel.This process uses liquefaction, pyrolysis and the catalytic breakdown of plastics. Pyrolysis and catalytic conversion of plastic is a superior method of reusing plastic waste. The distillate product is an excellent fuel and makes Thermo fuel on of the best, economically feasible and environmentally sensitive recycling processes.A major advantage of the process is its ability to handle unsorted, unwashed plastic and its extremely high efficiency. The most contaminated plastics can be processed without difficulty including silage wrap, trickle tape and other agricultural plastics. The high rating of the fuel ensures safe, clean and efficient operations of diesel engines in any application including trucks, buses, trains, boats, heavy equipment and generators.*

OBJECTIVE

Present a prioritized listing of the best resources and most promising up-coming technologies. Take into mind such things as overall efficiency of converting waste to energy while neutralizing any toxicity that might reside in the waste. With input from knowledgeable people worldwide, this page can become the most reliable and helpful place to find solutions to waste problems, from home to industry to large cities.

Transcript:

The saying, "One man's trash is another man's treasure" is coming true in the waste-to-energy field. With some landfills overflowing, much real estate at a premium, groundwater and air pollution concerns, and fossil fuel scarcity concerns; methods of turning refuse into fuel or electricity are attractive for many reasons.

Who would have ever thought that junk and sewage could be cost-effectively turned into a valuable commodity?

It turns out that there are several approaches being developed -- and even some already in commercial operation -- that, with tipping fees, can turn a profit from turning garbage and sewage into electricity and fuel.

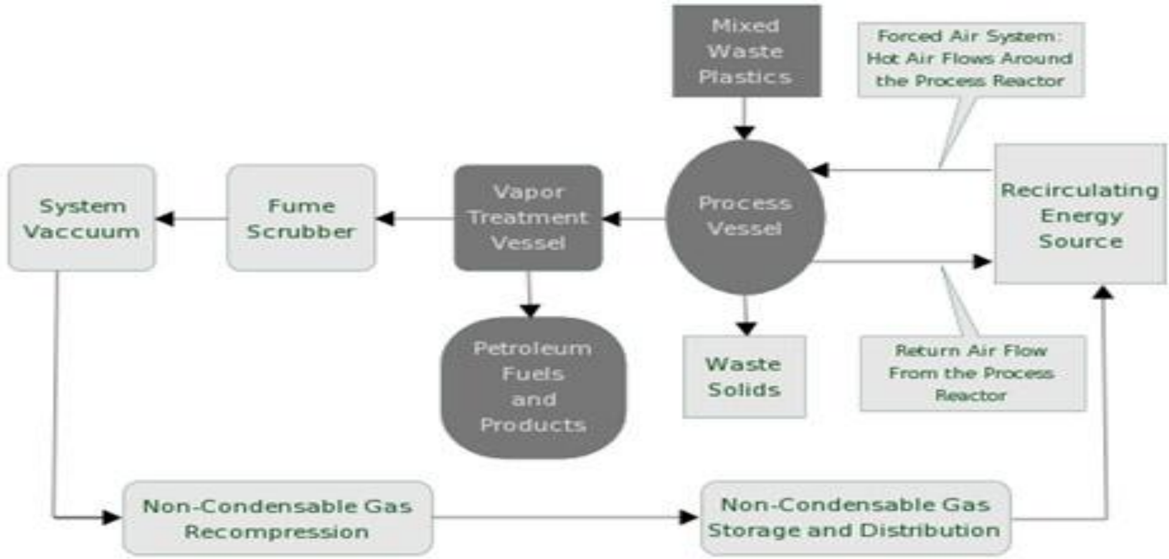
According to their Vice President, Lynn Brown, Waste Management, the company the comes around to haul off garbage, is increasingly turning some of that garbage into energy -- enough to power over one million homes -- the equivalent of 14 million barrels of oil per year or 3.6 million tons of coal. And the company has a goal to double that amount to 2 million homes by 2020.

Some landfills now capture the methane that comes out of the buried trash, which used to escape into the atmosphere as a potent greenhouse gas. Instead, they now burn this methane to run generators. Solar Hydrogen Energy Corporation (SHEC Labs) has developed a process that uses solar energy to convert this methane into hydrogen, and expect that within 5 years they will compete with the cheapest sources of Hydrogen.

Plastic-to-Diesel Conversion Technology:

After extensive research created an exclusive conversion of plastic-to-diesel technology with efficiencies and commercial viability that far surpass any other waste to liquid fuels technologies on the market. *This technology converts most kinds of plastic destined for landfills into ultra low sulfur, clean burning diesel fuel for use in all diesel-burning vehicles and industrial applications.*

The technology is being continually upgraded in a research and development project being conducted by an internationally recognized engineering university to improve efficiency and capacity of technology.



This technology helps to acquired waste from the commodities market, Infinity will establish a minimum of four 26-ton per day plastic-to-diesel units at each location, which will produce approximately 20,000 gallons of ultra-low sulfur diesel fuel daily.

Similar to the APC technology, a four-unit facility will require approximately an acre under roof, including fuel handling/processing equipment and fuel storage space. Diesel storage tanks of 50,000 to 100,000 gallons will be located outside of the structure housing the conversion units

II HOW THE PLASTICS-TO-DIESEL

Conversion Technology Works:

This technology converts several types of residual plastics to diesel fuel. This low sulfur, high quality fuel is suitable for use in any diesel engine, as well as industrial or highway applications. The latest generation of the technology emerges from nearly a decade of refinement and improvements from the original process deployed in six plants in Japan, culminating in a 26 ton per day machine.

The conversion of plastics to synthetic diesel fuel operates with minimal emissions from start to finish, since the system is a closed loop; i.e., all gasses produced during the conversion process remain inside the system and are re-used as fuel along with natural gas in the unit's heat source - a methane-natural gas burner. The only stack emissions produced by the machine are those from the burner, and typically require an air permit only because of their volume, not because of any noxious fumes produced by the process.

The conversion process from the energy value in the plastic to the energy value of the diesel fuel is near 95%, with the only waste product produced during the process - other than the stack exhaust gasses - being the pass-through of inert material clinging to the feedstock when it enters the machine's inlet. This char is non-toxic and can be sold as topsoil or used as daily landfill cover.

Waste from municipal, medical or other waste are grinded and flow to thermal converter it rise temperature of about (1400 to 1600) and it is oxidized and again reheated by using heat generator the dust particles get collected in dust collector by using induced draft fan it exhausted through a chimney at that time the steam is passed through steam generator it used to rotate turbine and by using transformer we get electricity.

III TECHNOLOGY

The Infinity total waste solution incorporates two of the industry's leading edge pyrolytic technologies: a proprietary *Advanced Pyrolytic Thermal Conversion System* and a proprietary

Plastic-to-Diesel Conversion System.

The pyrolytic system converts the caloric portion heat, which then drives a steam-powered turbine electric generator or is used to make other energy products. The plastic-to-diesel technology converts most kinds of waste plastic into ultra low sulfur, high cetane diesel fuel for use in all diesel-powered vehicles and industrial applications.

Technologies that are more effective to convert waste to fuel are:

1. Pyrolysis technology.
2. Advance pyrolysis technology.
3. Envo smart technology.

Creating an Efficient, Cost Effective Process:

For both the APC plants and the plastic-to-diesel facilities, Infinity uses a nationally recognized waste handling consultant and system provider as the initial process designer and equipment supplier. For further design integrity, a process-engineering consultant is then brought in to review the design. Some of the plastic-to-diesel plants will have waste plastic supplied by Infinity MRFs on the front end of the pyrolysis plant process train. The system Infinity will incorporate into its plants is in operation in Europe and supplied by a single vendor. It has lower capital and operating costs than any system available in the US, is fully automated and tunable to produce a feedstock engineered from MSW that exactly meets the requirements of the APC.

Pyrolysis

Pyrolysis is a process of thermal degradation in the absence of oxygen. Plastic waste is continuously treated in a cylindrical chamber and the pyrolytic gases condensed in a specially-designed condenser system to yield a hydrocarbon distillate comprising straight and branched chain aliphatic, cyclic aliphatic and aromatic hydrocarbons. The resulting mixture is essentially equivalent to petroleum distillate. The plastic is pyrolised at 370ºC-420ºC and the pyrolysis gases are condensed in a 2-stage condenser to give a low sulphur content distillate.

The essential steps in the pyrolysis of plastics involve:

Evenly heating the plastic to a narrow temperature range without excessive temperature variations Purging oxygen from pyrolysis chamber,

Managing the carbonaceous char by-product before it acts as a thermal insulator and lowers the heat transfer to the plastic

Careful condensation and fractionation of the pyrolysis vapours to produce distillate of good quality and consistency

Structure of the System:

The system consists of stock in feed system, pyrolysis gasification chamber, catalytic converter, condensers, centrifuge, oil recovery line, off-gas cleaning, and adulterant removal.

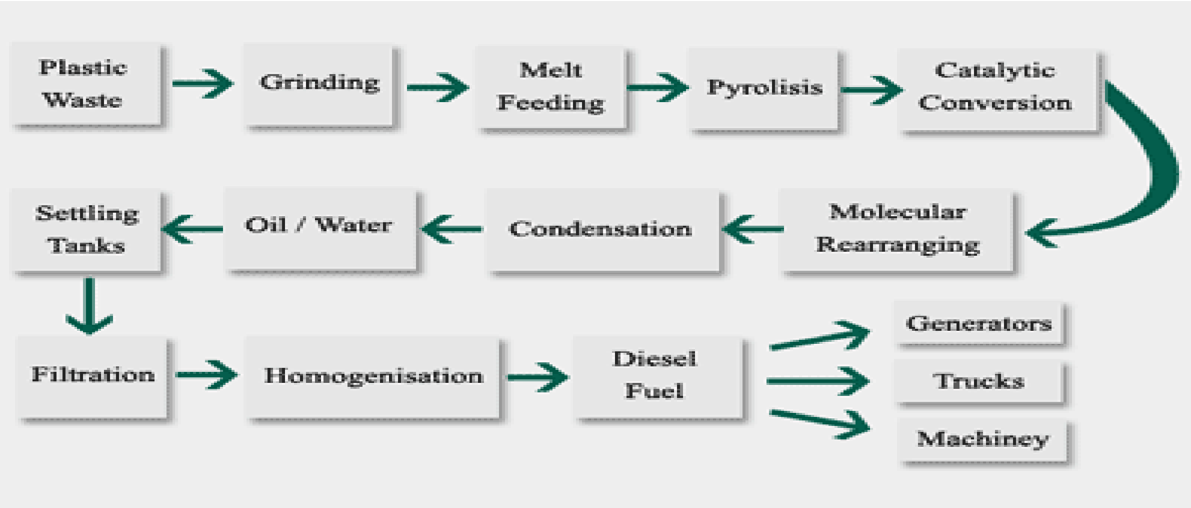
Waste plastics are loaded via a hot-melt in feed system directly into main pyrolysis chamber. The chamber can generally be filled within 30min.

When the chamber temperature is raised, agitation commences to even the temperature and homogenize the feed stocks.

Pyrolysis then commences to the point of product gasification. Non-plastic materials fall to the bottom of the chamber.

The gas goes through the (patented) catalytic converter and is converted into the distillate fractions by the catalytic cracking process. The distillate then passes into the recovery tank after cooling in the condensers.

From the recovery tank, the product is sent to a centrifuge to remove contaminants such as water or carbon. The cleaned distillate is then pumped to the reserve tank, then to the storage tanks.



IV OPERATIONS

The heart of the pyrolysis system is the prime chamber, which performs the essential functions of homogenization, controlled decomposition and out gassing in a single process. The process requires minimal maintenance apart from carbon residue removal, and produces consistent quality distillate from mixed and low-grade plastic waste.

The key to an efficient pyrolysis process is to ensure the plastic is heated uniformly and rapidly. If temperature gradients develop in the molten plastic mass then different degrees of cracking will occur and products with a wide distribution of chain lengths will be formed. Another important aspect of pyrolysis is to use a negative pressure (or a partial vacuum) environment. This ensures that oxidation reactions are minimized and that gaseous pyrolysis vapours are quickly removed from the process chamber thereby reducing the incidence of secondary reactions and the formation of undesirable by-products.

The polymer is gently 'cracked' at relatively low temperatures to give predominantly straight chain aliphatic hydrocarbons with little formation of by-products. These hydrocarbons are then selectively condensed and cleaved further catalytically to produce the average carbon chain length required for distillate fuel.

Power Co-Generation:

High efficiency generators can be integrated into the design of the Thermo Fuel system. The system can produce up to 1.4Mwh of electrical power from 10 tones of plastic per day.

Specifications:

Process - Continuous feed 24/7 operation.

Process Capability - Systems in 10 and 20 tones per day modules.

Fuel Produced - Synthetic fuel suitable for all internal combustion engines.

Fuel Yield - Up to 95% weight to volume.

Plant Dimensions - System floor space approx. $360m^2$. (10tpd system)

 IJARSE
ISSN: 2319-8354

Plus approx. $350m^2$ for ancilliary equipment and tanks

Advanced Pyrolytic Converter (APC)

Since the early 80s, the developers of the APC have sought to engineer a pyrolysis system designed to convert the carbonaceous portion of municipal solid waste (MSW), also known as refuse derived fuel (RDF), to heat in an efficient and cost effective manner with very low emissions. They have developed the unit in a 3-ton-per-day size, which operated continuously for 9 consecutive months, and a 40-ton-per-day prototype currently operating. The prototype machine is permitted to operate in California on a batch basis, giving Infinity a significant advantage in streamlining the permitting process.

The APC will be deployed by Infinity in build-own-operate plants in single or dual applications in a 125-ton-per-day thru-put capacity. Initially, Infinity will begin siting APC projects in the state of California. Approximately 60,000 tons per day of MSW throughout southern and central California are available to Infinity. The facilities will consist of a material recovery facility (MRF) with a capability of processing at least 500 tons/day of MSW, engineering approximately 250 tons/day of feedstock, as well as generating quantities of metal, glass and aluminum commodities for sale to re-manufacturers.

The plants containing two 125-ton/day APC units will produce from 8 to 10 megawatts, depending of the heat value of the RDF being supplied, and will require approximately one acre under roof. From procurement to commissioning, construction of each facility will require 14 months, and will employ 15 full time supervisors and technicians in long-term operation.

How the Advanced Pyrolytic Converter Works:

Waste is conveyed to the conversion unit through a specifically designed material processing system (front-end system), which will consist of a sorting line (when applicable), shredders, grinders, dryers, magnetic separators, and conveying system. The drying process assures a lower moisture content of the feedstock for more efficient energy recovery, and, of note, the dryers use waste heat from the conversion unit, requiring no additional gas or electricity cost. The APC is designed for optimal reuse of the waste heat produced by its operation.

APC engineers have developed and constructed an innovative, Patent Pending knife valve design for the machine feedstock inlet, which allows the feedstock to enter the pyrolytic chamber without the presence of oxygen. With this proprietary design, pyrolysis of the waste may proceed in a safe, efficient and economical manner.

Upon entry into the pyrolytic chamber, the waste transverses the length of the retort via a novel and proprietary paddle-screw design. During this process waste streams are subjected to very high temperatures in the absence of oxygen (1,800° F), which reduces the waste to gas and a benign carbon char residue. These two products are separated via gravity, with the solid carbon char dropping out of the bottom of the pyrolytic chamber, and the gaseous product being vented to the entry of the thermal oxidizer, also known as a fire tube.

The unique benefit of the paddle conveyor design for the feedstock conveyance system is that it virtually eliminates clogging from the odd foreign objects that inevitably make their way into the feedstock, such as aluminum cans, reinforcing or re-bar, and assorted other metallic materials.

In the thermal oxidizer, or the second stage of the APC, the gas produced from the heating of the RDF is mixed with ambient air and results in spontaneous combustion, as a result of its high temperature. This high temperature is maintained in the thermal oxidizer, which eliminates virtually all of the furans and dioxins, rendering the gasses safe for emission to the environment after first passing through the air cleaning system.

The hot gasses leaving the thermal oxidizer go next to a boiler to convert the heat to steam energy. The steam is then fed to a steam turbine generator to make electricity.

Upon exit from the boiler, the oxidized off-gasses – now at a temperature of about 400° F, are delivered to a spray scrubber, where the gasses are further cleaned to the point where they are safe for elimination to the ambient environment. The carbon char byproduct from the waste is non-toxic, commercially saleable, and therefore may be disposed of by several methods. Technology is currently under development that will enable the gasification of the of the char, in a second pyrolytic chamber, extracting all of the energy from the feedstock and entraining any heavy metals in the char in a lava-like briquette. There are at least two factors that give the APC unit a significant advantage over its competition for Infinity's purposes:

The technology was designed to convert RDF to heat. Due to its lack of homogeneous content and contamination, RDF is a unique feedstock that does not lend itself to easy separation, and presents unique material handling and conversion challenges. Yet it also carries a disposal fee that will be paid to Infinity, is abundantly available, contains significant amounts of energy, and when otherwise landfilled, creates an environmental hazard. However, because of the difficulties the commodity presents, there are very few RDF machines available that are designed for RDF conversion, most converting more predictable feedstocks such as tires, wood and paper.

The APC technology has been permitted in California in a batch mode, providing a major advantage for Infinity in terms of the issuance of permits necessary to allow operation of its facilities in a reasonably short period of time.

Plastic-to-fuel solution in demand. (EnvoSmart Technologies)

New private Australian company, Ozmotech Pty Ltd, has developed Thermo Fuel technology to recycle plastic waste into commercial grade diesel fuel that complies with international fuel and EPA standards.

This contract brings the total number of Thermo Fuel system sales to over 60, with 46 destined for export. In full production, these systems will produce an estimated 350 million liters of diesel per annum from over 400 000 tones of waste plastic, most of which will be diverted from landfill. Currently, 20 per cent of our waste is non-biodegradable plastic that just ends up in landfill.

Renewable Gasoline and Diesel from Lingo-Cellulose Biomass Produced at Dynamotive's Research Facility in Ontario, Canada:

The process developed by Dr. Desmond Radlein and his research team, involves pyrolysis of lignocellulosic biomass to produce a primary liquid fuel, BioOil, which is then hydro-reformed to a Stage 1 gas-oil equivalent liquid fuel that can either be directly utilized in blends with hydrocarbon fuels for industrial stationary power and heating applications or be further upgraded to transportation grade liquid hydrocarbon fuels (gasoline/diesel) in a Stage 2 hydrotreating process. The major by-product from lignocellulosic biomass pyrolysis is Biochar which has emerging value for soil productivity enhancement and carbon sequestration. Dynamotive markets its Biochar under the trade name CQuest

Based on initial test and analysis, the Company currently estimates that it can deliver advanced (second generation) fuels from biomass at a cost of less than $ 2 per gallon of ethanol-equivalent fuel in facilities processing about 70,000 tonnes of biomass per annum (current scale of its 200 metric tonne per day plant). The upgrading process addresses several critical issues in the development of sustainable fuels from biomass.

Food vs. Fuel: The Company converts residual biomass from agricultural and forestry operations and/or dedicated non-food crops through a thermo chemical process into BioOil and Biochar. BioOil and Biochar plants can coexist with existing forestry and agricultural facilities, providing an additional benefit to operations.

Yield: Dynamotive's pyrolysis process converts roughly 85% of the total biomass feed into useful solid (char) and liquid (BioOil) fuels. The balance is utilized to provide energy to the process.

Yields of Diesel/Gasoline from BioOil through the Stage 2 upgrading process of 37% have been achieved at bench-scale. The net overall yield from whole biomass to diesel/gasoline is approximately 25%, which to our knowledge is the highest ever reported.

Scale: It is projected that a plant processing under 70,000 tones of biomass a year would produce approximately 4,500,000 gallons of renewable gas-oil .Scale factor enables distributed production i.e. plants can be developed in diverse locations creating sustainable "green" jobs, while being compatible with agro and forestry operations.

V FUTURE PLAN

One approach being pursued by several companies is to turn the incoming waste into plasma through a high intensity electrical arc. In the plasma state, the inflow is broken down to its elemental components -- individual atoms. What comes out is a burnable gas and an inert solid that can be used for things like pavement, bricks, and other building materials. Starting out, they are targeting medical waste because of its high tipping fees.

Green Power Inc has developed a method of inexpensively converting biomass and municipal waste into high quality diesel fuel, solving the world's energy and waste problems at the same time, without upsetting the CO2 balance.

We consider waste for energy technologies to fit the "free energy" mold. Waste is an inexhaustible or renewable energy source that will be around as long as there are humans. All trash can be recycled into something useful. Within a generation, we may begin to see home-based devices that turn your personal garbage into energy, right in the comfort of your home. It's Back to the Future in its infant stages.

IJARSE
ISSN: 2319-8354

ACKNOWLEDGEMENT

I take this opportunity to record my sincere thanks to our faculty **Mr.Vasa Ramu** Department of mechanical engineering, RMK College of Engineering and Technology for their valuable guidance and encouragement for the successful completion of this paper.

I express my grateful acknowledge to our faculty members and my classmates for their timely help in fruitful completion of this work.

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