Greene Tweed

Replacing Metallic Wear Components with Composites in Centrifugal Pumps

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INTRODUCTION

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In centrifugal pumps, wear materials are used as a buffer between rotating and stationary parts. Historically, these components have been metallic in nature. To avoid galling and possible equipment seizure, dynamic metal clearances are set at a generous minimum. The American Petroleum Institute (API) published Standard 610 which addresses these clearance recommendations for centrifugal pumps used in petroleum, petrochemical, and natural gas industries.

Since 2003, non-metallic materials have been recognized by API Standard 610 as suitable wear materials for such applications. Composite wear components (such as wear rings, bearings, and bushings) can be installed with a smaller dynamic clearance than metallic components (see Figures 1 and 2). A smaller dynamic clearance has two distinct advantages. First, the reduced clearance restricts the recirculation or escape of process media. Secondly, the reduced clearance generates increased fluid pressure around the shaft, which has a centering effect that stabilizes the shaft and reduces system vibration.

FIGURE 1 | Vertically Suspended Pump

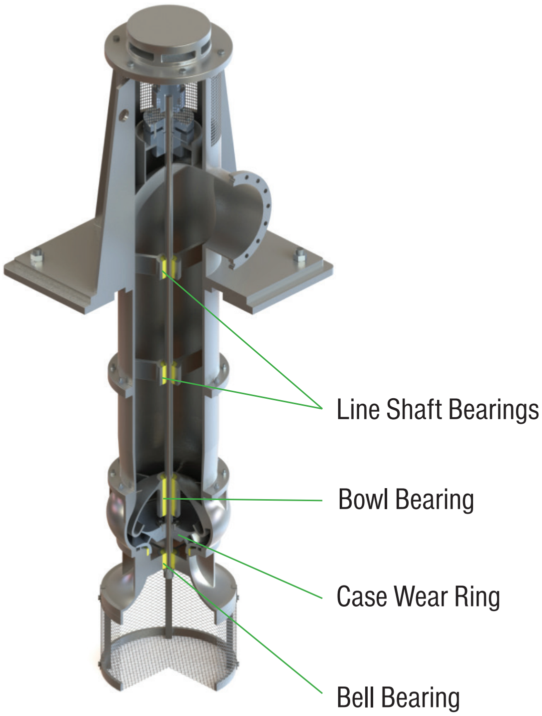
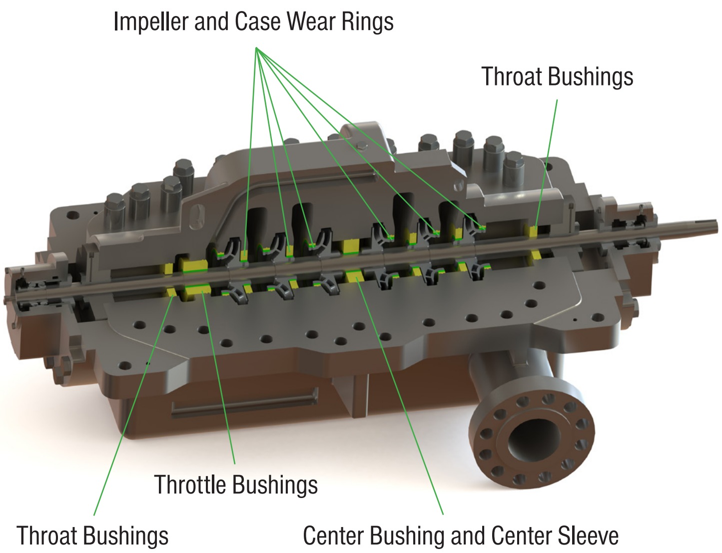


FIGURE 2 | Multistage Between Bearing Pump



COMPOSITE BASICS

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A composite is an engineered material composed of two or more different materials that produce unique properties which neither material could singularly achieve. Greene Tweed's wear composite product line of engineered composites is formulated for use as wear materials in centrifugal pumps and other rotating equipment.

Centrifugal pumps are designed to operate under optimal conditions, including a fluid film between stationary and rotating elements within the equipment. However, unplanned incidents can occur, resulting in low levels of lubrication. Greene Tweed wear composites have excellent friction and wear properties that enable survival during such events, and in extreme cases will mitigate the risk of damage to pump hardware by serving as sacrificial components.

DYNAMIC CLEARANCE GUIDELINES

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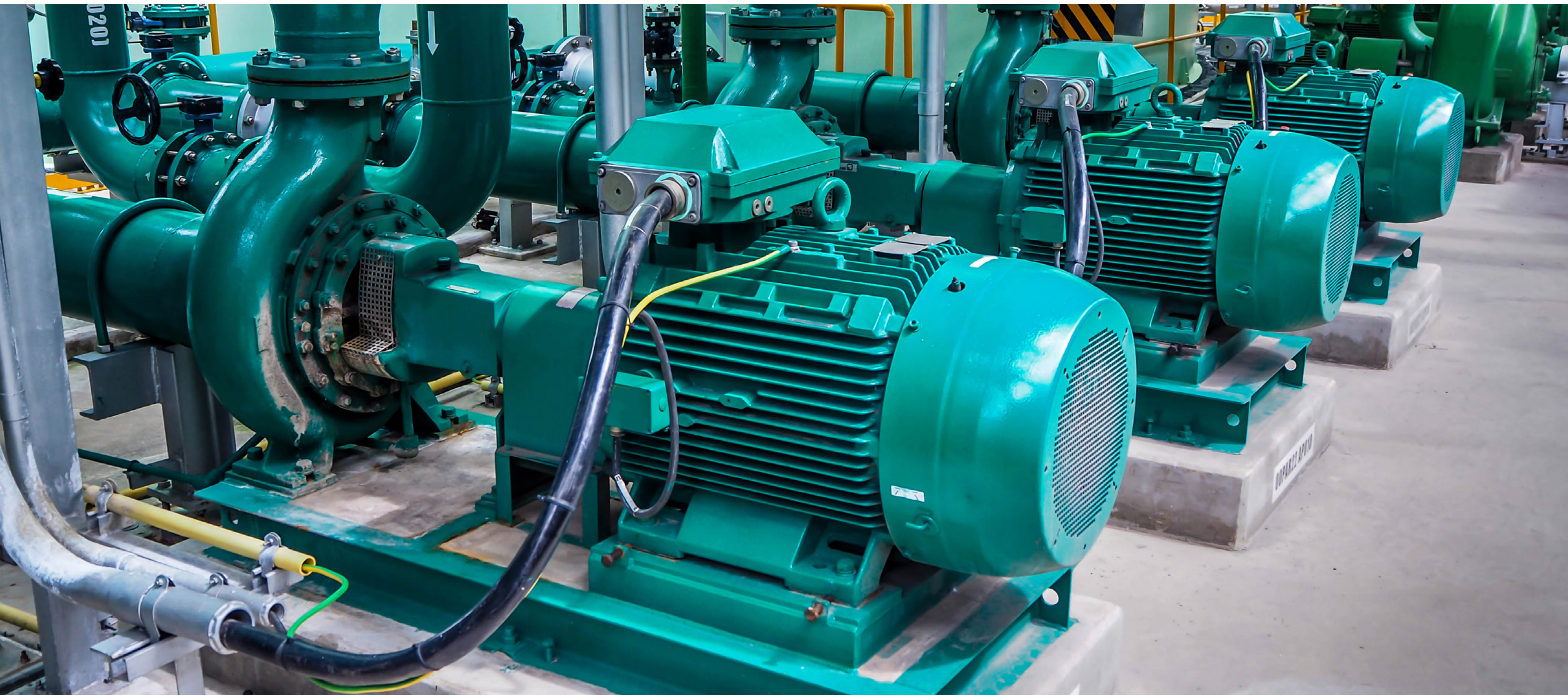
Proper dynamic clearance between rotating and stationary components is a critical factor in the performance and life of centrifugal pump components. In liquid media containing systems, a low dynamic clearance is desirable, which results in higher fluid film pressure between the stationary and rotating components. This higher pressure has a centering effect on the rotating element that provides additional stability, thus reducing vibration and likelihood of unexpected contact between stationary and high-speed rotating elements. Reducing clearance appropriately can improve system reliability.

Along with the increased reliability, a smaller clearance also means less recirculation of process media through wear rings, which results in a more efficient system. Although individual components can be designed for very close running clearances, the pump designer should be aware of tolerance stack-up in multistage systems, in which a larger clearance may be required for assembly.

To mitigate the risk of dynamic surfaces coming in contact, it is standard practice to run metallic components with a generous clearance gap. The use of composites enables clearance reduction to enhance system performance.



TESTING

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Laboratory testing has shown Greene Tweed wear composites to be non-galling. When tested under ASTM G98 standard conditions (see Figure 3), Greene Tweed composites exhibited no evidence of wear or gall at 20 psi, 100 psi, and 200 psi loadings.

Testing under modified ISO 7148-2 conditions (water lubricated; 2600 fpm; 10 psi; 410 stainless steel shaft), Greene Tweed composites have shown to survive up to 38 minutes after loss of lubrication (see Figure 4).

Further testing under modified ISO 7148-2 conditions (5% abrasive solution; 350 fpm; 25 psi; 304 stainless steel shaft), Greene Tweed composites have shown to provide best-in-class resistance to erosive wear when compared to metallics, carbon, rubber, and other non-metallic bearings.

FIGURE 3 | ASTM G98

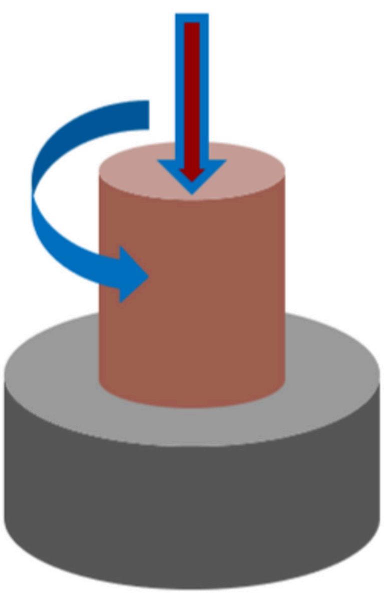
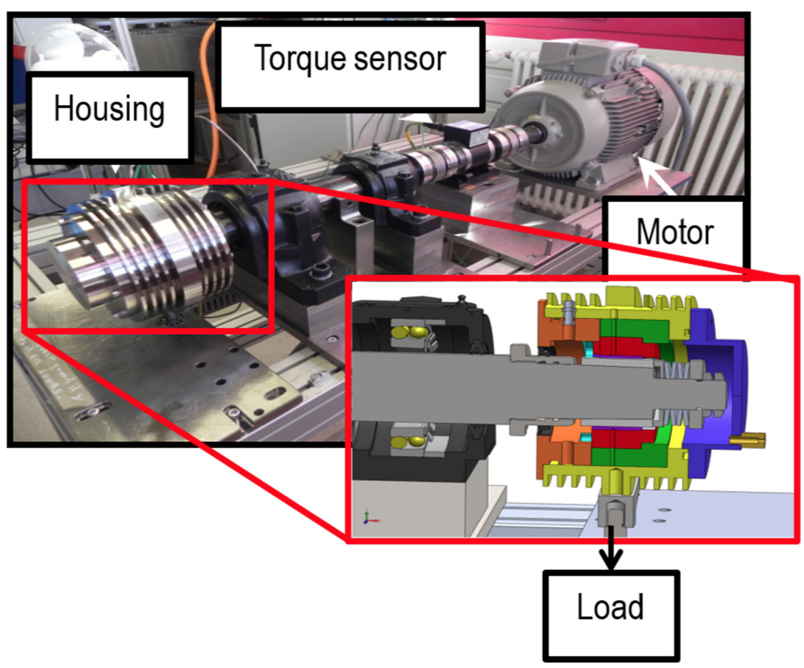


FIGURE 4 | ISO 7148-2



CASE STUDIES 5

The following case studies demonstrate improved performance and increased MTBF (mean time between failures) achieved with Greene Tweed material.

CASE STUDY 1

Three Materials in One Application

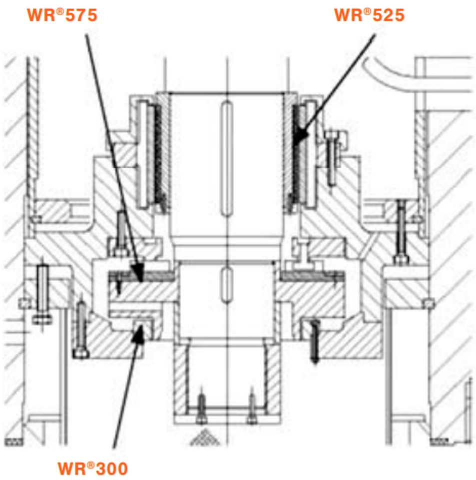
WR® 300/525/575 Materials Double MTBF of Boiler Circulation Pump

Challenge

A leading pump OEM customer in the U.K. needed to remove asbestos bearing materials in the Hayward Tyler wet wound motor boiler feed pumps to comply with legislation. These pumps are used in a variety of power plants. In this particular application, the pump was used by a coal-fired power plant.

Solution

After testing several competitive bearing materials, the customer chose on Greene Tweed's WR® materials as the new bearing and thrust material. The WR® material was selected because it showed negligible wear during the test cycle.



Customer Goals

The customer wanted to increase MTBF over four years, which was the maximum running time of the conventional bearing material.

Applications

The pump circulates cooling water in boiler feed applications. Boiler circulating pumps contain wet wound stator motors that traditionally used Ferrobestos bearings for both the journal and thrust bearings.

CASE STUDIES 5

CASE STUDY 1 (continued)

Benefits

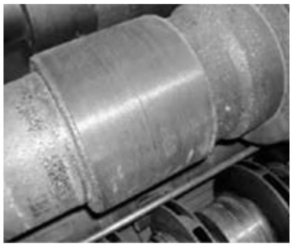
- **Reliability/MTBF –** As a result of the WR® material upgrade the pump's MTBF increased from 4 to 9 years, more than doubling run times with zero faults and continues to run smoothly. The pump uses three different WR® materials in three different areas, showing the versatility of the WR® portfolio.
- **The customer increased pump lifetime** while complying with environmental regulations.
- **Dry-Run Protectio**n – The non-galling and non-seizing properties of WR® help avoid catastrophic pump failures caused by dry-run startup or excessive vibration.
- **Easy to install –** Not brittle or easily damaged during installation, like other materials, e.g., ceramics. Greene Tweed provides total engineered solutions and final machined clearances.

TECHNICAL DATA	
Former Product	Conventional asbestos-based material
Pump Type	Hayward Taylor boiler circulating pump motor power: from 350 kW to 1120 kW; velocity: run at 4-pole speeds (1500 rpm)
Media	Water
Temperature	230°F (110°C)

WR® 525 sleeve bearing:

Test included 120 starts & stops

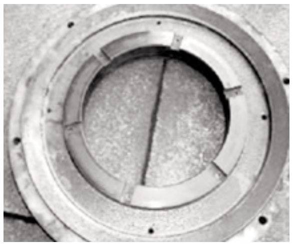
- No significant wear on the composite
- No damage to the 12% chrome-steel mating components



WR® 300 thrust pads:

Test included 120 starts & stops

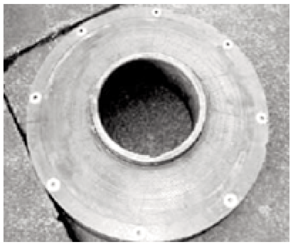
- No significant wear on the composite
- No damage to the 12% chrome-steel mating components



WR® 575 thrust pads:

Test included 120 starts & stops

- No significant wear on the composite
- No damage to the 12% chrome-steel mating components



Due to the WR® material upgrade, the pump's MTBF (mean time between failure) increased from 4 to 9 years, so run times could be more than doubled.

CASE STUDIES 5

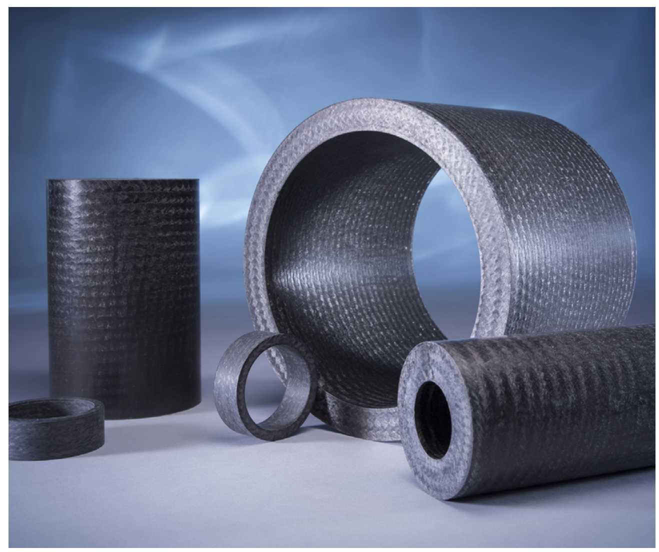
CASE STUDY 2

Greene Tweed's WR® 650 Wear Ring

Improves Pump Efficiency in Dryer Circulation Pumps

Background

One of the biggest chemical plant operators in Southeast Asia came to Greene Tweed with a challenge involving one of their dryer circulation pumps. Their existing centrifugal pump was an older model, without a wear ring, and needed an upgrade to operate more efficiently.



Challenge

The customer wanted to cost effectively increase pump efficiency – modifying the existing pump casing and impeller shaft instead of reworking the entire pump.

Solution

Greene Tweed recommended modifying the existing pump casing (the existing pump did not have a wear ring) to accommodate a composite wear ring to increase pump efficiency. We recommended Greene Tweed's WR® 650 for the composite wear ring because of the material's durability in high sulfuric acid content and proven dry run capabilities.

The customer provided the dimensions of the pump casing and impeller for the composite wear ring and pump hardware (casing ID and impeller shaft OD). We also recommended the WR® 650 wear ring ID to be machined finished after installing in the casing to provide maximum accuracy and concentricity. The WR® 650 wear ring enabled the customer to reduce the diametrical clearance to 0.05 mm without risking damage to costly metal components.

Greene Tweed recommended modifying the existing pump casing to accommodate a composite wear ring to increase pump efficiency.

CASE STUDIES 5

CASE STUDY 2 (continued)

Benefits

- **Increased efficiency** – The reduced clearance of the composite material versus the metallic hardware improves pump performance and efficiency.
- **Dry-run protection** – The non-galling and non-seizing properties of WR® 650 help avoid catastrophic pump failures caused by dry-run startup or excessive vibration. WR® 650 has the best dry-run capability in the WR® family.
- **Impact resistance** – Its excellent physical properties allow the wear ring to receive impact from the impeller shaft without breaking and cracking during operation.

Result

Since installation, the application has been running successfully for over a year with increased pump performance and efficiency. By upgrading the pump and controlling dynamic clearances, Greene Tweed's WR®650 wear ring has helped reduce internal loss/leakage. Initial results from the commission test show pump efficiency has increased by 9%, with improvements in discharge pressure and improvements in power derived from increased flow rates and pump capacity.

Application Data

- Product: Centrifugal pump
- Temperature Range: 24° to 30°C (75° to 86°F)
- Media: 90% sulfuric acid
- Pressure: Suction 12.8 psi suction to 69.8 psi discharge

By upgrading the pump and controlling dynamic clearances, Greene Tweed's WR®650 wear ring has helped reduce internal loss/leakage.

CONCLUSION

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Whether choosing a material for dry run, wear resistance, or erosion resistance, Greene Tweed has a portfolio of proven solutions to improve the efficiency and reliability of your application.

Our high-performance material and engineering expertise enable multiple industries to benefit from our composite solutions.

For more information on Greene Tweed's WR® portfolio of solutions, or to speak with a Greene Tweed engineer regarding your specific wear-resistant application, click here.

DAVE NOBLIN

is a Technical Product Specialist for Greene Tweed's Structural and Engineered Components group. He started at Greene Tweed in 2000 as a Design Engineer with a primary focus on composite wear solutions. His various engineering positions have included Design, Material Development, and Manager of Downstream Engineering, and Manager of Upstream Engineering.