# Noise reduction of an electric motor

H.G. Tillema

University of Twente
Twente Institute of Mechanics
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4892460, email hedzer.tillema@skf.com

## Introduction

The demand for silent bearing applications, like gearboxes and electric motors, has resulted in a research project in cooperation with SKF on the development of a viscoelastic damping layer.

## Objectives

The investigations aim to develop an effective damping layer mounted between the bearing and the surrounding structure.

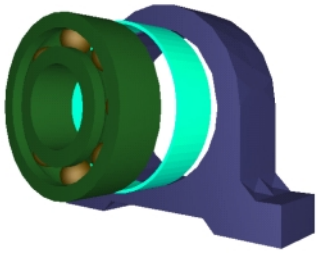

*Figure 1 : Viscoelastic layer mounted between the bearing and the housing*

The influence of material, design and mounting properties will be studied to optimize the layer.

## Methods

An electric motor is considered as shown in figure 2.

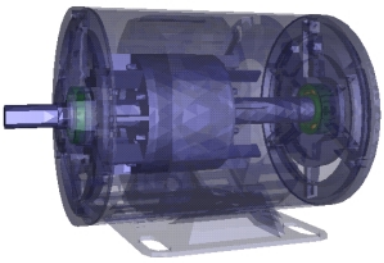

*Figure 2 : Model of the electric motor*

The housings and the rotor of the application are modelled with FEM, whereas the ball bearings are represented by spring-damper models [1]. A finite element formulation using Maxwell elements was developed to model viscoelastic components. The equations of motion are written in a linearized form in the discretized time domain.

$$[M]\{\ddot{x}\}_{n+1}+[C]\{\dot{x}\}_{n+1}+[K]\{x\}_{n+1}=\{F\}-\{H\}_{n+1} \quad (1)$$

where $\{H\}_{n+1}$ contains the historical forces in the viscoelastic material. To save computation time, the FEM models are reduced with the Component Mode Synthesis technique.

## Results

A harmonic analysis was performed on the electric motor with two viscoelastic layers mounted between the bearing and the end shields. A radial force was applied on the middle of the rotor, representing an electromagnetic excitation.

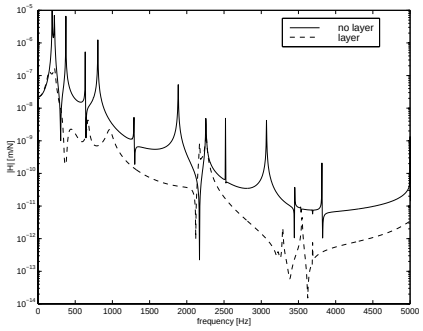


*Figure 4 : FRF of top of the housing in vertical direction*

It is seen that vibrations of the housing are reduced significantly by adding a viscoelastic layer to the system.

## Conclusions and further research

By using thin viscoelastic layers in a rolling bearing application, radiating sound from the housings can be reduced as vibrations of the rotor are isolated. In order to optimize the isolation effectiveness a general layer design strategy will be developed. Additionally, experiments will be carried out on the real electric motor for validation and demonstration.

## References

1. Wensing, J.A. (1998) On the dynamics of ball bearings, PhD-thesis, University of Twente, Enschede.