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Review On Characteristics of Mechanical Seal Face Materials Used In Abrasive and Corrosive Applications

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ABSTRACT: A mechanical seal is an essential part of modern industry. A seal is typically used as a method to contain fluid or gas within a pump, compressor or vessel. Shaft seals are Used in pumps, mixers, or anything where a rotating shaft passes through a stationary housing. Mechanical face seals are a specific type of seal used where leakage must be reduced to a vapor.

Mechanical seals are manufactured using three basic sets of parts.

Each seal will have a set of **primary seal faces, a set of secondary static seals,** typically O-rings, wedges and, or, V-rings, and a spring to maintain face contact. The major part of sealing is done by seal faces, where the seal face material is most important. The mechanical seals are used in various pumps and chemical mixers and reactors, where different types of fluids are processed.T he face materials may posse's different material properties and material will be varied based on the fluid properties. This review highlights the Characteristics of Mechanical seal face materials used in Abrasive and Corrosive fluid Applications

KEYWORDS: Mechanical seal, Face Materials, Hard faces, Abrasive and corrosive Applications, Material properties, Hardness,

I. INTRODUCTION

1.1 Working principle:

- A mechanical seal consists of rotary and stationary parts. The primary leak is achieved by two very flat lapped faces which creates a difficult leakage path perpendicular the shaft
- The general construction of a seal is that one face is fixed to housing or gland which is a stationary member and other face is fixed to the rotating shaft
- The springs exert force on the rotating seal face which makes the both seal faces in contact with each other
- Due to the contact between the two faces the leak minimizes due in flat topography
- The two face materials should not be same one should be harder, and one should be softer to prevent the adhesion
- The face material which Is smaller should be soft and the it should wear

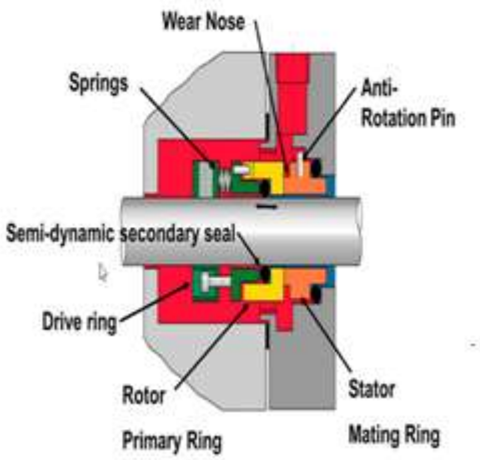

Fig 1: General Mechanical Seal Construction

1.2 Material selection criteria:

Primary seal material selection can influence seal life as well. Chemical or process compatibility is just one consideration. Harder materials are more resistant to abrasive processes, but if both sealing elements are hard materials, the wear characteristics may be less desirable in a nonabrasive application.

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Using one sealing element made of a softer material and/or one that contains lubricating components such as graphite decreases friction for starting and incidental contact. The use of composite hard faces will also reduce friction by providing microscopic reservoirs of system fluid at the interface.

Thermal conductivity of materials will dissipate heat away from the sealing interface, promoting seal life. Material toughness also can play a dominant role in mechanical seal life. The inherent material surface texture may also play a role in promoting desirable film thickness.

II. MATERIAL PROPERTIES CONSIDERED FOR SEAL FACE MATERIAL:

- The mechanical seal face materials are hard, corrosion resistant, and capable of accepting a very flat finish.
- Most of the face materials can exhibit poor wear characteristics when in frictional contact with another surface of same materials so dissimilar materials are usually selected.
- In extremely abrasive or corrosive environment it is sometimes preferable to mate surface of identical materials, but this is particularly only with extreme Hard materials like tungsten and silicon
- In this case the sealing liquids have adequate lubricant property to prevent heat checking of the faces

2.1 General Seal Face Materials:

- Carbon, Ceramic, Ni-resist, 17-4, Silicon Carbide, Tungsten Carbide, GFPTFE (glass filled PTFE.... often called Teflon (R)).
- Another group of seal faces would be those of coated seal faces. The coatings are "plasma coatings" and are generally a form or silicon or tungsten carbide sprayed onto a stainless-steel seal head. They have been sold by various trade names by the major mechanical seal companies but in our opinion are not worth the money. We have found the coating will always eventually wear and once it has will need to be completely recoated.
- In contrast, if a Silicon Carbide or Tungsten Carbide seal face is worn, it can generally be re-lapped and polished, bringing it back to "like new" condition and allowing a second, third or even fourth use of the same seal head.

2.2 The materials used in Abrasive and corrosive environment are

- Tungsten Carbide
- Silicon Carbide
- Ceramic

2.2.1 Tungsten Carbide:

Tungsten carbide (WC) was introduced to mechanical seals in the late 1950s.

Good thermal conductivity aids in dissipating seal generated heat, which can improve lubrication conditions at the running surface and prevent fluid flashing.

Among ceramics in general and specifically carbides, tungsten carbide's superior fracture toughness is much appreciated by users.

Tungsten carbide has superior hardness, a wide range of chemical resistance and excellent anti-frictional characteristics

Due its modulus of elasticity it can be used in high pressure applications which can helps to prevent face distortion

2.2.2. Silicon Carbide:

Silicon carbide is bluish black crystalline material manufactured by infusing silica and coke at a temperature of 2200 Deg C.

The resulting crystalline powder with a hardness rating of 2500 on Knoop scale, retain its strength at elevated temperature, has a low thermal expansion rate, a high thermal conductivity and excellent corrosion resistance.

The above properties make it an ideal material for mechanical seal faces especially for application in Abrasive and Corrosive environments such as Nitric Acid, HF or Sodium Hypochlorite.The corrosion and abrasive resistance of silicon carbide varies with variance in material, % of free silica, Grain size, Free silicon distribution and free carbon content.The low coefficient of friction, high hardness and high modulus of elasticity make it an ideal material to resist deflection in high pressure, high temperature and high-speed application.

Its extreme hardness makes it ideal for abrasive application.Self-sintered silicon carbide has excellent abrasive resistance and is chemically inert to all corrosive environments.

2.2.3 Ceramics:

Ceramics as seal face materials could categorically be described as one of the most significant leaps forward in mechanical seal capabilities. Ceramic is a standard solid, high purity ceramic seal face that contains 99.5% of aluminum oxide.Specific ceramics were selected for high

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hardness, high thermal conductivity, and high chemical resistances. Ceramics such as aluminum oxide were first introduced in the late 1950s and 1960s

However, its thermal conductivity is like metallic-based seal faces and its tribological properties are poor.'

Because of its hardness, ceramics offers excellent wear characteristics

Ceramic contains less than 0.5% of silicates, it is chemically inert and can be applied to nearly any abrasive environments like sodium hypochlorite and hydrofluoric acid

III. COMPARISON OF FACE MATERIALS AS PER THE PROPERTIES

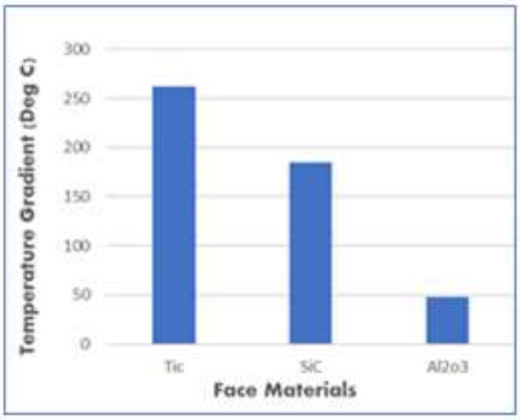

Fig 2 : Thermal Conductivty of Face Materials

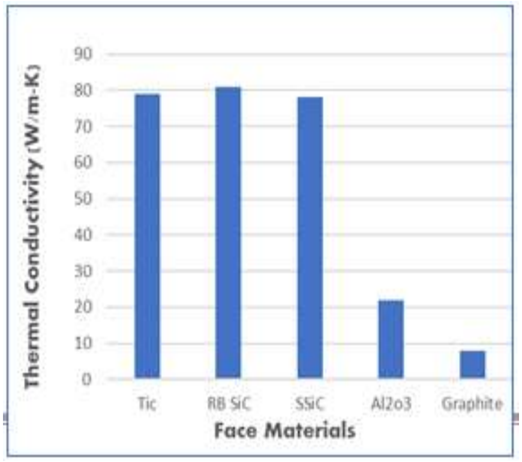

Fig 3 : Temperature Gradient of Face Materials

IV. CONCLUSION

In this paper we can conclude that selection of seal face materials will depends on the characteristics of face materials. The material characteristics for the Hard face materials like Tungsten carbide, Silicon Carbides and Ceramics are studied and we can determine that they are best suitable materials for Abrasive and corrosive applications due to their excellent characteristics. The advancement of requirements by the end users makes the seal face material is challenging which can be overcome by suitable alloying and binding Methods.

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