**Sub- and Supercritical Hydrothermal Processing ror PET Waste Recycling.**

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**Highlights**

* The chemical degradation of PET in sub- and supercritical water.
* Complete depolymerization of PET at short reaction times.
* High yield of monomer TPA.

**1. Introduction**

Polyethylene terephthalate (PET) is a semi crystalline polymer derived from terephthalic acid (TPA) and ethylene glycol (EG). It has excellent tensile and impact strength, chemical resistance and appropriate thermal stability. Because of the low price it is suitable for wide use. Typical PET products are mainly foils, different plastic bottles, glazing panes, advertising, synthetic fibres [1,2]. Natural decomposition of PET waste is very slow, however, the amount of waste of this material dramatically increases every day on a global scale and consequently, recovery and recycling of PET waste seem to be the best alternatives to minimize its hazards [2]. PET waste can be recycled with four main methods namely, primary (re-extrusion), secondary (mechanical), tertiary (chemical) and quaternary (energy recovery) recycling. Chemical recycling is the most desirable process because the polymer is converted into its monomers (raw materials), which can be used for reuse [3]. Hydrothermal degradation of polymers e.g. PET with sub- and supercritical water is an attractive method for chemical degradation of waste plastics into a wide range of useful products, without expensive and often harmful organic solvents. Furthermore, sub-and supercritical water has a great advantage in use such as: short reaction times, use without catalysts, high yield of monomers and simple after treatment technology [4]. In this study, hydrothermal degradation of PET with sub- and supercritical water has been investigated.

**2. Methods**

The hydrolysis reaction of PET was carried out in a high pressure and high temperature batch reactor at different temperatures from 250 °C to 400 °C, for reaction time from 1 to 30 min and water/PET waste ratio 10/1. The certain amount of colourless post-consumer PET bottles and water was placed into the batch reactor. The batch reactor was several times flushed with N2 to avoid oxidation. The initial pressure of N2 was 20 bar. In addition, the batch reactor was heated to desired temperature and then maintained at the certain temperature for selected reaction time. When the hydrothermal reaction was completed, the reactor was immediately cooled down, the reaction products were collected and analysed. The main degradation products (TPA, EG) and secondary products were determined by HPLC and FT-IR analysis.

**3. Results and discussion**

PET waste treated in sub- and supercritical water at 250, 300, 350 and 400 °C and at reaction time 1, 10 and 30 min completely decomposed in each case. The experimental results showed that with increasing temperature and reaction time up to 300 °C and 10 min, the yield of TPA increased and then it started to decrease, or it remained the same. The highest yield of TPA has been identified at subcritical conditions, namely at 300 °C and at reaction time 10 min, and it was 96 %. The yield of TPA decreased at supercritical conditions, which can be a consequence of formation of higher amounts of secondary products (benzoic acid, 1,4-dioxane). The purity of precipitated TPA was also analyzed and it was very high (95 %).

**4. Conclusions**

PET waste was successfully decomposed to main products TPA and EG in sub- and supercritical water. The high yield and purify of monomer TPA were achieved under mild conditions. It was concluded that sub- and supercritical water is an excellent reaction medium for chemical recycling (decomposition) of synthetic polymers.

**References**

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