7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Advanced Bearing Technologies for Challenging Space Applications

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Space bearing applications present numerous unique engineering challenges that are often times met through advanced technologies. Dry film lubricants, conventional steel rolling element bearings and vacuum compatible greases are typically employed but often are found to be inadequate. In this presentation, the successful use of high-speed magnetic bearings and newly emerging corrosion immune NiTi alloy super elastic bearings are introduced.

Keywords: magnetic bearings, NiTi, space, mechanisms

1. Introduction

Machinery and mechanisms used in space present unique challenges to conventional bearing technology [1]. Operation in vacuum, extreme heat and cold, life requirements that are measured in decades are among such requirements that are difficult to satisfy. Though commonplace bearing materials and designs coupled with vacuum compatible oil and grease are often adequate, some applications demand new approaches. This presentation introduces the application of two new technology approaches, corrosion immune, super elastic NiTi alloy rolling element bearings and magnetic levitation to two space systems.

2. Approaches

Magnetic bearings offer the potential for unlimited life, no possibility of contamination from lubricant leakage and operation in a vacuum. Figure 1 shows the cross section of a recently developed air blower used in a CO_2 removal system for the ISS [2]. The use of magnetic levitation represents a major shift from existing technology solutions like ball or foil air bearings.

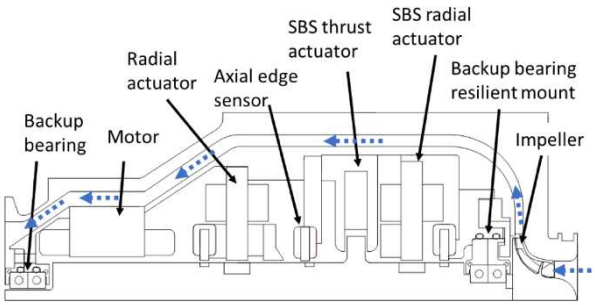

Figure 1: Cross-section of magnetically levitated blower used in the ISS CO_2 removal assembly.

Super elastic NiTi alloy ball bearings are another new and emerging technology approach for space applications that encounter corrosive environments. Alloys like 60NiTi (60 wt.% Ni, 40 wt.% Ti) easily harden to HRC 60 and cannot rust. They also can withstand 3-10x higher elastic strain without permanent deformation (denting). This makes them ideal for corrosive applications that encounter high static loads (shock loads). Figure 2 shows the use of 60NiTi bearings in the International Space Station (ISS) urine processor distillation assembly (DA) [3].

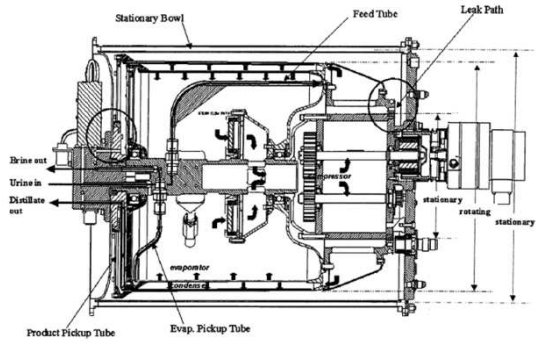

Figure 2: The ISS urine processor distillation assembly employing 60NiTi ball bearings.

3. Results and Discussion

The ISS CO_2 blower operates to 60,000rpm, can encounter vacuum conditions and particulate debris in the pumped flow stream. Foil air bearings have been the norm for such machines but are less tolerant to debris ingestion and cannot operate in a vacuum. Several hurdles overcome during this machine development included the selection of a non-toxic solid film lubricant for the back-up bearings and meeting pre-existing overall machine length requirements.

60NiTi bearings have been installed in the ISS DA and have alleviated bearing damage due to corrosion and high loads. Future work involves compositional tailoring such as the addition of Hf to improve processability. Both of these demonstrations advance the tribological state-of-art.

4. References

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