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4. Unification of friction and wear

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Abstract

Friction and wear are often treated as unrelated, distinct phenomena. In fact, friction and wear are macroscopic manifestations of common physical processes operative at sliding interfaces. Friction and wear are related through the physics of these processes, which are thermodynamically irreversible and dissipative, since energy loss is almost always involved. This chapter attempts to unify friction and wear, by focusing on the dissipative processes found at sliding interfaces. Prominent mechanisms of friction and wear are first reviewed, with goal of identifying the associated dissipative processes. The laws of thermodynamics are then reviewed, with a focus on entropy generation and the first and second laws. This is followed by review of the Degradation-Entropy Generation theorem, which relates degradation of any form to the irreversible entropy generated by responsible dissipative processes. The theorem is applied to sliding interfaces and a tribological control volume, to relate wear to responsible interfacial dissipative processes. Friction force is also related to entropy generated by interfacial dissipative processes. Next, dissipative processes associated with friction and wear, and found at sliding interfaces, are identified and reviewed, and the entropy generated by these dissipative processes is presented. Finally, conclusions regarding friction and wear, relations to dissipative processes, are presented.