Accepted Manuscript

On the assessment of variable loading in adhesive wear

Hossein Fereidouni, Saleh Akbarzadeh, M.M. Khonsari

PII: S0301-679X(18)30373-6

DOI: 10.1016/j.triboint.2018.07.035

Reference: JTRI 5329

To appear in: *Tribology International*

Received Date: 19 April 2018

Revised Date: 19 July 2018

Accepted Date: 22 July 2018

Please cite this article as: Fereidouni H, Akbarzadeh S, Khonsari MM, On the assessment of variable loading in adhesive wear, *Tribology International* (2018), doi: 10.1016/j.triboint.2018.07.035.

On the assessment of variable loading in adhesive wear

Hossein Fereidouni, Saleh Akbarzadeh, M. M. Khonsari[1]

Department of Mechanical Engineering, Isfahan University of Technology, Isfahan, 84156-8311, Iran

Department of Mechanical and Industrial Engineering, Louisiana State University, LA 70803, USA

Abstract

An experimental procedure for assessment of adhesive wear subjected to variable loading is presented. The applicability of the Miner's rule to variable loading and an experimental methodology for determining the Miner's rule constant is described. The results of extensive pin-on-disk tests subjected to various loading scenarios reveal that the cumulative power dissipation and entropy remain relatively constant and independent of the loading sequence. These findings offer a reliable approach for estimation of wear when a component experiences variable loading.

Keywords: Miner rule; entropy flow; dissipated power; variable loading sequence

1. Introduction:

Dating back to 1924, Arvid Palmgren, a German engineer, was the first to consider cumulative fatigue damage caused by variable stress [1]. Subsequently, Langer went on to evaluate the two main stages of fatigue damage, namely the crack initiation and crack propagation [2]. Shortly thereafter, Kommers considered the change in the endurance limit as a measure of damage [3]. In 1945, the results of these studies finally culminated in the development of the mathematical form of Palmgren's concept by Miner—what is commonly referred to as Miner's rule or Linear Damage Rule (LDR) [4]. The LDR determines the damage per applied stress as a fraction of the fatigue life. This hypothesis states that failure occurs when the sum of the damage fractions reaches a constant value of C=1. However, research shows that in practice, C varies between 0.7 to 2.2. Furthermore, Miner's rule does not take the loading sequence into account. This problem surfaced experimentally by Miller [5] in 1970 who showed that when a low-load is followed by a high-load, the value of Miner's constant is often larger than unity and that for the same loads applied in the reverse order (from high- to low-loading), it is lower than unity. In fatigue literature, this is referred to as the loading-sequence problem.

Turning our attention now to wear, we note that the problem of variable loading has not received much attention. In fact, the experimental validity of applying the Miner's rule to adhesive wear and its implications on the applicability of the Archard' law was only recently investigated [6] even though the relationship between formation of wear particles to fatigue was described by Krageslkii [7] in 1965.

In dealing with wear in a tribosystem, the frictional heating and the surface temperature should also be considered, for they are known to have a significant influence on the tribological behavior and failure of rubbing parts [8]. Contact temperature is the key factor in transition between the wear mechanisms such as mild oxidational wear or melt wear [9]. It substantially

[1] Corresponding author: khonsari@lsu.edu; 1+225.578.9192