

Using Pyrolysis to Recycle Polymers into Synthetic Fuels

Korzienko, Nikita (School: The Andrey Melnichenko Foundation: The Centre for the Development of Children's Creativity in Science and Engineering (Novomoskovsk))

Polymer waste processing is a pressing issue because disposal requires much energy and the garbage must first be sorted – adding labor costs. Scientific and engineering literature showed that thermochemical processing of mixtures of polymeric materials can be an efficient recycling method. Furthermore, there is evidence that pyrolysis can yield a useful by-product: synthetic motor fuel. My project investigated pyrolysis of individual polymers and polymer mixtures. Component ratios were based on weight and prevalence in municipal solid waste. During the first stage, I studied the pyrolysis of individual polymers: polyethylene terephthalate, polystyrene, polyethylene, polypropylene and styrene-butadiene rubber to show that each is suitable for this processing method. The second stage involved pyrolysis of a polymer mixture and atmospheric distillation of reaction products, followed by rectification of the condensate and cracking of the still residue. The work was conducted in the low-temperature range (500–600°C). Non-condensable gaseous products produced during the destruction-reaction were recycled through a gas bubbler and incinerated to heat the pyrolysis reactor. Compounds with double bonds $C=C$; $C\equiv C$ and $C=O$ were then hydrogenated on a nickel catalyst. The composition of fractions was monitored at all stages using 1H NMR and IR spectroscopy, chromatography-mass spectrometry and gas chromatography. Gasoline and diesel-type fractions corresponding to industrial analogues resulted. The method allows important environmental & economic aspects to be addressed: disposal of waste polymers, production of synthetic fuels, and environmental protection. A full cycle of processing polymer mixtures was created: pyrolysis, rectification, cracking and hydrogenation.