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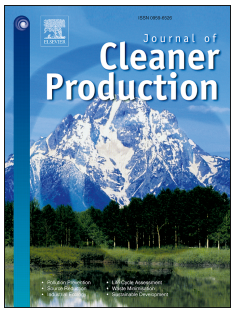

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Development of composites based on recycled polypropylene for injection moulding automobile parts using hierarchical clustering analysis and principal component estimate

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Abstract: Adapting recycled plastics into demanding manufacturing industry is helpful in promoting recycling rate of waste plastic scrap, but yet only a few researchers are tackling with this issue and recycled plastics are still ending up in low-value products. This paper presents a novel method to adapt recycled plastic for demanding industrial applications by designing suitable formulae which satisfy the technical requirements of the applications. To illustrate the proposed method which combines hierarchical clustering analysis and principal component estimate, actual requirements of some selected automobile parts were acquired and benchmarked in this study. Two common particle fillers - talcum powder and organically modified montmorillonite were added in recycled polypropylene with maleic anhydride grafted polypropylene as a compatibiliser. The initial compositions were selected according to the specific composition selection rules which are adapted from Taguchi method for reducing the number of trials. Corresponding mechanical, rheological, and thermal properties were tested based upon the technical requirements of selected automobile parts. The interrelationships between multiple objectives (requirements) were analysed and classified by hierarchical clustering analysis, and then the total number of requirements were reduced. Effects of each component were identified numerically by principal component estimate, and a corresponding linear regression model was obtained. The linear regression model was compared to other linear regression models which obtained by other mathematic techniques, and it has been proved to be the best model which has the smallest gap between predicted values and experimental results. Optimal formulae were calculated via linear programming with the objects of minimising material cost and satisfying the reduced technical requirements of selected automobile parts. In verification tests, the experimental performance of the obtained formulae closely matched the model predictions. The proposed formula design method is novel and original, and it is shown to be effective and efficient in designing recycled plastic based composites for demanding industrial applications.

Keyword: Manufacturing; Decision support system; Polypropylene; Principal component estimate; Hierarchical cluster analysis

1. Introduction

Plastic, which is usually synthesized using non-renewable fossil resources, is one of the major materials used in modern life. With a continuous growth over 50 years, the global plastic production in 2013 rose to 299 million tonnes (PlasticsEurope, 2014). According to the statistics (PlasticsEurope, 2014), 25.2 million tonnes of post-consumer plastics waste in 2012, only 26% is recycled and 36% is recovered

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