



AGMA Technical Paper

Dynamic Simulations of Radial Lip Seals Followability in an Industrial Gearbox

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

Industrial gear units are widely used in power transmission systems. They are composed of shafts, gears, rolling elements bearings and dynamic lip seals. The seals performance is critical for a proper functioning of the system. Water or contamination ingress into a mechanical system may lead to a premature failure. Leakage of oil may have the same effect and be harmful for the environment. Depending on the application, seals may need to operate under various dynamic conditions, such as wide range of rotational speed (RPM) and temperatures, shaft-to-bore-misalignment (STBM), shaft dynamic run-out (DRO) or global structure deformations.

The prediction of dynamic seal performance is a complex task. The rotating lip seals are usually made in elastomeric materials which display a hyper-elastic and viscoelastic behavior. Combined with the dynamic operating conditions, the simulation of the seal performance requires time dependent approaches which are very often time consuming. Innovative modeling methods need to be developed in order to be usable by the development engineering community.

This paper presents a novel approach to predict seal dynamic performance under dynamic conditions. A formulation of viscoelastic super-elements is developed to predict the deformations of the seal lips. It is combined with a contact solver to assess contact force and its distribution around the shaft and other lip countersurfaces (such as other radial or axial locations). In order to demonstrate functionalities and advantages of the developed method, please consider an example of radial lip shaft seal. The problem addresses prediction of seal performance at cold temperature, large shaft-to-bore misalignment and dynamic run-out conditions. Different material and spring options are assessed in order to improve the performance.

This unique modeling capability will allow selecting or developing the shaft seals which would meet and exceed modern gearbox demanding application. It will also enable gearbox manufacturers to bring to the market more performing and reliable gearboxes.

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Introduction

Industrial gear units are widely used in power transmission systems. They are composed of shafts, gears, rolling elements bearings and dynamic lip seals. The seals performance is critical for a proper functioning of the system. Water or contamination ingress into a mechanical system may lead to a premature failure. Leakage of oil may have the same effect and be harmful for the environment. Depending on the application, seals may need to operate under various dynamic conditions, such as wide range of rotational speed (RPM) and temperatures, shaft-to-bore-misalignment (STBM), shaft dynamic run-out (DRO) or global structure deformations.

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This paper presents a novel approach to predict seal dynamic performance under dynamic conditions. A formulation of viscoelastic super-elements is developed to predict the deformations of the seal lips. It is combined with a contact solver to assess contact force and its distribution around the shaft and other lip contours (such as other radial or axial locations). In order to demonstrate functionalities and advantages of the developed method, please consider an example of radial lip shaft seal shown in Figure 1. The problem addresses prediction of seal performance at cold temperature, large shaft-to-bore misalignment and dynamic run-out conditions. Different material and spring options are assessed in order to improve the performance.

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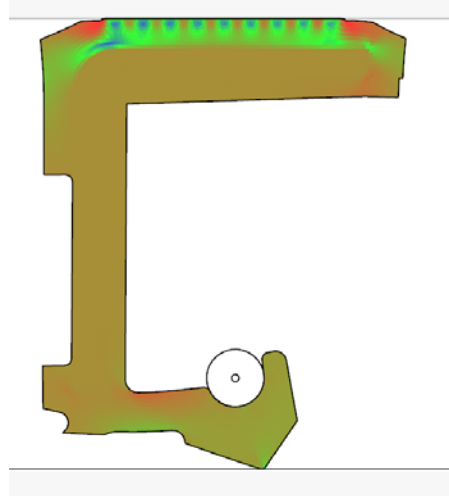


Figure 1. Example of FEA results from SKF Seal Designer: static seal deformations