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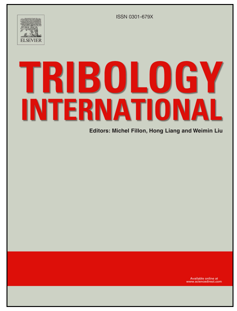

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PII: S0301-679X(18)30228-7

DOI: 10.1016/j.triboint.2018.04.035

Reference: JTRI 5229

To appear in: *Tribology International*

Received Date: 7 February 2018

Revised Date: 18 April 2018

Accepted Date: 29 April 2018

Please cite this article as: Zhang Y, Li Xh, Hong J, Yan K, Li S, Uneven heat generation and thermal performance of spindle bearings, *Tribology International* (2018), doi: 10.1016/j.triboint.2018.04.035.

Uneven heat generation and thermal performance of spindle bearings

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Abstract: The force that an angular contact ball bearing suffered is non-uniform due to the radial loading of an operating spindle, which leads to more heat generation in the contact zone. To this end of improving spindle thermal characteristics, non-uniform preload adjusting method was employed. Firstly, a novel quasi-static five-degrees-of-freedom model for an angular contact ball bearing under rigid axial preload was deduced, then a local bearing heat-generation power model was employed to assess power losses in different contact zones, in which bearing contact parameters, external loads, rotation speeds, and bearing preload conditions were fully considered. Additionally, variance analysis was used to estimate heat generation fluctuations in bearing local contact zone. Finally, an adjustable preload platform was designed and thermal features of uniform and non-uniform preload were discussed. The results show that, a suitable non-uniform preload for operating spindle can reduce bearing temperatures by 15.4% at most.

Keywords: angular contact ball bearing; non-uniform preload; heat generation; thermal characteristics

Nomenclature

a	Long axis of the Hertz contact ellipse on contact zone /mm	Q	Normal contact force between rolling elements and inner or outer raceway /N
C	Bearing condition	R_p	Distance between the preload acting point and bearing centre/mm
C_s	Static load rating of bearing/N	*Greek letters*	
d_m	Pitch diameter of bearing /mm	α	Contact angle/rad
D_i	The diameter of the contact point between the inner ring and rolling elements/mm	β	Angular between ball velocity vector and pitch circle/rad
E	Second type of elliptic integral of the contact zone	v	Kinematic viscosity of the lubricant at the operating temperature/mm·s^2
F	Bearing preload/N	φ	Direction of the equivalent moment
F_a	Axial load applied on bearing /N	ω	Rotating speed/rad·s^{-1}
F_r	Radial load applied on bearing/N	μ	Friction coefficient
F_β	Equivalent force applied on bearings/ N	ψ	The angle between ball and the first ball in the clockwise direction
F_x^{eq}	Principal vector/N	*Subscripts*	
f_0	Coefficient associated with the bearing type and lubrication type	0	Original

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