AN EXTENTED R_P-R_F FRICTION ENERGY APPROACH FORMALIZING THE NORMAL FORCE FLUCTUATION EFFECTS ON FRETTING WEAR RATE.

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Fretting-wear; friction energy approach; normal force fluctuation effects

ABSTRACT
In nuclear power plants, tubes of the rod cluster control assemblies undergo impacts at low contact pressure against guides, causing specific wear on the contact surfaces. The present study investigates fretting wear behavior under complex loading, using an original double-actuator fretting wear system which allows independent control of tangential sliding and normal force fluctuation. Using this experimental set-up, the fretting wear response of a nitrided 316L SS cylinder fretted against a 304L SS plate in air is investigated.

The effect of normal force fluctuations, quantified by the $R_P = P_{\min} / P_{\max}$ ratio ([1]-[2]), combined with the effect of frequency ratio defined by $R_f = f_{fretting} / f_{impact}$, was investigated keeping the tangential sliding amplitude constant. Surface damage evolution was followed by 3D profilometry and the specimen surface and cross-section were characterized using different analysis techniques (SEM, EDX, EBSD) (Fig.1).

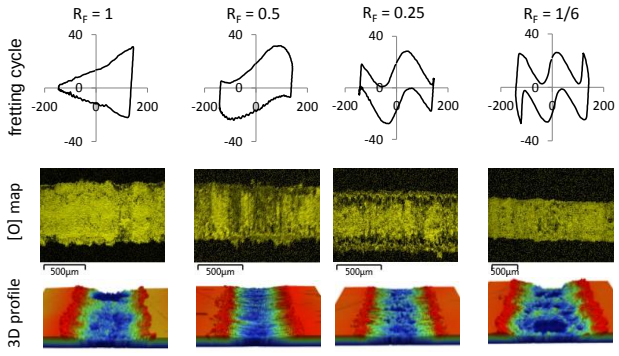

Fig.1 Evolution of fretting-cycle, oxygen map and 3D profile with R_f

Finally, to quantify the wear volume extension (V), a R_P - R_f -friction-energy-wear model is introduced with $V = \alpha^* \times \Sigma Ed$ where $\alpha^* = R_P{}^{\eta} \times R_f{}^{\omega} \times \alpha$ with α the energy wear coefficient when $R_P = R_f = 1$ and ΣEd the accumulated friction energy (Fig.2). This new description of the wear coefficient allows us to account for friction work, normal force fluctuation and frequency ratio all at once. For a dry interface, both η and ω are found to be very low and of the opposite sign ($\eta = -\omega = 0.15$), suggesting that the wear volume is controlled by the friction work and nearly not affect by normal force fluctuations in amplitude and frequency.

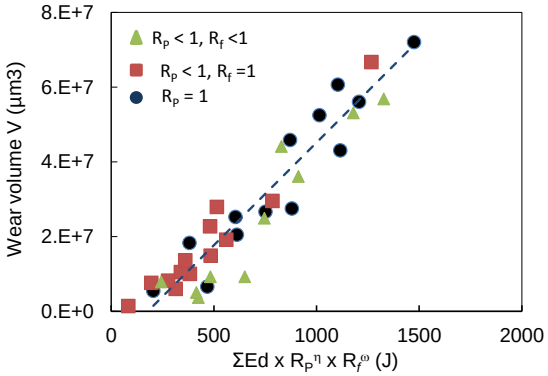

Fig.2 Fretting-wear volume versus accumulated effective R_P - R_f - weighted friction energy.

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