E-WASTE (CELL PHONE) TREATMENT BY THERMAL PLASMA TECHNIQUE

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Abstract

Cell phone ia an indispensable service facilatotor. But its disposal is a problematic. Cell phones are made of plastics, metals, ceramics and other trace substances. Land filled or incenerated cell phones create the potential for release of heavy metals or halocarbons materials. Primitive recycling or disposal of cell phone waste to landfills and incinerators causes irreversible environmental damage by polluting water and soil, and contaminating air. In this work, the treatment of cell phone wastes by thermal plasma under reducing condition has been investigated. 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.During the process, the combustible reformed gas was recovered. The experimental results show that gaseous by-products are of CO, H_2 and hydrocarbons (CxHy). Generation of hydrogen gas of high concentration is from the hydrogen of the plastic part of the cell phone waste. Formation of hydrocarbons is also from the carbon and hydrogen part of the cell phone waste. CO_2 generation is almost below the detection limit. No significant other toxic gases such as NOx and H_2S were observed. SEM, XRD analysis of the plasma treated cell phone residue has also been charaterized.Research results indicated that this thermal plasma technique is an energy recovery system-contributing saving of resources or reduction of climate change gases.

Keywords: E-waste, thermal plasma, combustible gas, metal recovery

1. Introduction

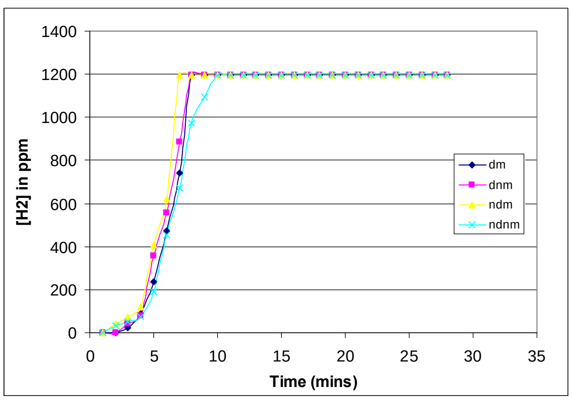
Cell phone waste, as one of E-waste, is much more hazardous than many other municipal wastes because it contains thousands of components made of deadly chemicals and metals. Cell phone, today an indispensable service facilitating everyday life, has experienced a tremendous increase in penetration since the implementation of the innovative Global System for Mobile Communication (GSM) standard in the early 1990's. Concern over the negative impacts associated with the production, use and end-of-life (EoL) of cell phone is particularly high due to large production volumes and characteristically short time scale of technological and stylistic obsolescence. Cell phones contain a large number of hazardous substances and valuable metals. Hazardous substances can pollute the air when burned and leach into soil and drinking water when buried in landfills. These toxic substances include arsenic, lead, cadmium, copper, nickel, etc. and valuable metals includes gold, silver etc. The disposal of cell phones thus needs to be managed in an environmentally sound way to minimize releases into the environment and threat to human health. When recycled responsibly, the metals can be put back into circulation, decreasing the need for new metal mining. The objective of this work is to treat cell phone waste by thermal technique for its safe disposal and option for recovery of metals from cell phone wastes.

2. Materials and Methods:

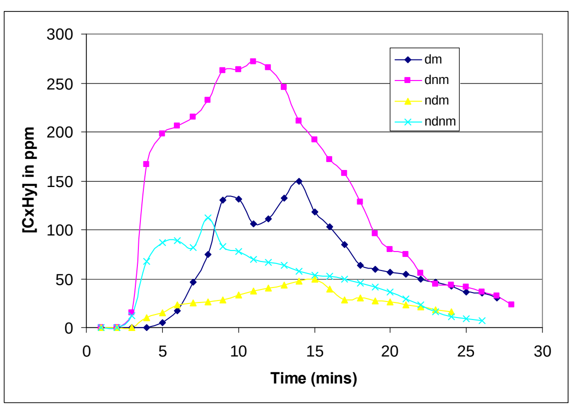
Cell phone waste was first separated into display and non-display part. After crushing, the samples were cut into small pieces of around 5 mm size by sheet metal cutting scissor. With a magnet, ferromagnetic were separated from non-ferromagnetic components. Cell phone waste was divided into four categories: Display magnetic(dm), display non-magnetic (dnm), non-display magnetic (ndm), and non-displaynon-magnetic (ndnm). Cell phone waste samples were placed into a 99.8 % pure alumina reactor with maximum operating temperature of 1950ºC in reducing atmosphere. The ceramic reactor with a diameter of 7.5 cm and depth of 2.6 cm was placed 5 cm below the torch. The sample weights were mostly in between 7 g and 10 g. The thermal plasma was generated by a DC 10 kW plasma torch and was ejected vertically through the top of the environmental chamber. The power was limited to 1.5 kW. Pure argon gas with a fixed flow rate of 35 L/min was used in order to produce a reducing atmosphere. A constant-voltage power supply, in series with a resistor bank, was applied to control the power of the plasma torch. K-type thermocouple was introduced in the environmental chamber to measure the temperature near the reactor wall. An on-line combustion gas analyzer (Eurotron Greenline 8000) and a hydrogen gas analyzer (Beacon 200) were installed at the exit of the reaction chamber behind a heat exchanger. All samples were treated for 30 minutes.

3. Results and Discussions:

The results clearly shows that the exhaust gas contects mainly H_2 and hydrocarbons (C_xH_Y) as conbustible gas which has the heating value and can used for power generation.



Concentration of H_2 as a function of treatment time with argon flow rate at 35 L/min



Concentration of CxHy as a function of treatment time with argon flow rate at 35 L/min

4. Conclusion

- Plasma treatment of cell phone waste in reduced condition generates gaseous components viz. hydrogen (H_2), carbon monoxide (CO) and hydrocarbons (CxHy), which are combustible gas. So, this system is an energy recovery system- contributing saving of resources or reduction of climate change gases.
- Provides volume reduction of the waste streams contains only the metallic portions, which can be recycled to get the valuable and precious metals.
- Complete destruction of plastic part of cell phone waste may be possible provided reactor design has to be modified.
- Reduce the need for landfill
- Safer disposal technique of cell phone waste.
- Plasma chemistry is in the forefront of modern environmental analyses. The unique characteristics of plasmas should result in much broader applications in environmental mitigation and are increasingly becoming valuable environmental tools in future research of environmental areas.

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