Mechanical and Industrial Engineering Department-College of Engineering-Sultan Qaboos University

Process Modeling and Optimization of Date Palm Plastic Bio-Composite Production: A Statistical Approach

Ahmed Osman Mohammed

Abstract

This research presents modelling process of date palm plastic composite in which date palm leaves flour (DPLF) used as a natural filler and two types of high density polyethylene (HDPE) (virgin & recycled) used as thermoplastic. DPLF selected, as it is abundantly available in Oman as agro residues, virgin and recycled (HDPE) studied to be compared in order to determine the differences between both forms. Bio-composite sheets produced under controlled processing parameters based on Central Composite Design (CCD) to develop a statistical model for response using fractional factorial design of experiment (DoE) procedure. The experimental design of bio-composites cover three different factors with three different levels; DPLF content (10, 20, and 30 v. %), coupling agent (2, 3.5, and 5 wt. %), and initiator (1, 1.5, and 2 wt. %). Significant factors affecting the behavior of products have been indicated. Moreover, the Response Surface Methodology (RSM) also adopted in the analysis of interactions among the input factors and their effect on overall mechanical properties of the fabricated composite. The Tensile and Flexural Strengths of specimens prepared according to ASTM standards measured by direct physical testing. Analysis of Variance (ANOVA) and Quadratic models used to develop mathematical models for the process responses. Finally, optimization using Design Expert software based on the nonlinear regression modeling is used to predict the optimal set of the studied parameters to produce optimized bio-composites with desired properties and cost effective. It is found that the developed bio-composites could serve as potential material in broad range of industrial applications as an environmentally friendly substitute to virgin and recycled HDPE.