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Effect of face texturing on mechanical seals

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Seals are essential for the proper functioning of compressor, turbine, pumps, turbomachinery, …The improvement of rotary machines performances depends especially on leak performance, durability, seal technology and its adaptation to dynamic solicitations.
Cetim has focused in part of its projects on compact sealing technologies (reduction in mass and size), efficient (reduction in leaks) and enduring (robust, longer life). The technology concerned in this paper is the textured mechanical seals.
The objective of this study is to compare, experimentally, the performance of two types of textured mechanical seals with other smooth (non-textured) mechanical seals in terms of friction torque and leakage rate.

Keywords (from 3 to 5 max): mechanical seal, textured, friction torque, leakage rate

1. Introduction

Since the 1960s, several theoretical and experimental studies have shown that texturing, on a micrometric scale, can bring improvements to the performance of the mechanical seal. With the development of means for fine texturing of surfaces, the last 40 years, the interest in these technologies has not stopped increasing.

This study aims to identify first the best technique of texturing and on the second step to compare experimentally two types of textured mechanical seals with other one non-textured in order to determine the benefits of texturing in terms of lifetime service and friction torque.

This work was carried out in cooperation with the union of industrial mechatronics (ARTEMA) and the companies Technetics Group France, Latty Group and EagleBurgmann France. A special thanks for their collaboration and help during this project.

2. Process of texturing

In order to define the technique of texturing, a comparison of many processes of texturing was done. These latter are shown in Table 1.

Table 1: Texture manufacturing process

Process
Laser
Nitriding
Micro sandblasting
Ultrasound
Micro-electrical discharge
Mechanical indentation

After a comparative study (advantages and disadvantages) of each machining process, the textures of this study were made with the laser which presents a better regularity for complex shapes.
The shape, dimensions and dispersions of the textures come from the theoretical and numerical study of M. Adjemout in 2016 [1].

3. Test results

The results of the tests carried out on:

- 5 smooth mechanical seal
- 5 textured mechanical seal with depth 1
- 5 textured mechanical seal with depth 2 (3 times depth 1)

During the 15 tests carried out, no leak was detected.
The results of the tests showed, at the end of the tests, that the textured with depth 2 have a low friction torque. Indeed, compared to non-textured mechanical seal, the texture contribution is about 36% on the friction torque which represents a direct gain of about 36% in electric power.
The microscopic visualizations after tests showed the presence of low wear on some textured mechanical seals and the absence of wear on other textured mechanical seals.

4. Discussion

The test results clearly show that a hydrodynamic lift has been created by the textures (low friction torque, low loss of depth and no visible signs of wear). These operating conditions help extend the lifetime of textured mechanical seals.
The next step of this work will study the impact of the speed on the generation of the hydrodynamic lift for the textured mechanical seal with depth 2.

5. References

[1] M. Adjemout, N. Brunetière, and J. Bouyer. Numerical Analysis of the texture Effect on the Hydrodynamic Performance of a Mechanical Seal. Surface Topography: Metrology and Properties, 4, 2016.