A comprehensive study into the thermo-oxidative degradation of sulfur-based engineering plastics (Open access)

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J. Anal. Appl. Pyrol. 168 (2022) 105754

Abstract:

The use of sulfur-based plastics has led to the accumulation of end-of-life sulfur-based plastic waste that should ideally be recycled. In this study, several technologies were applied to investigate the thermal-oxidative degradation property of sulfur-based plastics (polyphenylene sulfide (PPS), polyether sulfone (PES), and polysulfone (PSU)). Thermogravimetric analysis (TGA) revealed that these plastics undergo major decomposition at 450–650 ºC under N_2, whereas two-stage weight loss at 450–690 ºC was observed in air. X-ray photoelectron spectroscopy (XPS) and in-situ radical monitoring by heated electron spin resonance (heated-ESR) spectroscopy revealed that the samples had altered their chemical structures, and that radicals are involved in samples treated at low temperature (≤ 400 ºC). The thermo-oxidative products were analyzed by customized pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS). PPS pyrolysis mainly produced sulfur-containing aromatic compounds, with H_2O, CO_2, and SO_2 released during two-stage degradation in air, which suggests that pyrolysis and oxidation occur simultaneously during the first stage. PES pyrolysis generated various oxygen-containing products, whereas the oxidation of PES resulted in a great number of furans and dioxins at the expense of phenolics. Extensive evolution of SO_2 was initially observed, irrespective of the degradation atmosphere. PSU pyrolysis produced various aromatics, phenolics, and esters, with SO_2 formed as the major sulfur-containing compound, which was released at a lower temperature (~50 ºC) in air compared to N_2, confirming that PSU is less thermally stable than PPS and PES in air, as observed by TGA. The thermo-oxidative degradation behavior of sulfur-based plastics was comprehensively characterized by combining conventional techniques (TGA and XPS) with advanced analytical technologies (heated-ESR and customized Py-GC/MS).

* Excerpted from online journal website (Click the title)

Frontier Labs Products used:

Multi-Shot Pyrolyzer (EGA/PY-3030D), UA$^+$-5, UADTM