Development a New Test Rig to Examine Mechanical Seal Failures due to Lateral Vibration and Pressure Fluctuations

NEW PROPOSAL

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Introduction

Mechanical seals are typically used as the end seal in pumps to contain working fluid within intended flow passages that have a moving boundary (rotor). These seals typically operate with small clearances (microns or less) to keep leakage down to drips. Mechanical seals are susceptible to shaft vibration and pressure fluctuations. There are two possible configurations, Flexibly Mounted Rotor (FMR) where the spring-seal assembly rotates with the shaft (Fig 1), and Flexibly Mounted Stator (FMS) where the spring-seal assembly is mounted to the pump housing. Seal failures in some systems, like electric submersible pumps, can lead to motor and/or bearing failures. Failures in surface pumps can lead to spillage of the working fluid. Green [1] developed a test rig and examined mechanical seal performance variation from tilting and offset misalignments. The tests provided dynamic data of flexible mounted rotor (FMR) mechanical seals for static misalignments of the stator, fig. 1. Other test rigs have been used but mainly to find the static performance of mechanical seals. Currently, there is not a clear understanding of the seal failure modes due to excessive lateral vibration. This test program will provide the first dynamic data set of a mechanical seal subjected to broad band vibration acting on the rotor and housing.

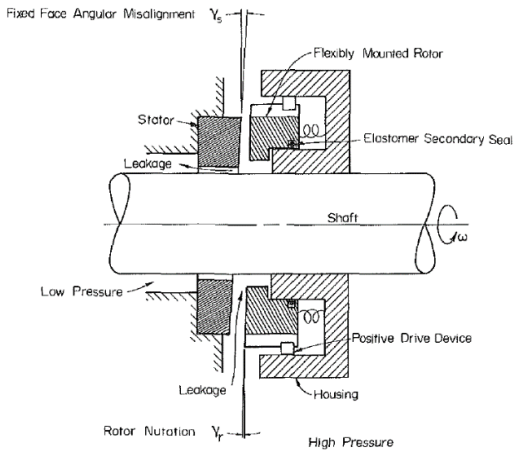

Figure 1. Model of flexibly mounted rotor (FMR) mechanical seal [1].

Proposed Work 2017-2018

The proposed tasks include building and commissioning a rig for testing Flexibly Mounted Rotor (FMR) and Flexibly Mounted Stator (FMS) seal configurations subjected to large lateral vibrations. Figure 2a shows the proposed design capable of measuring lateral and axial displacements while exciting the rotor or housing with a single or multiple frequencies up to the running speed. Fluid temperature, pressure and rotor speed will be controlled and measured. Figure 2b shows the conceptual design detailing the main components for a flexibly-mounted rotor configuration. Electrohydraulic shakers connected to the flexible support will exert the dynamic loads to the rotor-bearing system and impose either cylindrical or conical motions. Following the test rig commissioning, a mechanical seal (FMR) will he tested at the conditions listed in the table 1.

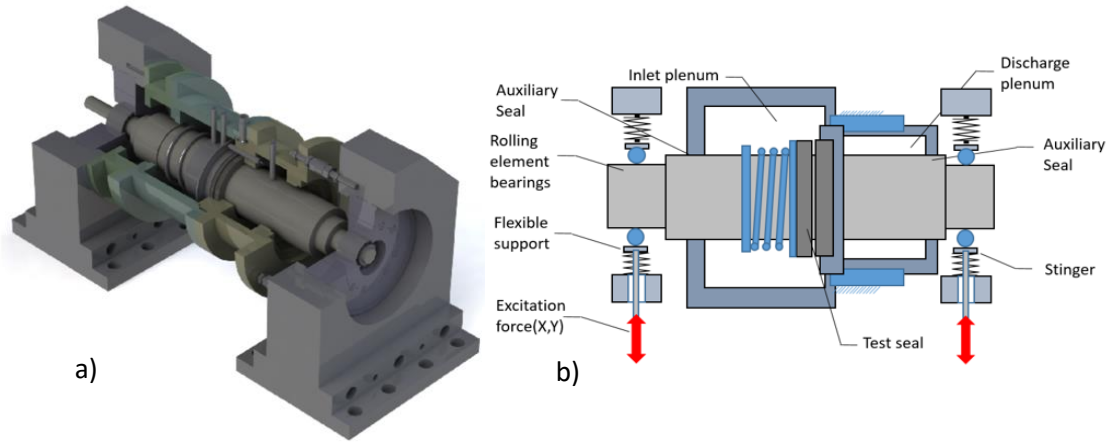

Figure 2. a) 3D model of proposed test rig, b) test rig schematic depicting main components for flexibly-mounted rotor configuration.

Table 1: Test Matrix

Parameter	Value
Seal configuration	FMR
Seal diameter	2 in
L/D	0.5
Speed	3600 RPM (capable of 8000 RPM)
Excitation	Up to 0.010 in (cylindrical and conical)
Pressure differential	50,75,125 psi

Budget

Graduate Student Payroll, 12 months @ $2200/month	$26,400
Fringe Benefits	$ 3750
Tuition and Fees(Spring and fall semesters)	$ 9000
Test Rig Cost	$70,850
Contribution by Dr. Childs	-25,000
Contribution by Dr. Delgado	-40,000
Total	**$45,000**

References

1. Green, I. (1987) "The Rotor Dynamic Coefficients of Coned-Face Mechanical Seals With Inward or Outward Flow" ASME Journal of Tribology Vol. 109
2. Lubbinge, H. (1999) "On the Lubrication of Mechanical Face Seals" University of Twente Thesis
3. Kavinprasad, S., Shankar, S., Karthic, M. (2013) "Experimental and CFD Inverstigations of Mechanical Seals under Dry/Compressed Air/Liquid Lubrication Conditions" International Conference on Design and Manufacturing