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Thermo-gravimetric Analysis (TGA) of combustion and gasification of Styrene-Butadiene Copolymer (SBR).

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Abstract

An investigation has been initiated to determine the effects of various atmospheres (6.9% O_2/N_2, 21% O_2/N_2 (air), 30% O_2/N_2, 3% H_2/N_2 and pure N_2) on the efficiency of gasifying or combusting rubber waste to produce synthesis gas or generate steam or power. This paper reports on the findings from a series of TGA experiments at various heating rates on styrene-butadiene copolymer (SBR), which is the main starting component for tire manufacturing. The results indicate that oxygen enhanced atmospheres have a significant effect on increasing combustion efficiency at the tested heating rates. A hydrogen-spiked atmosphere, surprisingly, did not have a significant effect on the gasification rates of SBR at any heating rate; in addition, this atmosphere resulted in a carbon residual that remained in the sample carrier, something that was not observed in the other atmospheres, including pure nitrogen. An unexpected result of the N_2-O_2 tests was the development of a plateau in the mass-loss versus temperature curves, at temperatures near 500°C.

Introduction

Each year approximately 270 million tires are disposed in the U.S. alone[i]. Currently this far outpaces the possible uses for scrap tires, thus leading to a significant disposal problem. Tire disposal requires special solid waste management because of their particular properties. The durability and strength of tires make their disposal and reprocessing extremely difficult. Furthermore, tires are not very amenable to biodegradation. That reason alone suggests landfilling of tires is not an option. Moreover, whole tires do not pack very well; approximately 75% of the volume is void space and they tend to float or rise in a landfill and come to the surface, piercing the landfill cover. Over 35 states have completely banned whole tire landfills and 48 states have been adopted strict regulations for the management of scrap tires. One option to remedy this is to shred or chop the tires, yet this requires additional processing, handling and costs.

The high organic content of tires, in the form of rubber, makes it an ideal fuel for energy production. There have been some investigations into the combustion and gasification of scrap tires that have shown some promising results. For example Caputo et al. [ii] reviewed the production of refuse derived fuel (RDF) pellets by mechanical benefaction that incorporated scrap tires are proposed to boost the heating value. They determined that the production and combustion of RDF pellets is not profitable, primarily because of the pre-processing that is involved.

With respect to gasification of tires, considerable work has been documented. A kinetic study by Leung and coworkers[iii] showed that products depend on the heating rates, not the surface area to volume ratio of the starting material. Gasification products, primarily CO and H_2, occur in three separate temperatures zone in pyrolysis and two