Authors' Closure to "Discussion of 'An Application of Dimensional Analysis to Entropy-Wear Relationship,' " (2012, ASME J. Tribol., 134, p. 011604)

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We thank Dr. Abdel-Aal for his interest in our paper and for providing an interesting discussion. The premise of this discussion is to further develop the entropy concept to account for the running-in (transient) period. The idea is to consider the variation of hardness as a function of temperature.

As pointed out in the paper (see Eq. (4) and its associated discussion), the analysis presented pertains to the steady state condition where the entropy *generation* and entropy *flow* are in balance. In the transient regime the total entropy of the system, which includes entropy flow and entropy generation, should be considered (see Eq. (1) in the original paper). The realization of connecting the entropy generation and entropy flow to degradation processes involving wear and fatigue has been a subject of intense research. Interested readers may refer to Refs. [1–6] for detailed discussions.

Dr. Abdel-Aal's derivation of Eq. (5) includes two terms: $T\dot{S}$ and $\mu lN\dot{T}/T'$. Considering the notation used in the paper, the term $T\dot{S}$ plays the role of entropy flow while the term $\mu lN\dot{T}/T'$ can be considered as the entropy generation. The latter term includes μlN, which is the energy dissipation by the friction force (μN) during a sliding distance of l. This equation takes into account the role of both entropy generation and entropy flow during the running-in period. However, it is important to note that during the running-in period, the coefficient of friction μ, (or in a similar way, the wear coefficient K) changes with time until a steady state is reached. This has been analytically and experimentally demonstrated. See, for example, Refs. [7,8].

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