Tests of a Plain Annular (Liquid) Seal with and without Swirl Brakes

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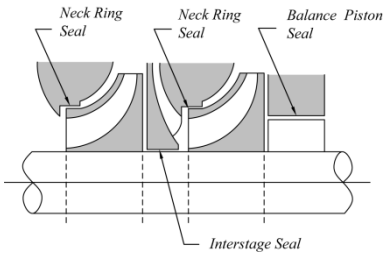
Annular seals dramatically influence the rotordynamics *of all* centrifugal pumps. The seals of interest are shown in figure 1. Leakage flow that goes down the front face of an impeller is restricted by the *neck ring* (*or wearing*) seal. The main flow exits an impeller and then proceeds through a diffuser before entering the following impeller. Part of the flow leaks back along the pump shaft through the *interstage* seal and then proceeds radially outwards up the back face of the preceding impeller. For a straight-through pump, leakage flow from the last impeller goes down the back face of the last impeller, out through the *balance piston* seal and is then returned to the pump inlet. The balance-piston seal absorbs the full head rise of a straight-through pump. A similar situation holds for the last stage of a back-to-back pump with leakage flow going down the back side of the last impeller, then through a center seal to proceed radially outwards along the back side of the last impeller of the opposing-flow stages. The center seal absorbs about one half of the pump's head rise.



Wearing-ring. Interstage, and balance piston seals

Fig. 1 Centrifugal-pump annular seals

Accurate rotordynamic predictions of pumps require accurate predictions of seal rotordynamic coefficients. *There are very limited data on the behavior of pump seals versus eccentricity ratio, none with an imposed and measure preswirl ratio, and none with and without swirl brakes.*

This project entails the manufacture and test a smooth annular seal, operating in the turbulent regime (ISO VG2 oil, running speeds to 8000 rpm, ΔPs to 20 bars, one clearance). The seal will be tested from centered to an eccentricity ratio of ≅ 0.9. Tests will be conducted with 3 pre-swirl rings (no swirl brake); then the tests will be repeated for the same seal dimensions and test condition with an empirically-designed swirl brake. The results will be compared to predictions from an existing code.

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