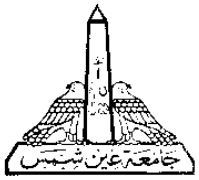


Ain Shams University

Faculty of Engineering

Design and Production Engineering

Dynamic and Static Characterizations of Biodegradable Polymer Composites

A Thesis submitted in partial fulfillment of the requirements of the degree of

Master of Science in Mechanical Engineering

(Design and Production Engineering)

by

Mohamed Hamouda Darwesh Mostafa Al Haron

Bachelor of Science in Mechanical Engineering

(Design and Production Engineering)

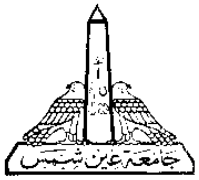
Faculty of Engineering, Ain Shams University, 2013

Supervised By

Associate Prof. Rawia Hamouda

Prof. Mahmoud Farag

Cairo – (2018)



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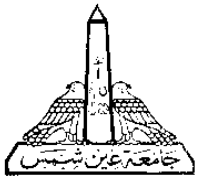

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Signature

Mohamed Hamouda Darwesh Mostafa Al Haron

Date:

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Thesis Summary

Worldwide concerns over disposal of petroleum derived polymers led to an increase in governmental regulations and environmental awareness. Using composite materials consisting of natural fibers and biodegradable plant-based polymers provides environmental benefits in terms of raw material utilization and safe disposal at the end of their life cycle. These natural composite materials are already being used in some applications such as car doors, sandwich plates, interior paneling, and tubes. Starch is regarded as a promising biodegradable material owing to its wide availability and low cost. However, starch has relatively low mechanical properties and tends to absorb moisture. These drawbacks can be controlled by adding fibers into starch matrix to form composites. Several types of natural cellulose fibers such as jute, sisal, date palm, and hemp have been used as reinforcements for starch-based composites.

This work examines the effect of DPF content and moisture absorption on the tensile and impact strengths of starch matrix composites. In addition, the fatigue behavior of thermoplastic starch (TPS) reinforced with short date palm fibers (DPFs) were investigated under bending loading conditions and the power law model was used to describe the fatigue damage behavior.

Biodegradable composites of starch–date-palm fibers were prepared by first plasticizing corn starch and chemically treating the fibers before being formed by compression molding. The effect of fiber content on mechanical properties was examined and it was found that tensile strength and Young's modulus for 50 weight percent (wt%) fiber composite improved by 7 and 12.5 times, respectively, compared to thermoplastic starch. Impact strength showed similar behavior and improved by 4.3 times for 50 wt% fiber composites. At higher fiber content the matrix was insufficient to cover the fibers, causing the mechanical properties to deteriorate. The results also showed that exposure to moisture resulted in progressive decrease in mechanical properties with increasing moisture absorption. It was found that after reaching moisture saturation, the retained tensile strengths were about one-third the starting values and the retained impact strengths were about two-thirds the starting values.

The fatigue strength of 50 wt% fiber content was the highest compared to other composites. The alternating stress at which the composites lasted for 10^7 cycles was about 16% of the flexural strength. Moreover, the experimental results of the residual strengths under various fatigue cycles and of the fatigue damage index at different levels of stresses were having a good agreement with Mathematical models following the assumptions of D'Amore et al. (1996) and Mao and Mahadevan (2002).

Keywords: Biodegradable Composites, Date-Palm Fibers, Thermo-Plastic Starch, Moisture Absorption, Tensile Strength, Bending Strength, Residual Strength, Impact Strength and Fatigue Behavior.

Contents

List of Figures

List of Tables