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CHEMICAL RECYCLING BY PYROLYSIS OF MIXED PLASTIC WASTE OF NON-RECYCLED MUNICIPAL SOLID WASTE

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PURPOSE OF THE ABSTRACT

Chemical recycling is a process that changes the chemical structure of plastic waste, converting them into smaller molecules that can be used for new chemical reactions. For example, processes such as gasification or pyrolysis break down plastic waste to produce syngas, as well as other liquid and semi-liquid products. In addition, new processes are being developed to convert some types of plastics into monomers for the production of virgin plastic. Therefore, chemical recycling can be used as a complementary technology, which can help turn away certain plastic waste from landfill that cannot be sustainably recycled with mechanical processes. In this sense, examples of flows suitable for this type of recycling are mixed low-quality plastics that come from non-selective collection of municipal solid waste (MSW).

As a general objective of this research, the technical viability of the recovery of this mixed plastic waste in chemical recycling processes through pyrolysis is being studied to obtain of liquid fuels of a quality similar to those derived from petroleum.

The specific objectives are:

? Identification and characterization of the plastic waste flow.

? Study of the influence of the operating conditions and the type of polymer on the distribution of pyrolysis products and their characteristics.

? Development of routes to improve the quality of the liquid fraction through in-situ and ex-situ catalytic cracking.

? Analysis of the socioeconomic and environmental impact of the process.

In a first stage, a complete characterization of the plastic waste contained in the non-recycled mixed fraction of MSW in Granada, Spain, has been carried out. Mainly, the types of polymers that are present, as well as other accompanying materials, have been identified. In addition, the quality of these materials has been determined in terms of moisture and dirt content.

In a second stage, pyrolysis tests have been carried out with the main polymers separately (polypropylene (PP), polyethylene film (PE FILM), polyethylene terephthalate (PET), polyvinyl chloride (PVC), polystyrene (HIPS and EPS). The pyrolytic transformation was carried in a R50/250/12 Nabertherm reactor (N2, 100 mL/min; heating rate, 20ºC/min; residence time, 120 min). The temperature of the process has been modified and the yield to products (solid, liquid and gas) has been determined.

Figure 1 shows the average composition of the mixed plastics. The highest percentage corresponds to PP, followed by PET, PE FILM and PS in their different types. In addition, it has been determined that the average moisture + dirt content of the material is between 15 and 20%.

Table 1 shows the yields of products obtained in the pyrolysis of polymers at different temperatures. Although the product yields depend on the type of polymer, in general, the increase in the pyrolysis temperature favors the formation of liquid and decreases the formation of char. This effect is more pronounced in some materials. For example, for PE FILM, an increase of temperature from 450 ºC to 475 ºC produces an increases of oil yield from 27.75% to 40.44%, while solid yield falls from 19.53% to 4.16%. Also, if the yields for different polymers are compared, it is found that PET and PVC produce a higher solid yield and a lower liquid yield, while the opposite occurs with PP, EPS and HIPS. Also, very different characteristics of the liquid fraction are visually observed depending on the type of polymer and the operating temperature. Thus, the liquid fraction obtained in the pyrolysis of EPS and HIPS remains as a dark brown liquid at room temperature for all temperatures tested, while the oil obtained from PVC is a black semi-solid at room temperature when pyrolysis was performed at 450 ºC and liquid when pyrolysis was carried out at 475 and 500 ºC.

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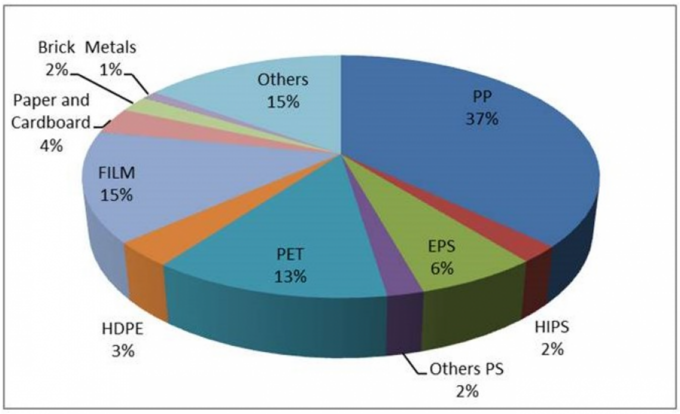
FIGURES



Material	T, °C	η_{Char}	η_{Oil}	η_{gas}
PE FILM	450	19.53	27.75	52.72
PE FILM	475	4.16	40.44	55.4
PE FILM	500	3.08	44.64	52.28
PP	450	4.06	41.44	54.5
PP	475	3.34	53.63	43.03
PP	500	1.98	61.91	36.11
HIPS	450	11.44	39.39	49.17
HIPS	475	10.54	41.42	48.04
HIPS	500	9.81	42.81	47.38
EPS	450	1.39	57.84	40.77
EPS	475	1.03	64.45	34.52
EPS	500	1.02	65.98	33
PET	450	24.07	12.5	63.43
PET	475	21.59	26.15	52.26
PET	500	21.09	24.35	54.56
PVC	450	34.61	2.99	62.4
PVC	475	34.32	5.75	59.93
PVC	500	31.24	4.09	64.67

FIGURE 1
Average composition of the mixed plastics contained in the non-selectively collected MSW.

FIGURE 2
Yields of products obtained in the pyrolysis of the different polymers (%).

KEYWORDS
Municipal Solid Waste | Plastic waste | Pyrolysis | Recycling

BIBLIOGRAPHY