

Chapter 39

Drilling of TiO_2 and ZnS Filled Gfrp Composites: A Taguchi Approach

Arun K. V.

Government Engineering College, Haveri, India

Sujay Kumar D.

University BDT College of Engineering, India

Murugesh M. C.

GMIT, Davangere, India

ABSTRACT

The main affecting parameter for Delamination of the composites and in turn the failure of composites is the Thrust force. In the present work an attempt has been made in order to investigate the Thrust force generated during drilling of the TiO_2 and ZnS filled Glass Fabric Reinforced Polymer Matrix Composites (GFRP). The volume fractions in the matrix were chosen as 1, 2 and 3%. A plan of experiments, based on the techniques of Taguchi, was performed to acquire data in a controlled way. An L_{27} orthogonal array and analysis of variance (ANOVA) were employed to investigate the influence of process parameters on the drilling of these composites. Drilling has been conducted on a radial drilling machine. Speed of drilling (S), volume fractions (VF) and drill tool diameter (D) were considered as the varying parameters with three levels. Thrust force has been considered as the output parameter and is been measured in each combination of parameters chosen. Results reveal that, the addition of filler will increase the thrust force developed during drilling. As per ANOVA values, drill tool diameter contributes more towards generation of thrust, followed by speed of drilling. Main Effect plots shows that, contribution of speed towards thrust generation is only upto a certain level of increase in speed.

1. INTRODUCTION

Polymer matrix composites are increasingly being used because of their high stiffness, specific strength and wear resistance. On account of their good combinations of properties, fiber reinforced polymer composites are used particularly in the automotive, aircraft industries and the manufacture of spaceships and sea vehicles (Pihtili Hasim, 2002). It is generally known that the epoxy resins with appropriate curing agents find use as products in protective coatings, adhesives, structural components because of their good mechanical properties, excellent chemical resistance, good wettability and electrical characteristics (Kishore, 2000).

The Optimization of cutting parameters on delamination based on Taguchi method during drilling of GFRP composite has been carried out by Kilickap (2010). The purpose of the work is to investigate the influence of the cutting parameters, such as cutting speed and feed rate, and point angle on delamination produced when drilling a GFRP composite. The damage generated associated with drilling GFRP composites were observed, both at the entrance and the exit during the drilling. The conclusion revealed that feed rate and cutting speed were the most influential factor on the delamination, respectively. The best results of the delamination were obtained at lower cutting speeds and feed rates.

An attempt has been made to develop empirical relationships between the drilling parameters such as fiber orientation angle, tool feed rate, rotational speed and tool diameter with respect to delamination in drilling of GFR–polyester composites by Rajamurugan (2013). The empirical relationship has been developed by using response surface methodology. The result indicated that the increase in feed rate and drill diameter increases the delamination size whereas there is no clear effect is observed for fiber orientation angle. The spindle speed shows only little effect on delamination in drilling of GFR–Polyester composites.

The work carried out by Palanikumar (2011) presents an effective approach for the optimisation of drilling parameters with multiple performance characteristics based on the Taguch's method with grey relational analysis. Taguchi's L_{16} , 4-level orthogonal array has been used for the experimentation. The drilling parameters such as spindle speed and feed rate are optimized with consideration of multiple performance characteristics, such as thrust force, workpiece surface roughness and delamination factor. Response table and response graph are used for the analysis. The analysis of grey relational grade indicates that feed rate is the more influential parameter than spindle speed. The results indicate that the performance of drilling process can be improved effectively through this approach.

Many researchers (Bijwe, 2004; Sari Nejat, 2007; Samyn Pieter, 2005; Bijwe Jayashree, 2000) were reported that the wear behavior of polymers was improved by the incorporation solid particles. The filler materials include organic, inorganic and mechanical particulate materials. The addition of filler particles to polymer matrices can produce a number of desirable effects, and this has been widely been investigated in the past decades. Among polymers, epoxy resin is widely used in production of glass fiber composites due to their wetting power and adhesion to glass fiber, low setting shrinkage, considerable cohesion strength, adequate dielectric characteristics, and thermal properties. Epoxies commonly modified by the inclusion of inorganic-particulate fillers, such as silica, alumina, mica or talc. Fillers are added to improve fracture toughness and electrical or heat transfer properties, to increase resin stiffness, wear resistance, and to reduce the coefficient of thermal expansion (McGrath, 2008). The tribological behaviour of glass epoxy polymer composites with SiC and Graphite particles as secondary fillers was studied using a pin-on-disc wear rig under dry sliding conditions. A plan of experiments, based on the

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