INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN

Faculty of Mechanical Engineering
Brno University of Technology

Review of Doctoral Thesis

1. PhD candidate
Kazumi Sakai / Kazumi.Sakai@vutbr.cz
2. Name of PhD programme
Design and Process Engineering
3. Title of PhD thesis
Study of correlation between grease film formations and mechanical losses on various surfaces

4. Principal supervisor
Prof. Ivan Křupka / krupka@fme.vutbr.cz
5. Co-supervisor
/

6. Reviewer
Dr R. Glovnea / R.P.Glovnea@sussex.ac.uk
University of Sussex

7. Overview of the scope of PhD thesis[1]
Very good
There are two main objectives of this thesis: to obtain a correlation between rolling bearings' frictional torque, on one side and greases' formulation on the other; to evaluate the correlation between grease behaviour and their properties. It was found that: 1) Greases' yield stress can be an indicator of bearing torque, when greases with similar thickener are compared. 2) At large speeds grease channelling is responsible for an increase of bearing torque, when there is no resupply of lubricant to the contact. 3) There is no direct correlation between thickener structure and frictional torque performance. 4) There is a correlation between thickener type and film thickness, however thicker lubricant film does not always translate into lower bearing torque. 5) The ability of greases to form thick film was related to the entrainment of the thickener into the contact area, which, in turn depends of the polarity of the thickener.

8. Significance of the topic and clarity of problem statement
Very good
There is a continuous effort nowadays towards increasing efficiency of machine components, reducing the usage of lubricants and increase their working life. The thesis subscribes to this scientific effort, by tackling the area of grease lubrication, with application to rolling element bearings. Rolling element bearings are

[1] Overview of the scope of PhD thesis is a short description of objectives of PhD thesis's research and summary of main findings and scientific achievements.

the second most numerous machine components with some 50 billion working at any time across the Globe. Given the fact that the vast majority of rolling bearings are lubricated by grease, efforts for understanding their mechanisms of lubrication in order to reduce friction torque are welcomed. From this point of view the thesis is well timed and relevant to the field of research. The author states clearly the scientific questions which they want to tackle in this research, following a thorough literature review.

9. Knowledge of existing literature

Good

There are a huge number of papers published on various aspects of grease lubrication. The author had a difficult task in sieving through and selecting those publications most relevant to the topic of the thesis. I have two comments to make: 1) There is a good number of papers which relevant to various aspects of this thesis which should have been included. For example: Eriksson, et al (2000), Proc. Inst. Mech. Engrs., 412, part J., pp. 309-316; Errikson et all (2000), Proc. Inst. Mech. Engrs., 412, part J., pp. 317-325; Cann, P.M., and Lubrecht, A.A., (2007, J. Phys., D: Appl. Phys., 40, pp. 5446-5451; 2) Papers on grease lubrication employing methods other than optical interferometry, should have been included; for example papers by Dyson and Wilson A. R.

10. Choice of methods and technical soundness

Very good

The methods used in this experimental investigation are appropriate and technical sound. The method of optical interferometry has proved to be most accurate in simulating real-life operation of EHD contacts. Moreover the method of optical colorimetric interferometry developed at the host laboratory has received wide appreciation from the researchers in the field. In my opinion a brief presentation of the principles of optical interferometry, with relevant references should have been included. The author also introduces a test rig for measuring the friction torque in rolling element bearings, however it is not clear whether that rig was designed and manufactured within the research frame of this thesis. This should be clarified. A schematic of this rig and detailed explanations of the operation should have also been included.

11. Quality, originality and significance of the results

Good

The results are significant in the context of the research carried out in this thesis. Some questions still arise. The load used in measuring the bearing torque was only 50N in redial and axial directions. This is very modest load especially for a medium size bearing. The author did not give an explanation to this choice. This is more striking when the bearing torques measured were in the region of 10 mNm to 50 mNm. It would have been interesting to see some results carried out a varying load so the load effect on the torque can be evaluated. The results concerning the behaviour of grease lubricants in dented surfaces are original and in my view their novelty and relevance should have been emphasised more in the thesis.

12. Quality of attached papers

Good

The author has published an important number of research papers and has presented his work at high calibre, international scientific event. These show sustained research commitment and effort over a long period of time. The published papers as well as the conference presentations are totally relevant to the topic of the thesis and are of good quality. The papers on the viscoelastic properties of greases and on the

effect of the formulation of greases upon the bearing torque are particularly notable. They are published mainly in Tribology Online, a high quality research journal, although I would have preferred to see a wider range of journal in this list.

13. Overall assessment, strengths and weaknesses (based upon the above evaluation categories 8–12)

Good

This thesis is the culmination of continuous research carried out by the author over a number of years. It approaches a topic which is of great actuality, enriching our understanding of the behaviour of the operation of greases in rolling element bearings. This potentially can lead to better design of grease as well as the surfaces of rolling element bearings, for better efficiency and durability. My assessment is that the thesis should have emphasised more strongly and clearly the novelty of the results and the contribution of the research to the field. Very often statements showed uncertainty or hesitation. In a thesis, especially in the discussion and conclusions chapters words like possible, could, seem, should be replaced by stronger words like believe, should, conclude, etc. I also expected more in terms of interpretation of the results which would reveal the physics of the phenomena described. On the other hand the thesis was written as if a potential reader has as close familiarity with the work as the author himself. Hence more detailed explanations were needed in some parts.

14. Other comments

The English is passable but a reader needs in places, to make great effort to understand the meaning of various statements. I have made a number of corrections as highlighted in the attached text, which I believe are crucial to improving the standard of the thesis.

15. Conclusion

PhD thesis is an independent scientific work that presents a novel solution to a significant problem in the research area and demonstrates the candidate's ability to conduct independent research.

YES

16. Date and signature

10/06/2018	

Please note

A. *Evaluate categories 7 to 13 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent. The qualification of 'excellent' should only be given for a PhD Thesis in the top 3% of the research in your field of expertise.*
B. *E-mail the completed form to: Klara.Javorcekova@vut.cz*