HYDROTHERMAL LIQUEFACTION OF MIXED PLASTIC WASTE TO OBTAIN BIO-CRUDE AND A RESIDUE COMPOSED BY PURE POLY-OLEPHINS

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The increasing concern about global warming pushed the use of renewable sources to produce energy, chemicals and fuels. Residual biomass, plastic waste and food waste are some of the most interesting feedstocks for the production of renewable fuels and chemicals. In particular, mixed plastic waste, coming from the mechanical separation of the plastic, is continuously growing in this last decade and its disposal is one of the most critical issues for the sustainable development. The chemical recycling of this materials is an effective option; however, its composition is variable, in the mixture the main components are usually polyolefins (PO) but also a relevant amount of residue of paper and tissues (mainly cellulose) and other polymers such as polyethylene terephthalate (PET) and polyurethane (PU) are present. These contaminations hinder the possibility to chemical recycle the POs to produce valuable compounds by thermochemical processes, usually pyrolysis to produce fuels.

Aim of this study is to use hydrothermal liquefaction to decompose the contaminants of the POs contained in the mixed plastic waste in order to obtain as liquid phase a bio-crude which after up-grading can be used as fuel and a solid residue composed by pure POs which can be then treated by pyrolysis to produce fuels. Hydrothermal liquefaction has been proven to be very effective in the decomposition of feedstocks to produce valuable compounds. The use of water as solvent makes this process environmentally sustainable. The mild operative conditions achieved in sub-critical HTL can succeed in decomposing cellulose residue and PET and PU but not the POs which have high energy C-C bonds.

In this work the liquefaction of waste plastic mixture is investigated as a function of temperature, residence time and presence of Fe as hydrogen producer. The tests are performed in batch microreactors heated in a sand bath using a water feedstock ratio of 5, a temperature range of 270-330 °C and a residence time interval of 10-30min. After the reaction the products are separated and analyzed (liquid products GC-MS, solid FT-IR and EA). The feedstock composition is characterized by FT-IR analysis resulting composed mainly by polyethylene (75 % wt.), paper (15 % wt.), and other polymers (mainly, PET and PU 10 % wt.). HTL of pure polyethylene in the harsh tested conditions was performed and the result shows that any decomposition takes place. The results showed in Figure 1 reports the yields of the degradable part of the waste excluding the POs. The conditions which minimize the char content are residence time of 10 min and temperature of 300 °C, however the amount of char is never zero hindering the possibility to obtain pure POs. The addition of Fe which acts as hydrogen producer stabilizing the decomposition fragments and so avoiding their repolymerization and the char formation, allows to obtain pure POs as residue without any char residue, however the POs results contaminated with Fe. Tests on POs pyrolysis with Fe are thus performed showing that Fe can act as catalyst in the PO pyrolysis processes.

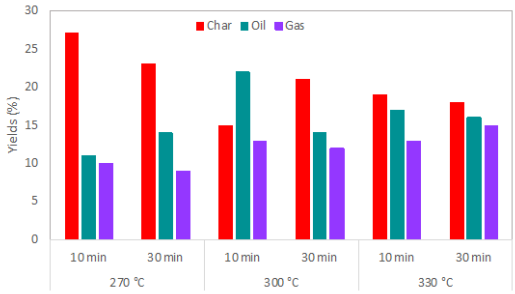

Figure 1: Yields of the HTL products referred to the amount of contaminants.