

Wilfley WCD4™ Duplex Stainless Steel vs 904L Austenitic Stainless Steel

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Basic Wear Mechanisms of Centrifugal Pumps Built in Stainless Steels

Due to general pump design the solid particles in pump fluid have a small angle of impingement against the wet end components. Therefore, impacting wear has very little effect on the overall deterioration rate of a material. Sliding wear, however, is considerably more harmful because it compounds shear stresses to the normal stresses that are already imposed. This increases the material plastic flow and fracture tendency in the contacting regions of solid particles and pump parts.

Sliding wear rate (γ) is directly proportional to the applied load (W) and sliding distance (L) and inversely proportional to the material hardness (H).

$$\gamma = k.W.L / H$$

k = wear coefficient which mainly depends on the solid particle hardness

The following are the sliding wear controlling mechanisms:

- Formation of plastically deformed grooves without material removal. In such case the material has a higher hardness and accommodates superior fracture toughness.
- Separation of fractured microchips which significantly increase the wear rate.

The Wear Resistance of WCD4™ and 904L was Established with the Pin-On-Disk Apparatus per ASTM G99

The wear rates of Wilfley WCD4™ duplex stainless steel and 904L austenitic stainless steel were calculated with the pin-on-disk apparatus per ASTM G99. This test method consists of a 0.25 in (6 mm) alumina ball that slides against a rotating material sample under a pre-determined set of parameters. The static load of the indenter is kept consistent throughout the testing time and the contact point between the indenter and sample is constantly flushed with water.

RPM	80
Testing Time	2 hours
Testing Temperature	72 °F (22 °C)
Mean Wear Groove Diameter	0.625 in (15.875 mm)
Sliding Length per RPM	1.963 in (49.848 mm)
Total Sliding Length	1,570 ft (478.54 m)
Static Load	10.425 N (1.063 g)
Sample Roughness	0.10-0.12 μ m

Testing Parameters

When the test began the alumina ball circumference was tangential to the sample's surface (fig. 1). As the test progressed, the indenter was able to easily break into the soft 904L sample and a wear groove was generated through plastic formation (fig. 2). The excessively deformed 904L material was either pushed forward by the indenter or piled up next to the groove edges. Some of the excessive 904L material also fractured, causing chips to be trapped between the indenter and the bottom wear groove, which significantly increased the wear rate.

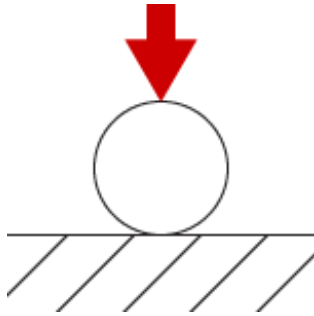


Figure 1

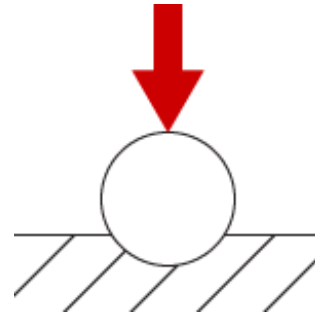


Figure 2

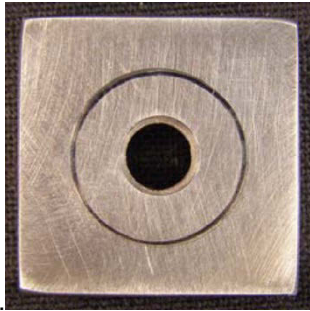


Testing Apparatus

Test Results and Conclusions

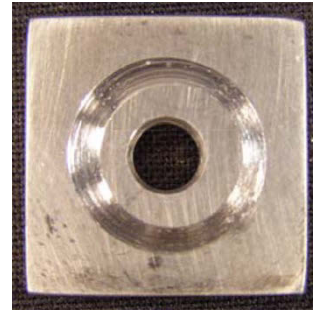
As you can see below, the wear groove on the 904L sample is substantially wider than on the WCD4™ sample. There are also several circular concentric scratches on 904L sample that were generated by multiple fractured chips that were trapped between the indenter and sample. The wear groove on the WCD4™ sample, on the other hand, is noticeably smoother because it was produced only through plastic deformation.

WCD4™ Sample



Hardness = 341 HBN
Wear groove width = 0.02 in (0.5 mm)

904L Sample



Hardness = 120 HBN
Wear groove width = 0.12 in (3 mm)

Material	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Volume Loss (mm ³)	Wear Rate (mm ³ /N/m)
WCD4™	30.8432	30.8395	0.0037	0.462x10 ⁻³	21.23x10 ⁻³
904L	32.5327	32.4705	0.0622	7.775x10 ⁻³	356.9x10 ⁻³

Test Results

Based on the data gathered, WCD4™ duplex stainless steel has a 1,680% increase in wear resistance over 904L austenitic stainless steel. This massive increase clearly demonstrates that WCD4™ is a far superior material for pumping applications that contain both corrosive and erosive wear.