SAPPHIRE VS. CHROME-PLATED STAINLESS STEEL PISTONS: A COMPARISON OF WEAR ON BAL SEAL® SPRING-ENERGIZED SEALS

Technical Report
TR-63 (Rev. B; 09-27-02)
(54-12)

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1.0 SUMMARY

This report contains the results of a series of tests performed by Bal Seal Engineering Company to determine the effect of two types of pistons used in a plunger pump. The tests compare the wear of BAL™ Seals made from GFPA and UP-40 polyethylene. A series of tests were run comparing the effects of sapphire and chrome-plated stainless steel pistons. The results indicate that the use of sapphire pistons results in substantially greater BAL Seal life.

2.0 MATERIALS, APPARATUS AND PROCEDURES

2.1 Materials

The testing involved BAL Seal UR134-106-MB made from GFPA and UP-40. The seals were run in a typical plunger pump against sapphire and chrome-plated stainless steel pistons.

2.1.1 GPFA

GPFA is a BAL Seal graphite fiber-filled PTFE compound that provides excellent service under high pressure, high speed, or elevated temperatures.

2.1.1 UP-40

UP-40 is a BAL Seal polyethylene type material. It provides excellent service in water or water-based fluids due to its ability to transfer a lubricating film to a counter surface in aqueous media.

2.1.2 Pistons

The seals were run in contact with 0.1875 inch (4.76 mm) diameter sapphire and chrome-plated stainless steel pistons. The sapphire piston had a surface finish of 1.0 microinch Ra (1.1 microinches Rq); the chrome-plated stainless steel piston, plated per specification QQC-320B Class 2E, had a surface finish of 2.5 microinches Ra (2.8 microinches Rq).

2.2 Apparatus

A sketch of a typical plunger pump is shown in Figure 1.

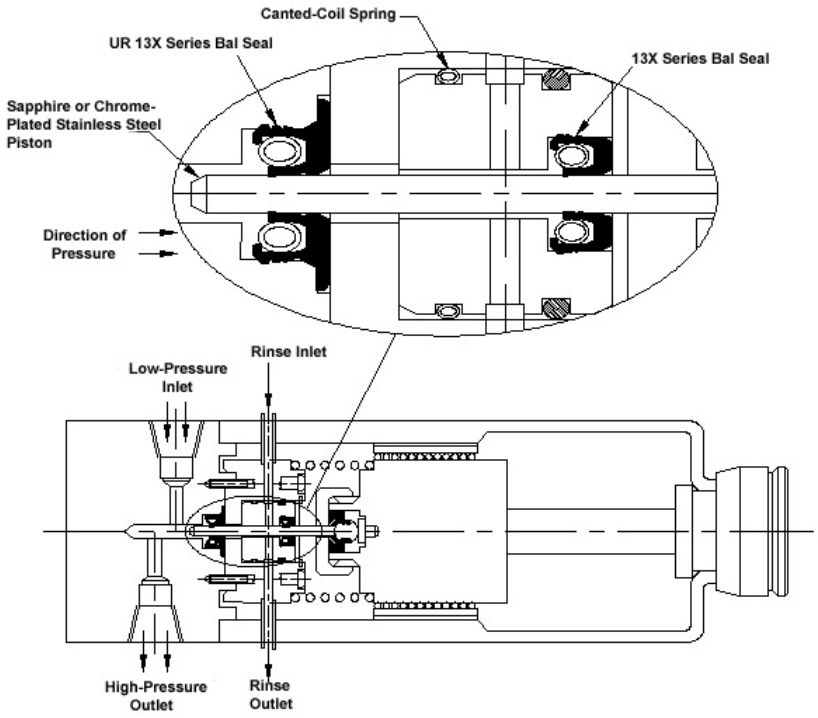

FIGURE 1: TYPICAL PLUNGER PUMP WITH UR-13X SERIES BAL™ SEALS

2.3 Procedures

Each seal material was run in contact with the sapphire piston and the chrome-plated stainless steel piston per the operating parameters indicated below. Failure occurred when visible leakage was present.

OPERATING PARAMETERS:

Pressure:	6,000 psi (422 kg/cm^2)	
Stroke Length:	0.200 inches (5.08 mm)	
Speed:	4 feet per minute (0.02 m/s)	
Medium:	Distilled water	
Flow Rate:	9.99 ml/min	
BAL Seals:	UR-134-106-MB seals made from GFPA and UP-40	
Pistons:	Sapphire	
	Chrome-plated stainless steel	
Base Material:	Aluminum Oxide	
	316 SS	
Surface Finish:	1.0 µin Ra (1.1 µin Rq)	
	2.5 µin Ra (2.8 µin Rq)	
Diameter:	0.1875 inches (4.76 mm)	0.1875 inches (4.76 mm)

3.0 RESULTS

Chart 1 shows that the type of piston used in a plunger pump has a significant effect on the BAL Seal life.

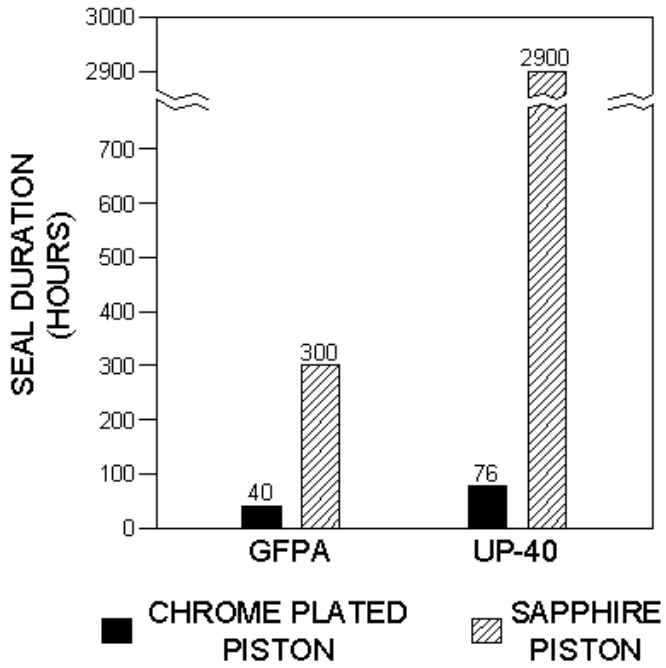

CHART 1: SEAL LIFE COMPARISON BETWEEN A CHROME-PLATED STAINLESS STEEL PISTON AND A SAPPHIRE PISTON USING BAL SEAL GFPA AND UP-40 SEALS. (213-5-1)

Seal life with a sapphire piston is approximately ten times greater than that of a chrome-plated stainless steel piston. The following parameters affect seal life.

3.1 Piston surface finish

In general, smoother piston surfaces result in lower BAL Seal wear rates.

3.2 Piston surface structure

The sapphire piston surface structure is nodular, while the hard chrome-plated piston surface structure is jagged. A nodular structure reduces abrasion of the BAL Seal and results in substantially less wear.

3.3 Piston hardness

A sapphire piston has an approximate Rc 78 hardness while a hard chrome-plated 316 stainless steel piston has an approximate Rc 65 hardness. In general, there is less adhesion between a hard piston and a BAL Seal than between a soft piston and a BAL Seal. Reduced adhesion produces lower friction, which results in lower seal wear rates.

4.0 CONCLUSIONS

Results indicate that seal life is longer with a sapphire piston than with a hard chrome-plated stainless steel piston because of better surface finish, nodular surface structure and greater hardness of the sapphire pistons.

5.0 REFERENCES:

Bal Seal Engineering Reports (100-32); (54-12); and (213-5-1).

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