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Upgrading of Pyrolytic Char Generated from Waste Tyre Pyrolysis for Solid Tyre Industry

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Abstract

In Sri Lanka, accumulation of tons of low-quality pyrolytic char (PT-char) in pyrolysis plants is a significant issue in waste tyre management. Finding a solution to upgrade low-quality PT-char is urgent in Sri Lankan context as it initiates a method of finding a solution to the disposal issue of PT-char. As a result, the current study introduces an efficient and cost-effective routine for upgrading low grade PT-char into value-added products which is not being successful before. The upgrading method entails carefully regulating size reduction of the low-grade PT-char (particle size<50 μm) and following optimization of acid-base demineralization parameters. After the size reduction of PT–char, demineralization procedure was introduced using low char: acid/base ratios (1:2), diluted acids and bases (2 M HCl and 2 M NaOH), low temperatures (30 ^{0}C-60 ^{0}C), and short reaction times (30-60 minutes). Purity and surface characteristics of upgraded char were investigated using XRD, elemental analysis, SEM, and TGA. Based on a CHN analysis, 67% (w/w) of initial carbon content of crude C-PT char was increased up to 91% (w/w) by washing it twice with 2 M HCl and once with 2 M NaOH (2 M H2+2 M S) while reducing ash content from 17.65% (w/w) to 3.59% (w/w). Significance removal of metals such as Zn (1.14% w/w) , Fe (0.34% w/w), Mg (0.25% w/w) and Ca (2.71% w/w) from C-PT char were observed after treating with 2 M H2+2M S (Zn 0.36%w/w , Fe 0.06%w/w, Mg 0.01%w/w and Ca 0.01% w/w). Removal of Zn from C-PT char further confirmed by XRD and surface modification was confirmed by SEM images. Additionally, the rheological and physico-mechanical properties of the upgraded char incorporated solid tyre base compounds were evaluated and compared with commercial grades of carbon black; N 330, and N 660. It was observed that tensile strength, tear strength, hardness and compression properties of purified PT-char incorporated rubber compounds were not significantly different and exhibit resemble properties to the samples prepared using commercial carbon black grades. Overall, it can be confirmed that upgraded PT char has a significant potential to be used as an economical alternative for reinforcement filler in solid tyre industry and upgrading procedure is efficient and economically viable than the conventional methods.

Keywords: Pyrolytic char, Demineralization, Purification, Modification