PILOT-SCALE CONTINUOUS FLOW HYDROTHERMAL LIQUEFACTION OF MIXED TEXTILE WASTE AND SUBSEQUENT BIO-OIL UPGRADING

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Clothing is an essential part of human life in addition to food and shelf. It also plays an important role in the economy and social well-being of many regions. However, the textile industry is amongst the most resource-intensive and polluting industries [1]. Globally, it generates about 10% of total carbon emissions and 20% of total wastewater [2]. Due to fast fashion trends, a large amount of pre- and postconsumer textile waste is generated, which is landfilled or incinerated. Only about 1% of the textile waste is recycled into new fibers [1]. Multicomponent composition of the textile waste and the presence of different finishing chemicals (dyes, antistatic, lubricant, flame-retardant chemicals, etc.) create challenges for conventional recycling processes. Mechanical recycling often downgrades the quality of fibers, whereas chemical recycling can be applicable to only pure streams.

In this context, hydrothermal liquefaction (HTL) is a promising technology to recycle mixed textile waste into bio-oil, a precursor for biofuels, and monomers. The HTL of the textile waste obviates any prior separation of blended fibers and/or removal of dyes, thus overcoming the existing limitations of conventional recycling processes. However, no studies have been conducted on the HTL of the mixed textiles. In addition, more efforts are needed on upscaling of the HTL process and upcycling the reaction products, in particular, the bio-oil fraction, into transport fuels or valuable chemicals.

In this context, this study investigates the effect of the operating temperature, alkali catalyst on the bio-oil yield and recovery of terephtalic acid (TPA), a monomer for poly(ethylene terephthalate) (PET), from the postconsumer mixed textile waste. It was found that about 38-54% of TPA and about 3-9% of bio-oil can be attained from the batch HTL of mixed textile waste containing cotton; PET and other fiber impurities, such as nylon, acrylic, etc. Moreover, the effect of recirculation of the HTL aqueous phase (HTL-AP) on the bio-oil yield was investigated, as it was expected to increase the bio-oil yield and improve the energy recovery [3]. In fact, the process water HTL-AP was recirculated in batch experiments for 4 cycles, resulting in an improvement of the bio-oil yield from 4 to 27%.

After a batch experimental campaign, for the first time the HTL experiments with continuous processing was successfully conducted for the mixed textile waste with and without recirculating the process water. The resulting bio-oil from the continuous campaign was upgraded by conventional hydroprocessing using sulfided CoMo and NiMo catalysts at 400 °C to produce biofuels and/or bioproducts precursors for their direct use in the current market. Physicochemical characteristics and molecular composition of the bio-oil and upgraded oils will be characterized by several analytical techniques. The results of the present study can provide valuable insights that can contribute to a sustainable transformation of the fashion industry.

References:

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