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MODELING AND PROPERTIES OF GLASS FIBRE-REINFORCED NYLON

NURIZZATHANIS BINTI MOHAMAD KUSASEH

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Faculty of Manufacturing Engineering
UNIVERSITI MALAYSIA PAHANG

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LIST OF SYMBOLS

σy	Yield strength or yield point
E	Elastic modulus
$\Delta L\%$	Percent elongation
σ_{UTS}	Stress-strain diagram

LIST OF ABBREVIATIONS

ASTM	American Society for Testing Materials
CAE	Computer Aided Engineering
CONH	Amide group
GF	Glass fibre
GFRP	Glass Fibre-reinforced Plastic
FKP	Fakulti Kejuruteraan Pembuatan
FRP	Fibre-Reinforced Plastic
PA6	Nylon
PBT	Polybutylene terephthalene
PDF	Portable Document Format
PET	Polyethylene terephthalate
PMCs	Polymers-Matrix Composites
PP	Polypropelene
UTM	Universal Tensile Machine
UTS	Ultimate Tensile Strength

ABSTRACT

Nylon is one of the synthetic polymers family that known as polyamides. This research study is about to analyze the modeling and properties of glass fibre-reinforced nylon. In spite of many advantages of plastics, the better physical and mechanical properties of plastic are needed. So that, reinforced plastics (composites plastics) has produced. The objectives of this study is to analyze process flow of plastic part modeling for injection molding process by using Autodesk Moldflow Insights software, to fabricate the plastic part of glass fibre-reinforced nylon by using injection molding machine, and to study the mechanical properties of glass fibre-reinforced nylon. Specimens of dog bone shaped with standard size ASTM D638 are used specifically in order to carry out this research. The processes involved in this research study are moldflow analysis, injection molding process, and tensile strength test. Moldflow analysis is used to identify the suitable process flow of injection molding process. The 3D modeling of dog bone shape specimen is used in completing the moldflow analysis. Then, the injection molding machine is used to produce the glass fibre-reinforced nylon dog bone shape specimen with different percentage of glass fibre. The glass fibre percentages used are 5%, 10%, 15%, and 20%. The mixtures were injected with a range of temperature of 210°C-255°C throughout the barrel. Lastly, the universal tensile machine is used to generate a tensile stress-strain graph for every specimens and the tensile strength of the testing parts is analyzed. As a result, it is concluded that the specimen with higher percentage of glass fibre-reinforced nylon that exceeds the percentage of pure nylon obtain high tensile stress at maximum temperature. This is due to the higher amount of weight of glass fibre-reinforced nylon increased as the percentage increased. The differences tensile strength between pure nylon and glass-fibre reinforced is tabulated and plot in a graph.

ABSTRAK

Nylon adalah salah satu daripada keluarga polimer sintetik yang dikenali sebagai polyamides. Kajian penyelidikan ini adalah untuk menganalisis model dan sifat-sifat kaca bertetulang gentian nilon.Walaupun banyak kelebihan plastik, sifat-sifat fizikal dan mekanikal plastik yang lebih baik diperlukan. Jadi, plastik bertetulang (komposit plastik) telah dihasilkan. Objektif kajian ini adalah untuk menganalisis aliran proses pemodelan bahagian plastik untuk proses pengacuan suntikan dengan menggunakan perisian Autodesk Moldflow Insights, fabrikasi bahagian plastik kaca bertetulang gentian nilon dengan menggunakan mesin pengacuan suntikan, dan mengkaji sifat-sifat mekanikal kaca bertetulang gentian nilon. Spesimen berbentuk tulang anjing dengan saiz standard ASTM D638 digunakan khusus untuk menjalankan kajian ini. Proses-proses yang terlibat dalam kajian penyelidikan ini adalah analisis moldflow, proses pengacuan suntikan, dan ujian kekuatan tegangan. Analisis Moldflow digunakan untuk mengenal pasti aliran proses yang sesuai bagi proses pengacuan suntikan. Pemodelan 3D spesimen berbentuk tulang anjing digunakan dalam menyiapkan analisis moldflow. Kemudian, mesin pengacuan suntikan digunakan untuk menghasilkan spesimen kaca bertetulang gentian nilon berbentuk tulang anjing dengan peratusan gentian kaca yang berbeza. Peratusan gentian kaca yang digunakan adalah 5%, 10%, 15%, dan 20%. Campuran telah disuntik dengan pelarasan suhu antara 210°C-255°C. Akhir sekali, mesin tegangan universal digunakan untuk menjana graf tegasan-terikan tegangan untuk setiap spesimen dan kekuatan tegangan untuk setiap satu bahagian ujian dianalisis. Kesimpulannya, spesimen dengan peratusan yang lebih tinggi daripada kaca bertetulang gentian nilon yang melebihi peratusan nilon tulen mencapai tegasan tegangan yang tinggi pada suhu maksimum. Ini adalah kerana jumlah berat kaca bertelulang gentian nilon meningkat apabila peratusan meningkat. Perbezaan kekuatan tegangan antara nilon tulen dan kaca-bertetulang gentian dijadualkan dan di plot dalam graf.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Fibre-Reinforced Plastic or FRP is a composite material consisting of reinforcing fibres thermosetting resins and other materials such as fillers. Glass fibre is generally used as a reinforcing material and polyester resins are usually used as bending agent. An FRP structure typically consists of unsaturated polyester resin. It is applied to a mould in combination with reinforcement, which most commonly glass fibre, to form a part that is rigid, highly durable and low in weight.

By reinforcing the plastic matrix, a wide variety of physical strengths and properties can be designed into the FRP composite. Additionally, the type and configuration of the reinforcement can be selected, along with the type of plastic and additives within the matrix. These variations allow an incredible range of strength and physical properties to be obtained. FRP composites can be developed specifically for the performance required versus traditional materials: wood, metal, ceramics, etc.

In addition, reinforced plastic has its own mechanical properties and physical properties. Type, shape, length and orientation of the reinforcing material can affect the mechanical and physical properties of reinforced plastics. The percentage parameters of the reinforcing material also give effect on the mechanical and physical properties of the reinforced plastic.

Glass Fibre-reinforced Plastic (GFRP) is a composites material combined plastic resin and glass fibre. Glass fibre is used to improve the mechanical strength, resistance to damage from the outside and to maintain a fixed shape. The results of combined both plastic and glass fibre, the high tensile strength is supported. Besides, the properties of

lightweight and good thermal insulation are one of the factor glass composition and modern composite material.

There are many conventional properties of glass fibre-reinforced plastic, for example long fibres are more effective than short fibres. Their resistance to fatigue, creep and wear also depends on the type and amount of reinforcement. GFRP have the ability properties to meet wide-ranging performance specifications and ability to markedly reduce part assembly. GFRP also have high strength at low weight, good impact and compression. The molding part is in close dimensional tolerances. Moreover, it is excellent chemical and corrosion resistance, good thermal insulation and respectable abrasion resistance with ready to bond with dissimilar materials.

1.2 PROCESSING TECHNIQUE

In this study, there is some method that will be use to complete the project such as Moldflow software, Injection Molding machine, and Universal Tensile Machine (UTM).

Firstly, the plastic part design must be analyze before undergoes injection molding process. Moldflow software is needed. It is used to calculate the fill analysis and wrap analysis that includes the molding process, or cooling system.

Then, to fabricate the plastic part with the combination of fibre and nylon at different percentages used is by using injection molding machine. Injection molding is a machine specially in making parts from thermoplastic. The process begins with the injection of molten plastic with high pressure into the desired shape of mold cavity inside the injection molding machine. Then, the part after injection will undergo cooling time by itself and the part can be ejected.

To study on mechanical properties of the glass fibre-reinforced nylon, the specimen formed by injection molding machine will undergo tensile test and impact test. The Universal Tensile Machine (UTM) is used to identify the tensile strength and other characteristic of the specimen.

1.3 PROBLEM STATEMENT

In spite of many advantages of plastics, the better physical and mechanical properties of plastic are needed. So that, reinforced plastics (composites plastics) has produced. Reinforced plastics has produced a good materials with light-weight properties, high levels of stiffness, high strength-to-weight ratio, outstanding fatigue resistance and very impressive corrosion resistance to compare to others most common metallic alloys, such as steel and aluminum alloys. The strength and stiffness of polymers are good by adding fibres of glass, carbon, nylon and etc.

1.4 OBJECTIVES

- To analyze process flow of plastic part modeling for injection molding process by using Autodesk Moldflow Insights software.
- To fabricate the plastic part of glass fibre-reinforced nylon by using injection molding machine.
- To study the mechanical properties of glass fibre-reinforced nylon.

1.5 SCOPE OF PROJECT

This thesis focuses on modeling and properties of glass fibre-reinforced nylon. Nylon is one of the synthetic polymers family that known as polyamides. Nylon is a thermoplastic. Nylons have good mechanical properties and abrasion resistance, self-lubricating and also resistant to all chemicals such as acids and alkalis. I need to analyze the plastic part modeling in commercial programme Moldflow for injection molding process. The analysis from Moldflow must be focus on the different percentage of used for both Nylon and fibre. After the specimen is formed, the mechanical properties need to be studied by tensile test.