



تقييم النماذج الحالية لتوصيف عملية التأكل

Abstract: This paper focuses on introducing several common wears describing mathematical models and empirical formulas, and discusses the current applications of wear prediction in enhancing the overall reliability of mechanical systems, aiming to gain a deeper understanding of the advancements in this field through the exploration of key findings and methods.

Keywords: *Wear prediction; Mathematical model of wear prediction*

الخلاصة: تركز هذه الورقة على تقديم العديد من النماذج الرياضية والصيغ التجريبية التي تصف التآكل الشائع، وتناقش التطبيقات الحالية للتنبؤ بالتآكل في تعزيز الموثوقية الشاملة للأنظمة الميكانيكية، بهدف اكتساب فهم أعمق للتقدم في هذا المجال من خلال استكشاف النتائج والأساليب الرئيسية.

الكلمات المفتاحية: تحمل الأمتل التشحيم. تقليل التآكل؛ التشحيم الهيدروديناميكي نمذجة الاحتكاك الدينامي



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المقدمة

Accurate wear prediction is crucial for enhancing the reliability and longevity of mechanical systems, as it optimizes maintenance cycles and reduces production costs. This paper explores several common mathematical models and empirical formulas used for wear prediction, highlighting their applications in improving mechanical system reliability. By examining key findings and methodologies, the study aims to provide insights into advancements in wear prediction techniques [1-3].

يُعدّ التنبؤ الدقيق بالتآكل أمراً بالغ الأهمية لتعزيز موثوقية الأنظمة الميكانيكية وإطالة عمرها، إذ يُحسن دورات الصيانة ويُخفّض تكاليف الإنتاج. تستكشف هذه الورقة البحثية العديد من النماذج الرياضية والصيغ التجريبية الشائعة المستخدمة في التنبؤ بالتآكل، مُسلّطة الضوء على تطبيقاتها في تحسين موثوقية الأنظمة الميكانيكية. من خلال دراسة النتائج والمنهجيات الرئيسية، تهدف الدراسة إلى تقديم رؤى حول التطورات في تقنيات التنبؤ بالتآكل [3-1].

النتائج والمناقشة

Mathematical models are typically based on physical principles and describe various influencing factors in the wear process; whereas empirical formulas summarize empirical relationships based on experimental data for quick estimation of wear amounts. Currently, the application of mathematical models based on wear prediction plays a crucial role in enhancing the reliability of mechanical components. Common wear prediction mathematical models and empirical formulas include wear models based on Archard's law, wear formulas based on the Coulomb friction model, and empirical formulas targeting different wear mechanisms, among others.

The Archard wear model is one of the most widely used classical models for wear prediction. This model assumes that wear is formed by small cutting, peeling, and other actions at surface contact points, and that the amount of wear is proportional to the contact area, normal pressure, and material hardness. Its basic expression is (1).

$$V = k \cdot \frac{W \cdot S}{H} \quad 1)$$

Where: V is the wear volume (mm³); k is the wear coefficient (dimensionless), usually determined experimentally; W is the normal pressure (N); S is the relative sliding distance (m); H is the material hardness (MPa).

The Coulomb friction model is primarily used to describe the relationship between the friction force and the contact surface of objects, particularly during sliding friction processes. This model assumes that the friction force is proportional to the normal pressure and is independent of the relative sliding velocity of the objects. Based on the Coulomb friction model, the wear prediction formula is (2)

$$F_f = \mu \cdot W \quad 2)$$

Where F_f is the friction force (N); μ is the friction coefficient (dimensionless); W is the normal pressure (N).

When the friction force is known, the relationship between wear rate and friction coefficient can be further obtained. For example, under conditions of a higher friction coefficient, the friction force is larger, resulting in greater wear. By combining the Coulomb friction model with the wear mechanism, the resulting wear formula is as follows (3)

$$V = k_1 \cdot F_f \cdot S \cdot \mu \quad 3)$$

Where k_1 is the wear constant, determined experimentally; F_f is the friction force; S is the relative sliding distance; μ is the friction coefficient. This formula indicates that an increase in friction force and friction coefficient will directly lead to an increase in wear rate. Unlike the Archard model, the Coulomb friction model focuses more on the relationship between friction force and wear, making it suitable for explaining mechanisms such as abrasive wear and adhesive wear.

Abrasive wear typically occurs when hard particles or particulate matter come into contact with the material surface. The amount of wear is usually related to hardness, abrasive particle size, and the contact time with the surface. An empirical formula is given in equation (4).

$$V = k_2 \cdot P \cdot D \cdot L \quad 4)$$

Where V is the wear volume (mm^3); P is the normal pressure (N); D is the diameter of the abrasive particles (mm); L is the sliding distance (m); k_2 is the wear constant, which depends on material properties and abrasive type. This formula is applicable to the abrasive wear mechanism, indicating the relationship between wear amount and normal pressure, abrasive particle size, and sliding distance.

الخاتمة

Mathematical models and empirical formulas for wear prediction provide important tools for tribological research and engineering practice. Although existing wear models can predict wear conditions under certain common operating conditions relatively well, in complex operating conditions, it is still necessary to combine experimental data and numerical simulation methods to improve the accuracy of predictions.

Literature المراجع والمصادر

1. Cortellesa V, Singh H, Cukic B. Early reliability assessment of UML based software models[C]//Proceedings of the 3rd international workshop on Software and performance. 2002: 302-309.
2. Ciancone A, Drago M L, Filieri A, et al. The KlaperSuite framework for model-driven reliability analysis of component-based systems[J]. Software & Systems Modeling, 2014, 13: 1269-1290.
3. Wang J, Li Y, Zhao R, et al. Physics guided neural network for machining tool wear prediction[J]. Journal of Manufacturing Systems, 2020, 57: 298-310.