TEXAS A&M ENGINEERING
EXPERIMENT STATION

Turbomachinery Laboratory
Turbomachinery Research Consortium

Continuation Project Year III

LEAKAGE AND FORCE COEFFICIENTS IN A WET ANNULAR SEAL:

INFLUENCE OF JOURNAL ROTATIONAL SPEED

In the oil and gas industry, compressors and pumps may operate at times under two phase or even multiple phase flow conditions, i.e., liquid in gas for compressors and gas in liquid for pumps. Subsea factory compressors must handle, without significant efficiency and power penalty, a two phase flow with a liquid volume fraction as high as 5%. Off-design operation affects system overall efficiency and reliability, including penalties in leakage and rotordynamic performance of secondary flow components, namely seals. Designing and constructing reliable compression systems to handle *wet* gases will eliminate L/G separators, reduce weight and parts, increase reliability and extend operation hours (five year desired).

Besides the seminal paper of Iwatsubo and Nishino (1993), there is no test data for the force coefficients of seals operating with either liquid in gas or a gas in liquid condition. The project funded the constructing a vertical seal test rig with provisions for *wet* seals.

During the third year, the project will continue to assess qualitatively and quantitatively the effect of a liquid in gas mixture on the leakage and dynamic force coefficients of a short length smooth seal. The operation will include journal rotation to 6 krpm (100 Hz) and a mixture supply pressure to 5 bar (absolute). Mixtures with an increasing liquid volume fraction (0 to 10%) will be supplied to the test seal, and the liquid and gas mass flow rates recorded. Dynamic loads with a single frequency (10 Hz - 200 Hz=2X) will be exerted on the test seal and the system complex stiffness derived from measurements of the seal dynamic displacements. Frequency dependent force coefficients will follow as a function of the liquid/air volume fraction. Specific tasks include

a) Improve data acquisition process to perform ensemble averages over multiple periods of external excitation. The time-averaging scheme, a must when dealing with non-repeatable measurements, will reveal more consistent results. Note that the inhomogeneity of the mixture drives the periodic-variability of the measurements.
b) Simple flow visualization reveals the gas (bubbles) and liquid (droplets) travel at different speeds through the seal film land. Hence, developing a two component inhomogeneous flow model is essential to better understand the effect of a liquid/gas mixture on the seal performance. This model (in the future) will aid to predict liquid pooling in a labyrinth seal, for example

TEL. **979.845.7417** | FAX **979.845.1835**
turbo@turbo-lab.tamu.edu
509 MEOB | 3254 TAMU | College Station, TX 77843-3254