How diamond coated mechanical seals can help prevent equipment breakdowns

Features

Kamesh Narayanaswamy, member of the European Sealing Association's Mechanical Seal Division and engineering manager of non-cartridge seals at John Crane looks at how diamond coated seals can help improve reliability and performance in the pumps sector.

A solitaire diamond with a coal background - *Image © Prashant - Adobe Stock.*

Diamond, nature's extreme material, is renowned for its incomparable properties such as exceptional hardness, high stiffness, low friction, biocompatibility and outstanding thermal conductivity. Technologies

have been developed to harnesses the extreme properties of nature's "perfect material" by turning natural gas into diamond in a highly controlled, reproducible process for a variety of industrial, environmental, electronics and biomedical applications.

Diamond coated mechanical seal faces are a significant advancement in the field of mechanical seals. This unique technology brings the tribological benefits of diamond to mechanical seals used for rotating equipment, such as pumps and mixers. Nearly every industry, including oil and gas, chemical, pharmaceutical, pulp and paper, water and wastewater, power generation and mining, use diamond coating to improve reliability and performance of mechanical seals, pumps, and other components.

Diamond coating is a synthetically produced pure diamond with the same excellent properties as natural diamond. Diamond addresses intermittent dry running conditions to improve the reliability of rotating equipment. And it can handle challenging applications with abrasive slurries, liquids above their atmospheric boiling point and poor lubricating fluids. Its low coefficient of friction reduces heat generation and energy consumption.

Here are some of the key benefits of diamond coated mechanical seals:

- Increased durability: The diamond coating provides unmatched hardness, superior chemical stability, and a low coefficient of friction. This makes seals more durable and extends their longevity.
- Improved reliability: The diamond coating enhances seal life and poor lubricating capabilities, extending Mean Time Between Failures (MTBF).
- Reduced costs: Diamond face treatments provide a lower coefficient of friction, resulting in cooler running faces, reduced power consumption, increased reliability, and lower lifecycle costs.

- Environmental benefits: Due to its low coefficient of friction, diamond coating generates less heat, reducing the need for cooling water and, in some cases, auxiliary cooling equipment. This results in less water consumption, reduced energy usage, and lower operating costs.

The technology behind it is a microcrystalline or an ultra-nanocrystalline diamond layer up to 15 µm (590 µin) thick which is applied to the seal face under vacuum at high temperatures by chemical vapor deposition (CVD).

The process of creating diamond-faced seal rings involves growing diamond on the surface of a silicon carbide (SiC) ring at high temperatures, roughly 800°C (1,475°F), in the presence of hydrogen (H_2). This is done using a carbon-bearing gas source, such as methane (CH_4). On the SiC, the diamond creates a dense, continuous surface with properties and surface finishes that can be adjusted for a range of sealing uses. When the diamond is applied to a silicon carbide ring, its surface finish can be precisely controlled to create a range of finishes, from a polished surface with a roughness of less than 25 nanometers (1 micro-inch) Ra to matte finishes of at least 300 nanometers (10 micro-inches).

The diamond deposition process enables the production of diamond coated seal rings that can be used in combination with a wide range of counter faces according to the application's needs.

The time to apply a diamond coating using the CVD process can vary, but most diamond-coated seals are in the chamber for one to two days. The deposition rate depends on the substrate design and power of the reactor. However, the exact time can depend on factors such as the thickness of the coating required and the specific conditions of the CVD process.

The durability and reliability of a rotary pump is critical to its overall performance. Using diamond coated mechanical seals has proven to

improve reliability, increase energy efficiency and enhance the useful life of rotating equipment and overall performance of a plant.

Overall, diamond coated mechanical seals offer a promising solution to overcome short seal life and equipment breakdowns caused by harsh operating conditions. There are many success stories about the implementation of this value-added technology across a wide range of global industrial sectors.

Diamond seal faces give us another great solution to challenging applications. Diamond seal faces are not a be all and end all for every application, but for the reasons previously mentioned, diamond has tremendous benefits for many applications.

About the Author

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