Contact and fretting wear properties of superalloy Rene® 77

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The nickel-based superalloy Rene® 77 is widespread used in turbine blades. The reason is the excellent mechanical properties and resistance to the oxidation at high temperature. In turbine blades, a further resistance to the fretting stresses is needed. This research is focused on the fretting wear characterization of Rene® 77. A point contact test rig was used to study fretting wear and contact parameters at room temperature and 600 C. Results at room temperature shows a non-linear increasing in wear volume at higher number of cycles or higher dissipated energy. At high temperature oxidation prevails at low energy and while wear prevails at high energy.

Keywords: Contact, Fretting, wear, friction coefficient, Rene® 77.

1. Introduction

Fretting is the degradation process which occurs on contact surfaces in relative reciprocating sliding motion of low amplitude with respect to the contact length along the sliding direction [1]. In turbine blades fretting is usually found near the contact surfaces of blade attachment, shroud and damper. The attachment usually works at low frequency and relative displacement comes from the application of centrifugal load [2]. On the other hand, relative displacement of contact surfaces of shroud and damper are induced by blade vibration. These have different origins included the fluid-structure interaction. This research aims to describe the fretting process on the contact surfaces of shroud at blade tip.

2. Methods

In order to study the fretting behavior Rene® 77 an experimental campaign was performed by means of a point contact test rig, details of rig can be found in [5]. The parameters of fretting process were stroke 150 µm, normal load 32 N, frequency 150 Hz, two temperatures (room temperature, 600) and three durations (5×10^6, 10×10^6, 15×10^6 Cycles). On this test rig were continuously acquired hysteresis loops i.e. friction force as a function of relative displacements. These loops were also stored with a frequency depending on the specific stage of fretting process, more frequent at the initial stage. Relative displacements were measured and controlled on both specimens in proximity of each contact surface. Thus, the real sliding amplitude of contact surfaces was not affected by measurement error due to the compliance of test rig components, usually an imposed sliding amplitude is measured and controlled in position distant from contact surfaces. Consequently, displacements measurement includes the compliance of test rig components [4]. Acquired hysteresis loops was post-processed in order to evaluate contact parameters and dissipated energy. Topographies of contact surfaces were measured before and after fretting processes by means of a measurement system based focus variation. Wear volume was evaluated on both contact surfaces by a methodology described in [5] that consider the effect of roughness. Scanning Electron Microscopy observation was performed at end of fretting processes.

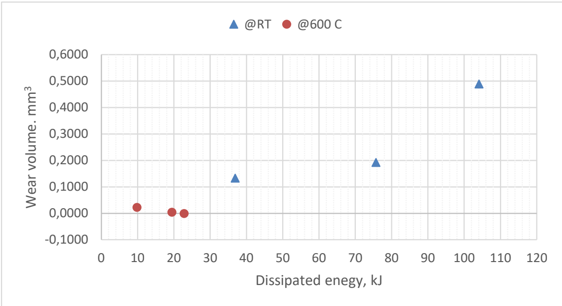

Figure 1: Wear volume as a function of dissipated energy.

3. Discussion

Wear volume as a function of dissipated energy was reported in Figure 1. Dissipated energy at room temperature was much lower than at 600 C. Similarly, consideration can be reported also about the energetically equivalent coefficient of friction, average value evaluate on all processes at 600 C are less than a quarter of midrange value at room temperature. Wear volumes exhibit a catastrophic non-linear trend at room temperature and high energy (higher number of cycles). This trend comes from the wear volume of spherical surfaces and can be attributed to the transaction of contact geometry (point contact – wear – conformal contact). At 600 C oxidation effect decreases with the increasing of dissipated energy.

4. References

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