Experimental investigation of products from thermal treatment of real-world mixed single-use and multilayered waste plastics

Uduak Bassey[14], Alex Bowles[2], Geoff Fowler[2], Abasi-ofon Tom[3], Gesa Beck[1], Satyanarayana Narra[4], Michael Nelles[4], Michael Hartmann[1].

[1]Berlin School of Technology, SRH Berlin University of Applied Sciences, Berlin, 10587, Germany

[2]Department of Civil and Environmental Engineering, Imperial College London, SW7 2BX, United Kingdom

[3]School of Chemistry, University of Glasgow, G12 8QQ, Scotland, United Kingdom

[4]Department of Environmental Sciences, University of Rostock, Rostock, 18051, Germany

Keywords: Waste-management, Plastics, Pyrolysis, Gasification, Waste-to-Energy

Email: uduak.bassey@srh.de

Abstract

The usage and disposal of highly abundant single-use (SUP) and multilayered plastics contributes to significant ecological problems. The thermochemical recovery of these plastics to useful products and chemicals will provide positive economic and environmental impacts. Most researches seldom use feedstock that is representative of the real-world waste stream. To address this, a range of real-world samples were collected from Ghana. These are now being thermochemically treated via pyrolysis and gasification under a range of conditions, including by catalytic processes. The chemical products are being analysed using a range of techniques. By measuring the CHNS and energy content of the oil and char fraction, and comparing with the compositional results of the pyrolysis gas by Gas Chromatography-Thermoconductivity Detection (GC/TCD), energy and carbon balances of the processes are being constructed. The char is being assessed by thermogravimetric techniques. The oil is being assessed via Gas Chromatography-Mass Spectrometry (GC/MS) and by Fourier Transform Infra-Red Spectroscopy (FTIR), to assess the presence of valuable compounds. The conclusions would help identify a fitting solution that would produce the most valuable products for Ghana.

Introduction

Materials and Methods

Feedstock characterization:

The source of the feedstock is one of the main significance of this work. The treatment option in this work took into consideration other waste plastics mitigation techniques namely, material reduction, reuse and recovery of the useful fraction. The feedstock was sourced from the rejected fraction of the waste in the material recovery facilities (MRFs) in Ghana. This is the left over (bound for the landfill) waste plastics after the useful fractions has been sorted and extracted. Characterization of these rejected fraction was carried out to identify and quantify the polymers present in the mix. The polymers were identified using a Viavi MicroNIR 1700ES pro spectrometer with integrated 128 pixel InGaAs photodiode array detector. The waste composition at the reject point after the useful fractions have been recovered is represented in Figure 1.

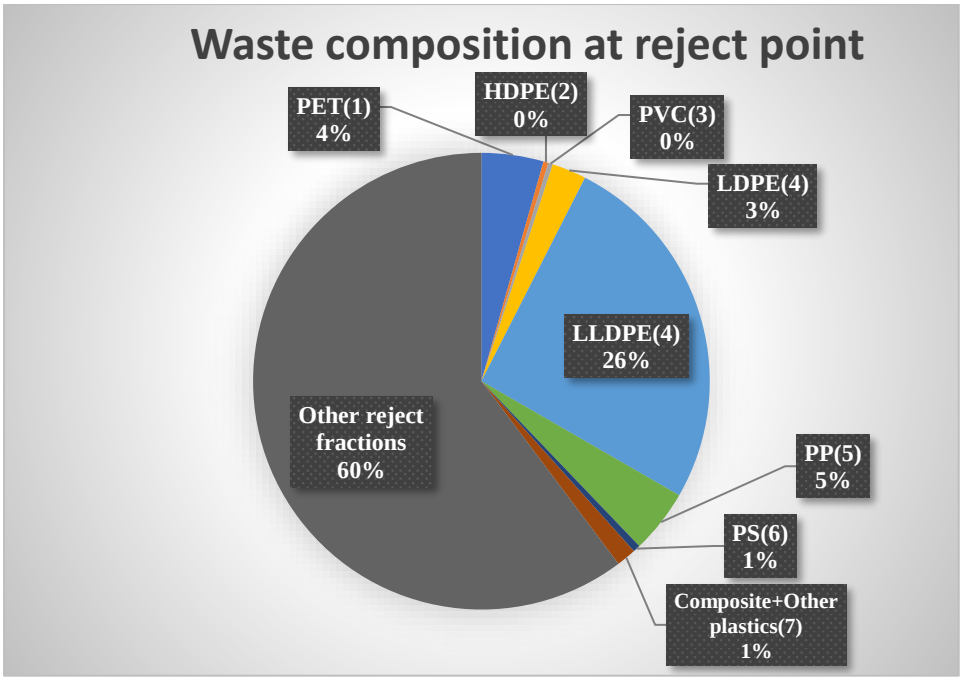

Figure 1: Waste composition after extraction of usable fraction from a material-recovery-facility in Ghana.

Experimental set-up:

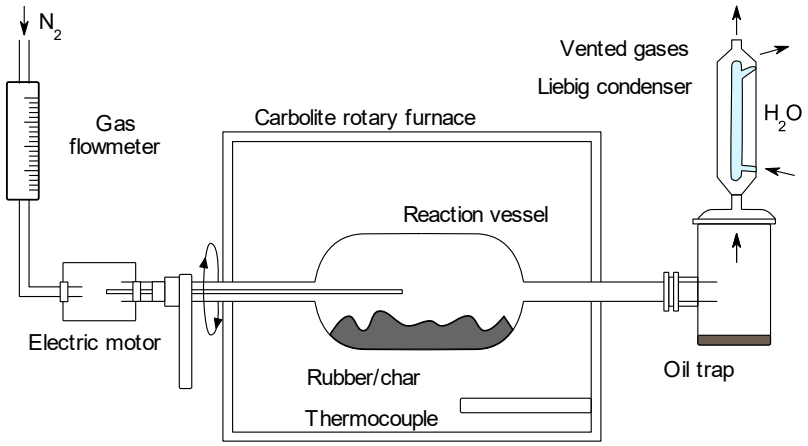

Figure 2: The rotary pyrolysis kiln used in this investigation.