WASTE TO ENERGY AND LANDFILLS
"WE ARE RUNNING OUT OF SPACE"

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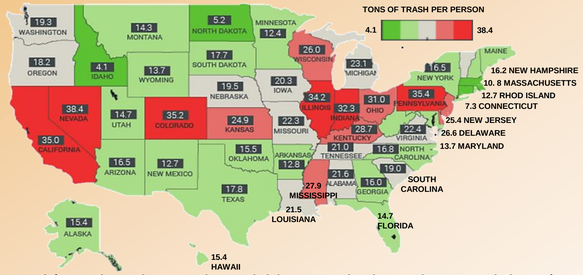
Introduction

The united states landfilled 146.1 million tons of municipal solid waste municipal solid waste (MSW), industrial solid waste and hazardous waste each year with 52.6% landfilled and 12.8% incinerated. For every 100 pounds of MSW in the United States, about 85 pounds can be burned as fuel to generate electricity. Waste-to-energy plants reduce 2,000 pounds of garbage to ash weighing about 300 pounds to 600 pounds, and they reduce the volume of waste by about 87%.



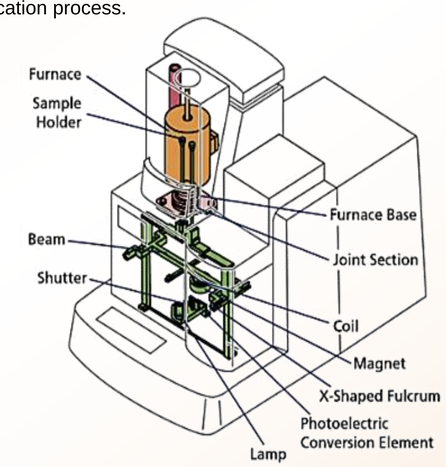
The main problem that the trash and biomass incineration used for electricity generation are the highest contributors to the CO2 emissions/MWh compared to coal power plants and landfills are also much worse than appears here because much of their emissions are from unfiltered toxic landfill gas escaping capture and leaking directly into the air. Besides the pollution problems, on average, it costs $30 per ton to recycle trash, $50 to send it to the landfill, and $65 to $75 to incinerate it.

Objective

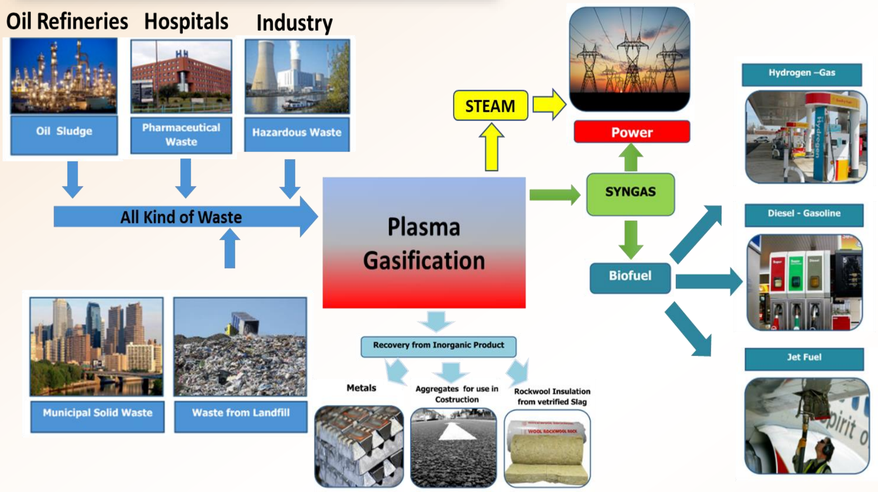
- Optimal use of energy resources and optimization of energy processes; Waste Management.
- Experimentally investigate the biomass gasification of different livestock manure with eight different heating rates.
- Design an alternative solution to optimize energy gain from wastes and reduce pollution.
- Economical study of the Plasma Gasification.

Methodology

- Thermo-gravimetric analysis is utilized in this research. The change of the mass of the biomass specimen is monitored with time.
- Differential Thermal Gravimetry apparatus is used simultaneously to perform the Thermogravimetric and Differential Thermal Analysis.
- The main parts of the devise are Furnace to supply the heat, measurement system including two detector rods and some thermocouples to measure temperature.
- The sample is loaded on one of the detectors while the other one is kept empty as a reference to the mass degradation with temperature.
- The purge gas used varies based on the process. The nitrogen was used for pyrolysis and co-pyrolysis processes while air and carbon dioxide were used for gasification process.

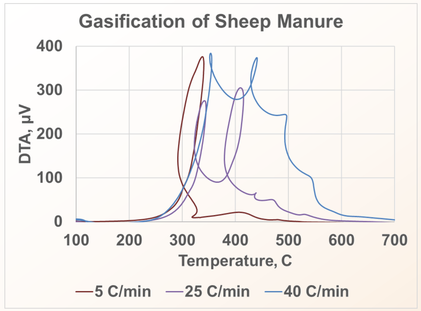


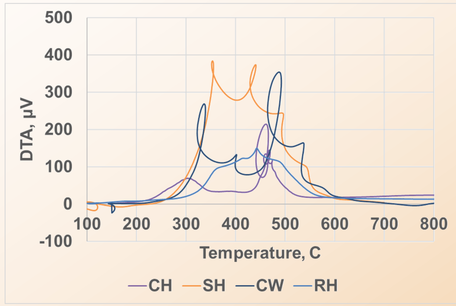
Results



1. Thermochemical Process Gasification With Different Biomass Species

- Four different biomass species with different heating rates were tested chicken manure, cow manure, sheep manure and rice husk.
- For all biomass species, it was found that the air gasification is exothermic. Therefore, with air gasification, the reaction has the potentials to be self-sustainable with no external heating
- For the chicken manure, it was found that the lowest heating rate (5 c/min) allows a quasi-equilibrium state and thus decreasing the effect of measurements error, while for other biomass species 40 c/min was chosen because it saves provided energy as there is no difference in energy obtained with the lower heating rates.
- The highest exothermic reaction is given by the sheep manure due to the highest energy content followed by the cow manure.
- The rice husk shows only one peak because of the chemical composition where there is no hemicellulose





2. Plasma Experimental Design

- The gasification process temperature can not exceed 1000 ºC which is not enough to obtain all the energy contained in biomass species.
- New experimental setup is designed which is capable of handling broad range of wastes.
- Temperature of new setup can reach up to 3000 ºC with a capability to achieve up to 90% mass conversion.
- All components of the experiment are shown in the top right corner.

3. Economic Feasibility Study (Table 1)

- Economical study have been made to compare classic combustion with two existing plasma power plants in united states, Westinghouse Plasma Corporation (WPC) and Integrated Environnemental Technologies.
- The classic combustion gives the lowest mass conversion and highest pollution which makes the profit higher compared the two plasma power plants.
- WPC gives a net profit $6.7 per which is higher than the gasification process.
- Although WPC achieves lower price in net profit, two major factors were not included which are the further use of steam (H2O) and price cost of treating pollutant

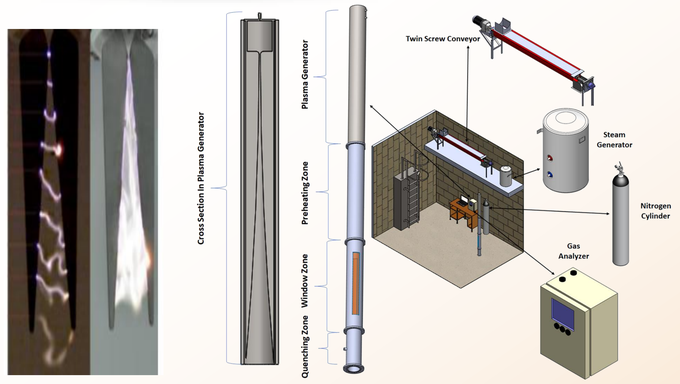


Table 1: Economical Study for different waste management techniques

	Classic combustion	Gasification	WPC	InEntec
Mass conversion%	75%	90%	90%	90%
Plasma Energy (kWh per ton MSW)			115.2	34
%CO	-	41%	31.50	41.40
%CO2	-	13.8%	8.33	16.6
%N2	-	12.1%	12.10	5.6
%H2	-	33.7%	16.20	34.8
%CH4	-	4.1%	1.00	0.1
%H2S	-	0.13%	0.02	NA
%HCL	-	0.13%	0.03	0
%H2O	-	6.3%	29.2	1.5
Net Power out (KWh)	500	533	617	450
Capital Cost ($/ton)	60	76.8	81	76.8
Operating Cost ($/ton)	38.8	53	42	53
Sale Power ($/ton)	50	53.3	61.7	40
Sale slag/metal ($/ton)	2.25	2.47	2.47	2.47
Net benefit ($/ton)	19.05	-8.68	6.72	-16.98

Conclusions

As a response to the world energy demand, and the fact that some landfills can not receive more waste, the waste management becomes a must. According to this study the following point can be obtained:

- In gasification the sheep manure gives the highest exothermic reaction at 40 c/min which has the potentials to be self-sustainable.
- Plasma Gasification is a potential technology to convert waste into energy with 90% mass conversion rate which is important to reduce
- Every ton of waste sent to a plasma gasification facility for power production, 2 tons of CO2 emissions could be reduced from the atmosphere.

References

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