بنیاد ملی نخبگان

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3D Investigation into the Thermal Behavior of the Wet Multi-Disk Axle Brake of an Off-highway Machinery

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Abstract: Accurate prediction of the thermal behavior of the axle-brake systems is an imperative part of the design process of the braking systems in off-highway machineries. The frictional heat generated during repetitive braking cycles under heavy braking loads can cause several negative effects including brake fade, thermal cracks and even fluid vaporization. Despite its significance, limited capability has been developed to predict the thermo-fluids of the wet axle-brake systems. The multi-scale and multi-physics nature of the problem in combination with the significant complexity of the geometries involved, renders the application of the common-practice Computational Fluid Dynamics (CFD) methods impractical. This paper, proposes a framework for the application of CFD to predict the time-dependent thermo-fluid state of a wet axle-brake system. The thermal model includes full consideration of the heat transfer in the friction pairs, air-oil mixture, and eventually the surrounding solid parts. To achieve this goal, the problem is broken into three sub-problems: the flow between a pair of the friction and separator plates, the global solution of the fluid motion of the air-oil mixture in the housing and eventually the heat transfer in the solid parts. Finally, the temporal evolution of the temperature in both fluid and solid phases predicted by the proposed simulation method, are validated against the experimental measurements. Keywords: Multiphase flow, Heat transfer, Multi-disk brake, wet axle brake, Computational fluid dynamics (CFD), conjugate heat transfer (CHT).

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