TEXAS A&M ENGINEERING EXPERIMENT STATION

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IMPROVING MECHANICAL SEAL LIFETIMES VIA MODELING THE IMPACT OF ROTOR AND HOUSING VIBRATIONS

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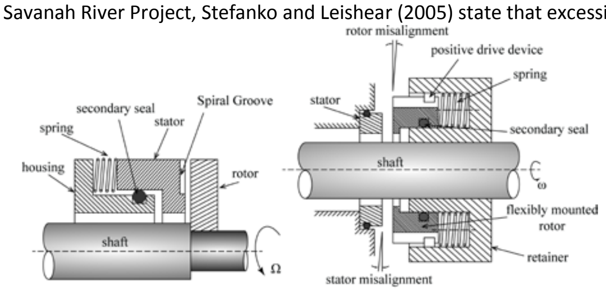
Introduction

Figure 1 illustrates the main two mechanical seal configurations used in centrifugal pumps; namely, a flexibly-mounted stator (FMS) configuration and a flexibly-mounted -rotor (FMR) configuration. If you choose to *Google* "Mechanical Seal Lifetimes" + Vibrations, you will get the following list of DO NOTS to follow in extending mechanical-seal lifetimes: (1) Do not run a pump near a critical speed. (Excessive synchronous vibrations at running speed ω. (2) Do not operate a pump in a condition of instability. (Excessive subsynchronous vibration at a precession frequency Ω where $0.5\omega < \Omega < 0.8\omega$, and (3) Do not operate a pump well back on its H-Q curve, creating a broad-frequency pressure oscillation spectrum.

In 1990 in regard to Electrical Submersible Pumps (ESPs), Durham [2] stated that radial vibrations killed ESPs by first killing their mechanical seals. For down-hole applications, ESPs normally use the FMR configuration; however, for surface, horizontal applications they are more likely to use the FMS configuration. Durham was reporting on horizontal applications that probably used the FMS configuration. Based on massive amounts of data collected in connection with the nuclear Savanah River Project, Stefanko and Leishear (2005) state that excessive vibrations killed a range of pumps by first killing their mechanical seals



(a) Flexibly mounted stator configuration (b) Flexibly mounted rotor configuration

Fig. 1. Mechanical seal configurations

The landmark papers on the dynamics of mechanical seals were written by Etsion and Green (E&G). Figure 1shows their seal geometry. The seal rotor is rotating with the pump shaft that supports it. The seal stator is held by an O-ring in the pump housing. They considered the impact of the seal rotor's fixed misalignment from the pump shaft and the seal-stator's constant misalignment from the pump housing. **They do not consider the impact of housing or shaft vibration on the seal's motion.**

Childs and Nguyen [1] extended E&G's model **for the FMR configuration** to include nonsynchronous shaft precession and excitation caused by motion of the seal stator. The model has been updated to include the FMS configuration.

The following tasks will be completed on this project:

1. Input data will be selected for the FMR configuration to complete the nonlinear model. The model will be subjected to steady-state synchronous and subsynchronous vibration levels for motion from the shaft and the housing. The resulting synchronous response predictions will be collated and presented as a function of the model parameters and vibration-response levels.
2. The FMS model configuration will be extended and completed to include the influence of both shaft and housing motion. Response for the completed FMS model will be calculated due to steady-state harmonic response with both synchronous and subsynchronous excitation.
3. We will proceed with inertial and spring-closure data for real seals (retaining E&G's coned-face seal stiffness and damping coefficients) to identify possible mechanical-seal failure modes due to vibration.
4. Additionally, we will be looking at a test rig design for dynamic excitation of mechanical seals.

[1] Childs, D. and Nguyen, H. (2015), Modeling the Impact of Lateral Pump Vibrations on the Dynamics of Mechanical Seals, STLE Extended Abstract, STLE National Meeting, Dallas, Texas, May 2015

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