EXPERIMENTAL AND FEA OF PARTICLE IMPACT EROSION FOR POLYMER COMPOSITES

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ABSTRACT

Polymer matrix composites are finding applications in many high tech areas. With the increased use of these materials in erosive work environments, it has become extremely important to investigate their erosion characteristics intensively. Hence, study of solid particle erosion behavior polymeric composites finds importance and such studies are scarcely reported in the open literature. In view of this, erosion trials are carried out at various test conditions. For this, an air jet type erosion test rig and Taguchi's orthogonal arrays are used. Significant control factors influencing the erosion wear rate are identified. This thesis also presents the development of a theoretical model for estimating erosion damage caused by solid particle impact on the composites. The theoretical results are compared and are found to be in good agreement with the experimental values.

The main aim of the project was to study solid particle erosion of PMCs such as vinylester/carbon using orthogonal array experimental approach. The controllable parameters selected for the study included impingement velocity (33, 45 and 66 m/sec), impact angle (30°, 60° and 90°), erodent size (177, 420 and 595μm) and stand-off-distance (130, 140, 180 mm). Analysis of Variance (ANOVA) was performed to find the most influencing factor. The laminates with [-55/+55] stacking sequence were characterized for erosion damage. Amongst the four parameters selected for the study, impingement velocity had the greatest influence on the erosion rate followed by impact angle. The other two parameters showed marginal significance. The morphology of eroded surfaces is examined by using scanning electron microscopy (SEM) and possible erosion mechanisms are discussed. The specimens that showed highest erosion rates in experiments indicated fibre breakage mode of damage in their SEM analysis. The specimens exhibited semi-ductile erosion characteristics with the peak erosion wear occurring at a 90^0 impingement angle.

Finite element models were developed using LS-DYNA for dynamic contact analysis. These models were used to simulate single particle erosion on carbon/vinylester laminates and the resultant stresses and strains were observed on the eroded surfaces, which is basically an impact analysis. To enhance the eroding effect on the laminate, the erodent is scaled three times bigger

than the original size and to save the computation time the target is scaled to half of the original size. Von-Misses stresses, maximum shear stress and plastic strains were predicted.

Finite element method (LS-DYNA) results showed that the kinetic energy of an impingement particle was more at 60° as compared to that at 90°and 30°, which determined the maximum erosion rate at an impingement angle of 60°. The results showed that the predicted data were well acceptable when compared with that of experimentally determined results.