PLASMA PYROLYSIS OF SCRAP TYRE - AN OPTION FOR ENERGY RECOVERY

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Abstract

Automobile tyres are nondurable goods, neither fusible nor soluble under normal conditions and cannot be remoulded into other shapes without serious degradation. Common treatments such as land filling or direct incineration (without recovery of value) not only waste the resources but also increase the area of land with pollution. The increasing production of tyres has caused considerable disposal problem. To explore the real potential of waste tyres for possible material and energy recovery, an efficient strategy should be found. From a chemical point of view scrap tyres are, ideal candidates for the plasma pyrolysis process. This process is a drastic non-incineration thermal process, which uses extremely high temperatures in an oxygen-starved environment to completely decompose input waste material into very simple molecules. The present work describes the treatment of tyre waste by thermal plasma under reducing condition. Combustible reformed gas (CO, H_2 and hydrocarbons) having high calorific value was recovered. The present study reveals that there is a great potential for development of thermal plasma pyrolysis technologies applicable to tyre waste disposal management with energy recovery.

Keywords: tyre waste, plasma pyrolysis, syngas, energy

1. Introduction

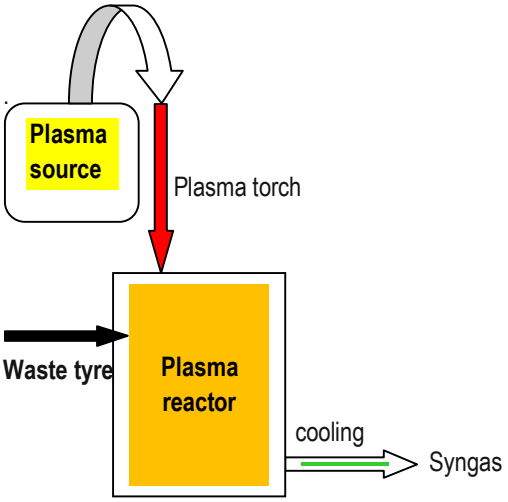
As the heat content of the automobile tyre is even higher than that of coal, they could be a source of alternate fuel for power generation. There have been attempts to burn scrap tyres directly in coal-fired boilers for the production of electricity. There are, however, environmental concernsthat must be addressed prior to burning scrap tyres because the combustion flue gas may contain acid gases, such as NOx, CHx and SOx and heavy metals such as Hg, Zn, Cd etc. Although many experiments have been done, tyre pyrolysis processes have been far from satisfactory either economically or environmentally. Pyrolyzing scrap tyres in thermal plasma to syngas may be an attractive option. In plasma pyrolysis, scrap tyres are dissociated into atoms and charged particles [1-3]. With the proper quenching process, it is possible to "freeze" the chemical reaction before unexpected substances are formed. Therefore, Plasma pyrolysis may be an attractive alternative to get "cleaner" fuel from scrap tyres by using an economic process.

2. Materials and Methods

The thermal plasma was generated by a plasma torch with the following operating conditions and was ejected vertically through the top of the environmental chamber.

Operating conditions:

Plasma generator voltage (v)
Primary voltage: 380-440 v, 3 phase 50 Hz
Secondary voltage: 260-280 v
Plasma generator current: 26 amps
Arc current: 80 amps
Plasma generator power: 9.6 KVA
Working gas pressure: 50-70 PSI



Block diagram- Plasma pyrlysis system for tyre waste

The centre of the experimental set-up is the plasma reactor. The experimental set-up consists of mainly plasma source, plasma reactor and cooling & characterization

sections. Ultimate and proximate analysis of tyre waste was carried out. The tyre wastes are gasified at high plasma temperature and a combustible gas resembling a synthetic natural gas (syngas) is produced. The syngas generated is passed through a heat exchanger and characterized by using Gaschromatograph.

3. Results and Discussion

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

Proposed reaction scheme for scrap tyre pyrolysis in a dc arc plasma
Step – *1*, primary pyrolysis reactions take place and the volatile matter is released including heavy hydrocarbons (tar), light hydrocarbons, and other gaseous components, leaving behind solid char.

Scrap tyre → char + heavy hydrocarbons + light hydrocarbons + gas (H_2 ,CO,CH_4 ,C_2 H_2 ,C_2 H_4 , etc.)
Step – *2*, Tar get cracked and light hydrocarbon may also decompose
heavy hydrocarbons → light hydrocarbons + gas (H_2 ,CO,CH_4 ,C_2 H_2 ,C_2 H_4 , etc.)

light hydrocarbons → H_2 + CH_4 + C_2H_2 + C_2H_4 +C_nH_m

4. Conclusions

Plasma pyrolysis of scrap tyre was carried out in a batch reactor. The present investigation provides an option for energy recovery with volume reduction and reduction of toxic gases

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