7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Lab-to-field upscaling for materials selection

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Wherever moving bodies are in contact with each other, the respective materials show certain friction and wear performance characteristics. These materials have to fulfil additional functionality requirements and meet ecological, health and safety regulations. In order to bring novel materials into products, extensive material characterisation is required. i-TRIBOMAT is aiming to be the world first open test bed for tribological materials characterisation to support industrial innovations among European industries and SMEs. i-TRIBOMAT enables the use of unique shared tribological infrastructure, data analytics, and upscaling tools to select and find new material solutions for engineering applications. The Collaboration Interface is designed to facilitate easy access for customers to i-TRIBOMAT upscaling tools.

Keywords: upscaling, model test, component test, experimental, modeling

1. Introduction

The general challenge related to experimental testing is, how to make the scale jump from small scale to large scale and to bridge the gap between the simple model tests and the larger scale components, pilot cases or even components operating in the field. In order to facilitate transfer of experimental laboratory results to product performance, and to reduce the number of required expensive system scale tests, a modelling based Lab-to-Field upscaling toolset is built in i-TRIBOMAT project.

2. Methods

The materials upscaling from simple model tests on laboratory scale to more complex and expensive component scale tests is based on three industrially relevant representative applications. To generate a tribo-test upscaling model chain, experimental data is generated by tests carried out in different scales. Life-time predictions in lubricated sliding contacts are approached via the journal bearing use case. Prediction of friction is covered by an engine cylinder liner use case. Finally, the material group of polymers is simulated in a seal use case with the aim to predict both friction and wear behavior. The tribological data collected from the tests reflecting the reguirements of the use cases, will be used to construct the upscaling functionalities. The main focus is to create an upscaling wear model for lubricated sliding conditions in different lubrication regimes. The upscaling model will enable lifetime predictions for different materials options to be used in machine designs.

2.1. Model building for wear prediction

The experimental data is used to facilitate the wear model building. The use of different wear models will be evaluated to generate the 'modified Archard-type' wear law. The wear law can be improved by more profound load (F) dependent true contact area probability (A,) estimates, whose determination can also utilize contact surface roughness measurement information.

2.2. Architecture of the Upscaling Model

The architecture of the upscaling tool is presented in Figure 1 for the example of lifetime estimation in journal bearings. The upscaling wear model is one of the key components in the concept. The complete concept is utilizing data from model tests combined with digital twins in both laboratory scale and larger product scale.

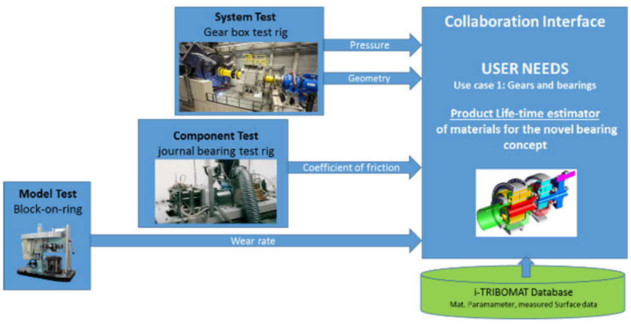

Figure 1: Architecture of the Lab-to-Field upscaling tool for the use case 1 for the life-time estimation.

3. Discussion

The upscaling of laboratory scale data to product scale for life-time estimation is challenging and requires model based tools to give valid answers. In our approach we utilize, e.g. the wear rate under the operating conditions to compute the life-time estimate for given component type. Coupling of the digital twins increases the accuracy of upscaling: the large scale simulation feed the operational parameters to tests, model tests provide wear data into the upscaling wear model, component scale tests provide lubrication regime sensitive data, and thus the product life-time estimation module can give life-time predictions for different material options.

Acknowledgement:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 814494, project i-TRIBOMAT. More details: https://www.i-tribomat.eu/.

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