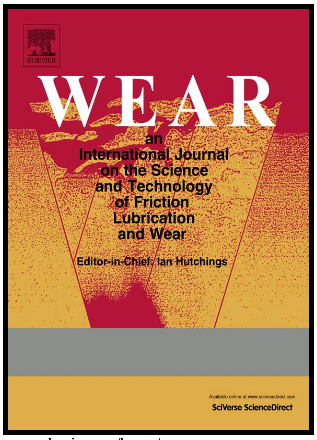

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Development of a constitutive model for erosion based on dissipated particle energy to predict the wear rate of ductile metals

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Abstract

A predictive model for erosion was developed based on kinetic energy with good experimental validation. A number of factors that contribute to the erosion process that have not been adequately defined were examined. For instance, the erosion mechanisms in many cases are unclear, and the method in which the energy is dissipated into the surface during erosion had not been sufficiently understood. Also, the effect of dissipated kinetic energy into the surface at different impact angles is not apparent in current erosion models.

Subsequently, an improved energy based erosion model incorporating the surface material properties such as elastic modulus, Poisson's ratio, dynamic pressure and coefficient of restitution was developed. In particular, the new erosion model was developed in this study based on impact parameters, surface material properties and energy factors. The theoretical results using the model compared well with the experimental erosion rates and concluded that the model could accurately predict the experimental erosion values at all tested impact angles from 15°–90° and impact velocities from 30 ms^{-1} to 90 ms^{-1}. The developed model also enables determination of the coefficient of restitution, strain rate, dynamic pressure and some valuable parameters to determine the erosion mechanism.

Keywords: Erosion model, energy factors, materials properties, erosion rate, experimental comparison.

1. Introduction

There are many erosion models available that can calculate and predict the erosion rate [1-13]. Most of the models considered the impact parameters such as impact velocity and angles [1, 3, 4, 6, 7]. However, some models considered impacting particle and impacted surface material properties [1, 2, 8-12, 14, 15]. It is clear from the previous studies that a single mechanism of material removal cannot be applied to all the different wear situations.

In early erosion research, Finnie [8] proposed the expressions for the volume loss of surface material, V due to the moving action of a single particle that has a mass m, velocity v, impact angle α, and depth of cut ψ, as is presented below.