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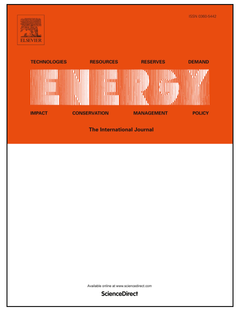

Pyrolysis of plastic waste for production of heavy fuel substitute: A techno-economic assessment

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Pyrolysis of plastic waste for production of heavy fuel substitute: a techno-economic assessment

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Abstract

Pyrolysis is widely seen as a promising technology for converting plastic waste into a wax/oil product which can be used as a heavy fuel oil substitute or as raw material by the petrochemical industry. A pyrolysis plant with a capacity of 100 kg/h plastic waste is modelled in the process simulation software Aspen HYSYS. The production costs of the pyrolysis fuel product is estimated at £0.87/kg which is 58% higher than current market prices; therefore, a scaling-up analysis is also carried out to determine the plant scale for which the pyrolysis process is economically feasible. To this end, the fuel production costs of the larger plants are approximately 2-18.9 times lower than the existing market prices of residual fuel oil, indicating their economic feasibility. Further results show that for the 1,000 kg/h case the facility needs to operate approximately four years to recover the capital investment, while for the 10,000 kg/h plant capacity, is one year, and the 100,000 kg/h case produces revenue and has a positive NPV within year one. A sensitivity analysis is also carried out, revealing that the fuel production rate is the most sensitive parameter for the 100 kg/h plant, as well as, the scaled-up plants.

1 Introduction

The amount of plastic waste generated every year is estimated to be increasing at a rate of 3.9% per year[1]. This, combined with the existing amount of municipal solid waste, make the management of plastic waste an ever-increasing problem. Additionally, owing to many countries' increasing desire for energy independence, there is a growing interest in alternatives to fossil fuels with waste derived feedstocks, like waste biomass and plastic waste, receiving most of the attention mainly due to their abundance and environmental benefits.

In 2013, 299 million tons of plastic waste was generated globally, with the European Union alone generating more than 25.2 million tons of post-consumer plastic waste each year[1]. Of this, around 26% is recycled, 36% is recovered by energy recovery processes, such as incineration, and the remainder is landfilled. Incinerating plastics can cause several environmental issues, such as dioxins formation, fly ash, production of sulphur and nitrogen oxides, and other toxins[2,3]. Additionally, if not disposed of properly, plastics can end up in the oceans negatively affecting the marine ecosystems[4]. To deal with those issues, the European Union (EU) is promoting plastics recycling by requiring 65% of municipal and 75% of packaging waste, including plastics, to be recycled by 2030[5,6].

Convectional mechanical recycling techniques cannot recycle all types of plastic waste due to their contamination with food, dirt, paper labels, and polymer mixtures which makes energy recovery technologies an attractive alternative[7]. Therefore in recent years, thermochemical conversion technologies such as pyrolysis, incineration and gasification, have gained significant attention for the management of plastic waste. Specifically, pyrolysis has shown significant advantages over the others, since it produces reduced gaseous pollutants, due to the absence of O_2 in the process. The pyrolysis