Consecutive recovery of three high-value products from waste tyres via pyrolysis in a rotary kiln

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The preliminary results of an investigation regarding the production of oil, recovered carbon black (a waste derived filler material), and limonene (a solvent) from the thermal pyrolysis of waste tyres is reported. Batch pyrolysis of waste tyre granulate was undertaken using a Carbolite HTR 11/150 laboratory scale rotary furnace at highest heating temperatures of 450, 550, and 650°C. The char (recovered carbon black) that was produced was evaluated by proximate analysis, BET surface area, and by the transmissibility of toluene extract, with N550 carbon black (Cb) tested as a reference material. The yield of oil was analysed, and its limonene content was measured via gas chromatography-mass spectrometry. The best recovery of both products was recorded when the tyres were pyrolysed at a highest heating temperature of 550°C. At 450°C, volatiles remained on the char which contaminated it, which negatively impacted the oil yield. Excessive highest heating temperatures (650°C) caused the thermal breakdown of valuable solvents such as limonene and can cause cyclisation reactions, producing polyaromatic hydrocarbons which contaminate the surface of the char. These factors require careful optimisation in a commercial tyre pyrolysis facility, to ensure that solvents, recovered carbon black, and tyre pyrolysis oil can be recovered consecutively from the same reactor. The recycling of these products reduces the environmental impact of waste tyres by significantly valorising them, greatly contributing to the objectives of a net-zero economy.