# PLASMA PYROLYSIS FOR RECOVERY OF ENERGY FROM PLASTIC WASTE

B.Ruj[1]*, P.K.Chatterjee[1], and A.K.Goel[2]

[1] CSIR-Central Mechanical Engineering Research Institute (CMERI), Durgapur-713209, West Bengal, INDIA
[2] Petroleum Conservation Research Associations, Ministry of Petroleum & Natural Gases, New Delhi, INDIA
e.mail: biswajitruj@yahoo.co.in ; bruj@cmeri.res.in
Phone: +91-343-6452156; Fax: +91-343-2544567

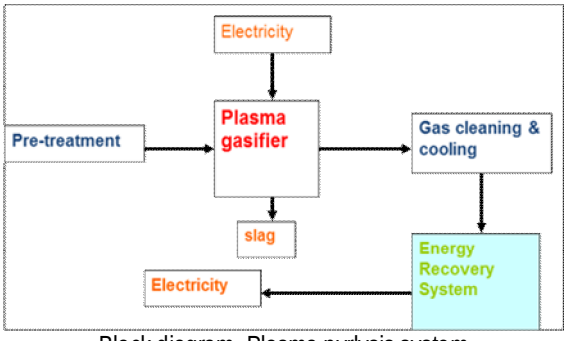
## Abstract

*The problem of safe disposal of plastic waste, together with the increasing cost of petroleum products, has encouraged research on the possibility of their conversion into useful forms of energy or chemical products. Plasma pyrolysis is an innovative technology for transforming high calorific plastic waste into a valuable synthesis gas (syngas) by means of thermal plasma. The process developed is a drastic non-incineration thermal process, which uses extremely high temperature in an oxygen-starved environment to completely decompose input plastic waste into syngas, composed of very simple molecules viz : CO, $H_2$ and hydrocarbons. A 20 kg/hr capacity plasma arc pyrolyser for treatment of plastic waste as well as energy recovery options from waste plastic has been indigenously designed, developed, installed and studied its performance. After pyrolysis of plastic waste in the plasma arc reactor, generated hot gases (syngas) are quenched through water scrubbing. The Syn gas produced from plasma reactor has been used in an IC-Engine Generator combination for generation of electrical power. Syngas composition has been characterized by Gaschromatograph, residue/ash collects at the bottom of the pyrolyser has been characterized by Neutron Activation Analyzer (NAA). Techno-economic study and research results indicated that the developed plasma pyrolyser may be a useful way of plastic waste treatment for energy recovery.*

**Keywords:** plasma pyrolysis, plastic waste, syngas, energy

## 1. Introduction

Plastics have been one of the materials with the fastest growth because of their wide range of applications due to versatility and relatively low cost. Since the duration of life of plastic products is relatively small, there is a vast plastics waste stream that reaches each year to the final recipient creating a serious environmental problem. So, the plastic waste management is an important issue in both developed and developing countries nowadays [1-4]. To alleviate part of our energy crisis and environmental degradation, it has become imperative to make use of appropriate technologies for recovery of resources from plastic waste. The present approach in this study ie, plasma pyrolysis has a number of unique advantages over conventional pyrolysis. When carbonaceous solids are injected into plasma, they are heated up very rapidly and the volatile matter is released and cracked giving rise to CO, $H_2$, $CH_4$, $C_2H_2$ and other hydrocarbons. It is therefore of considerable interest to study plastic waste pyrolysis in plasma processes for gaseous fuel or chemical production purposes.




Block diagram- Plasma pyrlysis system

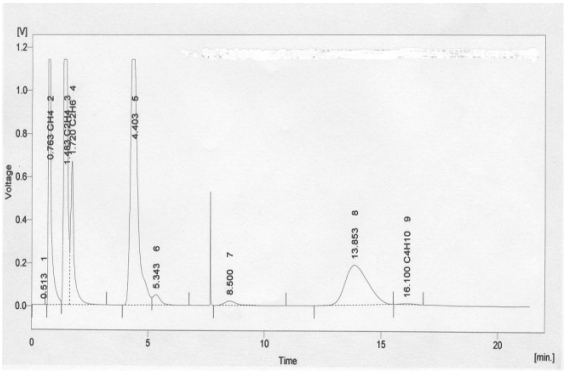
## 2. Materials and Methods

Experimental setup of plastic waste plasma arc pyrolyser

The experimental set-up consists of mainly feeding, plasma arc reactor and cleaning & cooling sections. Graphite and carbon electrodes have been fixed inside the plasma reactor in such a way so that supply of voltage through transformer generates high temperature at the sparking zone. Carbon electrode (-ve) is fixed upon a tripod arrangement at the bottom of the reactor and the graphite electrode is fixed at the top of reactor. The gap in between the electrodes is adjusted through a lead screw arrangement to facilitate the continuous arc discharge. The plastic waste beads are gasified at high arc temperature and a combustible gas resembling a synthetic natural gas (syngas) is produced. The syngas generated is passed through a water scrubber for cleaning and quenching the hot syngas. An ID fan is used to draw the syngas from the reactor. The syngas produced from plasma reactor has been used in an IC-Engine Generator combination for generation of electrical power. Techno-economic study of this process has also been carried out.

## 3. Results and Discussion

Performance study of the developed plasma pyrolyser has been carried out with the plastic waste as feeding material. The major gas components of the product gas are hydrogen, carbon monoxide, methane, acetylene, ethylene and other hydrocarbons which are combustible in nature




Chromatogram of syngas

It is observed from the experimental study that 1 kg/hr plastic requires roughly 1 $kW_e$ power in a plasma gasifier. The calorific value of plastic is 43.5 MJ/kg. If the overall efficiency of conversion is 30 % then the output electrical energy is 13.05 MJ which is equivalent to 3.6 $kW_e$ for 1 kg/hr plastic conversion. Considering 1.2 $kW_e$ for auxiliary power requirement the net recovery is 2.4 $kW_e$ .

## 4. Conclusions

The present study reveals that there is a great potential for development of thermal plasma pyrolysis technologies applicable to plastic waste disposal management with energy recovery. Again, considering the fact that the raw material used in this process is plastic waste which is a source of pollution and governments across the globe have spend huge amount of money to handle them. This developed process will be a handy and economic one in that perspective.

## References


[1] C.A.Boyle, *Waste Manage* 2000; 20(7): 517-26.

[2] M. Berkun, E. Aras, S. Nemlioglu, *Waste Manage* 2005;25(8): 847-55.

[3] J. Al-Hubail, K. Dash, *J Environ Manage* 2006; 79(1):43-50.

[4] H.Huang, L.Tang, *Energy Conv.Mange* 2007; 48, 1331-1337.