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LEADERS IN TRIBOLOGY TEST
INSTRUMENTATION AND SERVICES

Seal Durability Test

The goal is to evaluate and compare the old and new designs of lip-seal rings. The test objective is to measure the effects of shaft speed, temperature and normal load on the seal-shaft dimension, elasticity, friction coefficient and wear.

The Micro-Tribometer mod. UMT-2 (Fig. 1) is used extensively for tribology and materials research from macro- to micro and nano scales for such diverse applications as petroleum products, thin and thick coatings, ceramics, automotive, aerospace, electronics, etc. This universal, high precision and automated instrument can accommodate both ideal friction pairs like pin-on-disc, ball-on-disc, 4-balls, ring-on-block, disc-on disc and the real industrial assemblies like piston ring on cylinder, screw in nut, pin in chain, sliding and rolling bearings, shaft in seal, etc. The UMT accommodates both upper and lower samples of practically any shape with dimensions ranging from 0.1 mm to 150 mm. It can provide any combination of rotational and linear, including reciprocating, motions with speeds ranging from 0.5 micron up to 50 micron. The applied load is servo-controlled with a closed-loop feedback mechanism, and is programmable from 1 mN to 1 kN. During testing, the following tribological parameters can be measured in-situ:

- Friction force, torque and coefficient,
- Wear depth,
- Contact acoustic emission,
- Contact electrical resistance or capacitance,
- Temperature,
- Digital video.

Fig. 1. Photo of Micro-Tribometer UMT-2

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Fig. 2. Samples of Lip Seals

Then a series of 3-hour wear tests were done, under different normal loads (10 to 40 N) keeping both temperature and shaft speed constant, at different speeds (1,000 to 5,000 rpm) keeping the load and temperature constant, and finally in different chamber temperatures (75^{0}C to 150^{0}C) keeping both normal force and speed constant. Typical plots of friction, wear and temperature for the old-design and new-design seals are presented in Figs 5 and 6. The summarized results are shown in bar charts. With increase in load, friction reduced, wear and contact temperature increased (Fig. 7). With increase in speed, friction increased a little, both contact temperature and wear increased (Fig. 8). An increase in chamber temperature did not have much of effect (Fig. 9). New lip seals always performed better than the old ones in terms of wear, friction and temperature.

Seal samples of two types (Fig. 2), old design lip-seal and new design lip-seal, with the latter one subdivided into burned and unburned, have been tested. The wear study utilized a so-called block-on-ring testing mode (Fig. 3). Friction force, normal force, wear (deformation) and temperature were measured.

A static deformation test (displacement vs. load) was done to evaluate the seal deformation under radial loads at both ambient and elevated temperatures. The graphs of displacement versus load are shown in Fig. 4. Under the same radial load, the new

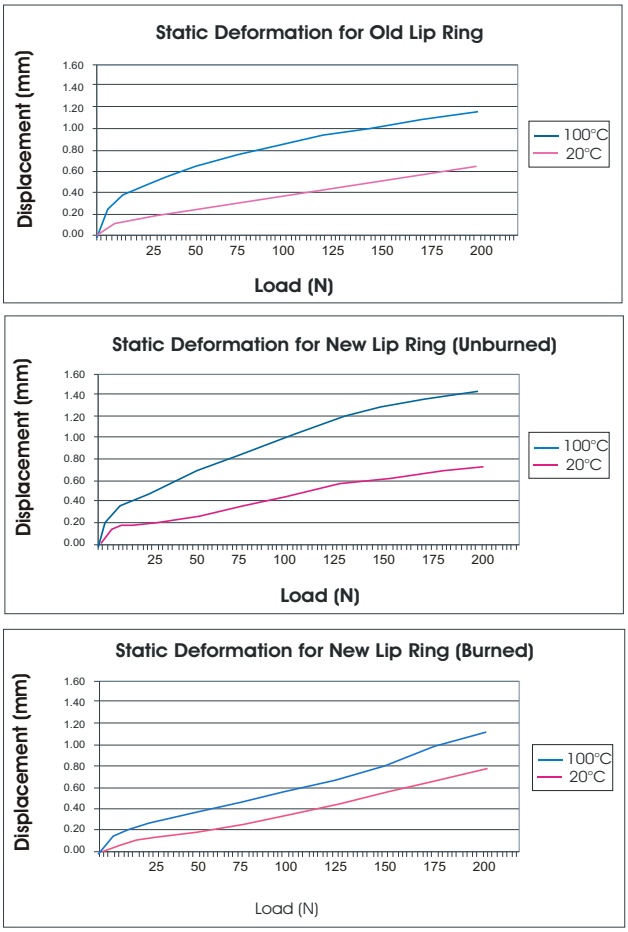

Fig. 4. Seal Deformation Plots

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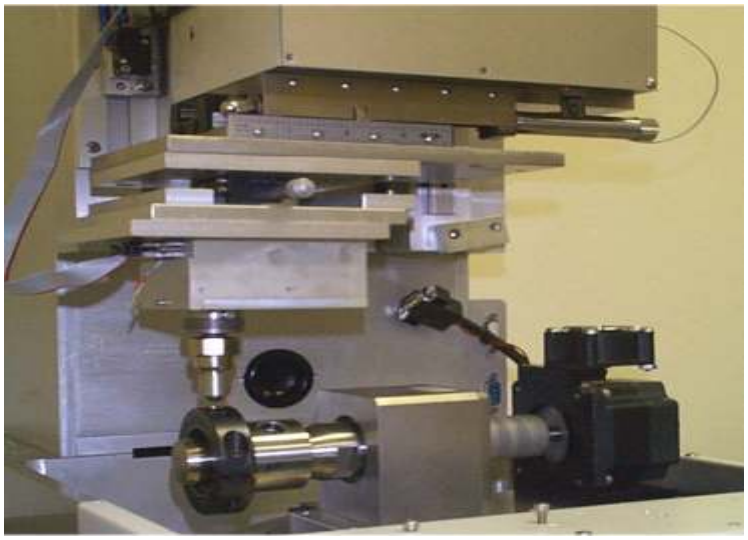

Fig. 3. Photo of Micro Tribometer Setup for Seal Wear and Friction Test

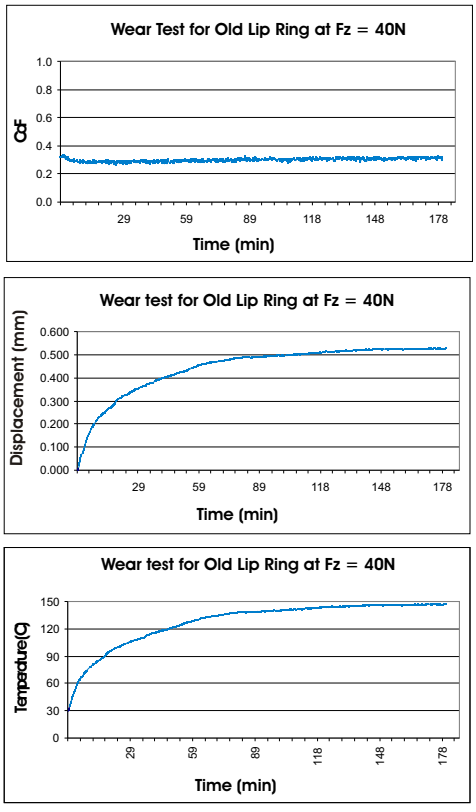

Fig. 5. Plots for Friction, Wear and Temperature for the Old Design

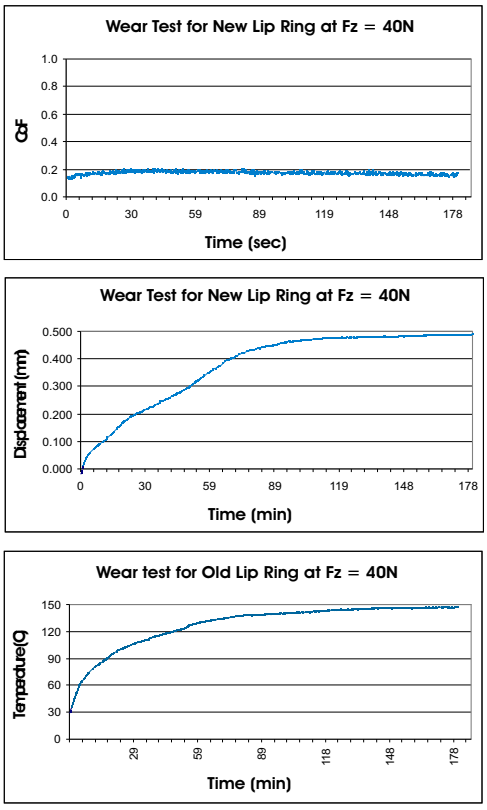

Fig. 6. Plots for Friction, Wear and Temperature for the New Design

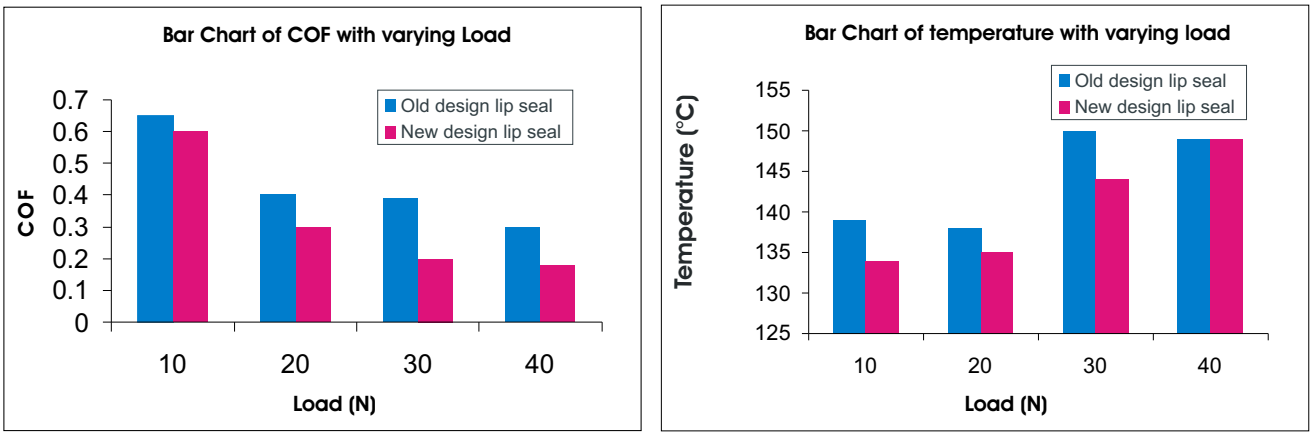

Fig. 7. Bar Chart for Varied Load

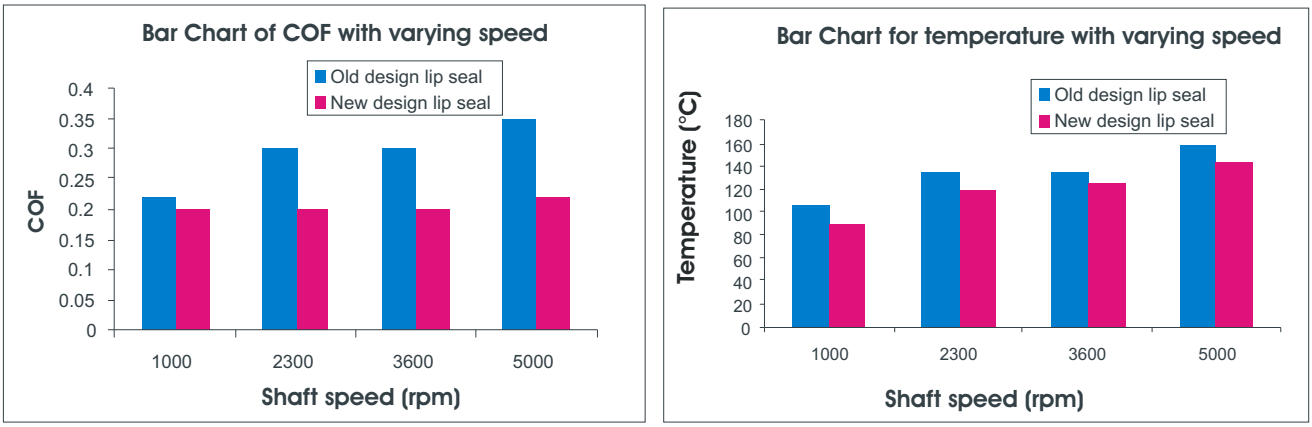

Fig. 8. Bar Chart for Varied Speed

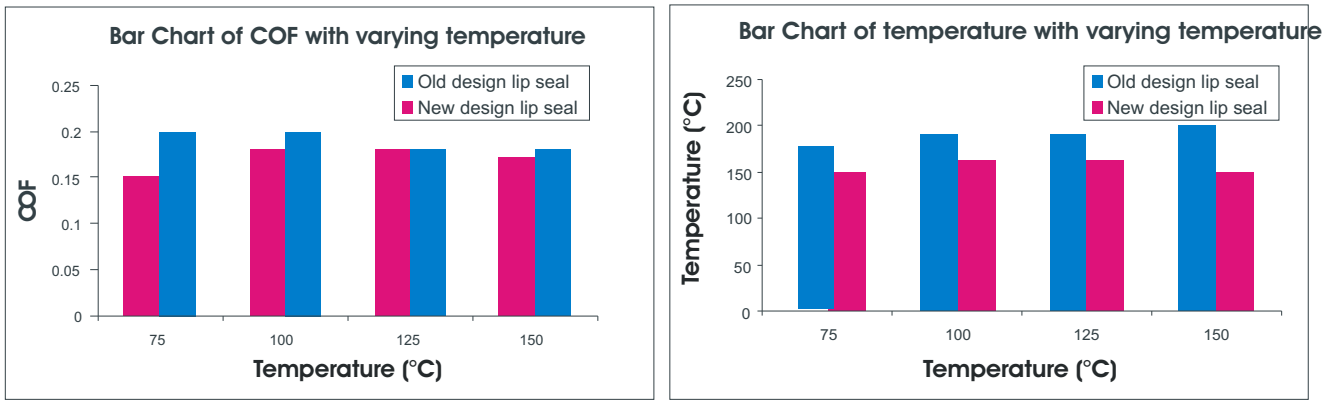

Fig. 9. Bar Chart for Varied Chamber Temperature

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