Ceramic Bearings for Water Processing, Water Filtration and Liquid Handling Applications

Boca Bearing Company

Bearings are an essential component in the majority of mechanical designs and equipment. It is important to consider the most effective materials when designing industrial machinery, especially in applications where water or other liquids are present. Many materials will be unable to overcome the challenges associated with operating in a wet or corrosive environment.

To overcome the challenges faced by industries involved in water processing, water filtration and liquid handling, full ceramic bearings should be used. This article will outline the properties of full ceramic bearings, and enable the reader to determine whether they are the most appropriate type for their mechanical processes.

Comparing full ceramic materials' properties

There are a number of ceramic materials that can be used to produce full ceramic bearings. While these share a number of properties, they also offer distinct characteristics, which will help to determine the most suitable material for the machinery. Here's a guide to the most common materials used to produce full ceramic bearings:

Zirconium Oxide (ZrO_2)

Zirconium oxide was first used in the 1960s. It was used in space travel, creating a thermal barrier to enable space shuttles to enter the Earth's atmosphere. It copes well with high temperatures, but doesn't handle thermal shock resistance to the same extent as alternative ceramic materials such as silicon nitride. It's best used in high temperature environments that involve minimal loads. It's highly resistant to corrosion, which makes zirconia the perfect choice for use with highly corrosive liquids. It's an incredibly strong material, which also makes it ideal for use in mechanical applications involving fracture risk. ZrO_2 has an operating temperature range of –85°C to 400°C

Silicon Nitride (Si_3N_4)

Silicon nitride is a ceramic material produced using a series of chemical reactions, creating a full ceramic material with distinctive properties. The material is dark in color, and is one of the most superior types of ceramic material in terms of quality and durability. This material is relatively expensive, but the extra cost is worthwhile if you're looking for something that can withstand high temperatures and harsh mechanical conditions. In terms of withstanding high temperatures, silicon nitride is superior to alternative metallic solutions, and it has a lower thermal expansion coefficient than many alternative ceramic materials. This makes it an excellent choice when thermal shock resistance is a high priority. Si_3N_4 has an operating temperature range of –100°C to 900°C.

Aluminum Oxide (Al_2O_3)

Aluminum oxide is the most popular ceramic ball material, and its common uses expand far beyond the realms of ceramic bearings. It's produced through the process of calcination of aluminum hydroxide, which creates a durable and highly resistant ceramic material. This material is best known for its high compression strength, and its ability to resist corrosion when faced with a variety of abrasive chemicals, even when the environment involves extremely high temperatures. Less expensive than some of the alternative ceramic materials, aluminum oxide is readily available and is the most popular choice ceramic bearing for projects in which the available budgets are limited.

Silicon Carbide (SiC)

Silicon carbide is produced by chemically combining carbon and silicon atoms. It has excellent mechanic properties, which makes it a fantastic choice for use in the creation of bearings. Grains of silicon carbide have been used for many years as an abrasive,

most commonly in the form of sandpaper. However, these grains can be combined through sintering to create the highly durable ceramic material used to create silicon carbide bearings. This is a strong, durable ceramic material with a low density, low rate of thermal expansion, and fantastic thermal shock resistance, making it suitable for use in a wide variety of applications.

Ensuring extensive lifespan of bearings

Generally speaking, ceramic materials are extremely durable. Most of them are man-made using chemical processes, and consequently can withstand extremely high temperatures and corrosive materials.

Full ceramic bearings have a much longer lifespan than hybrid ceramic bearings or the steel alternatives, particularly when they aren't placed under a considerable load. This can be attributed to many properties of full ceramic bearings. Firstly, ceramics are much stronger. As a result, the balls or races of the bearing do not become distorted when placed under load. However, the superiority of full ceramic material increases with the load, and full ceramic materials are still at risk of premature failure in these cases.

The main limitation of ceramic bearings is the fact they can be quite brittle. Consequently, you must analyze the load to ensure the chosen material can cope with the stress. Zirconium oxide will handle large loads better than the rest of the full ceramic materials.

Electrical insulation with ceramic bearings

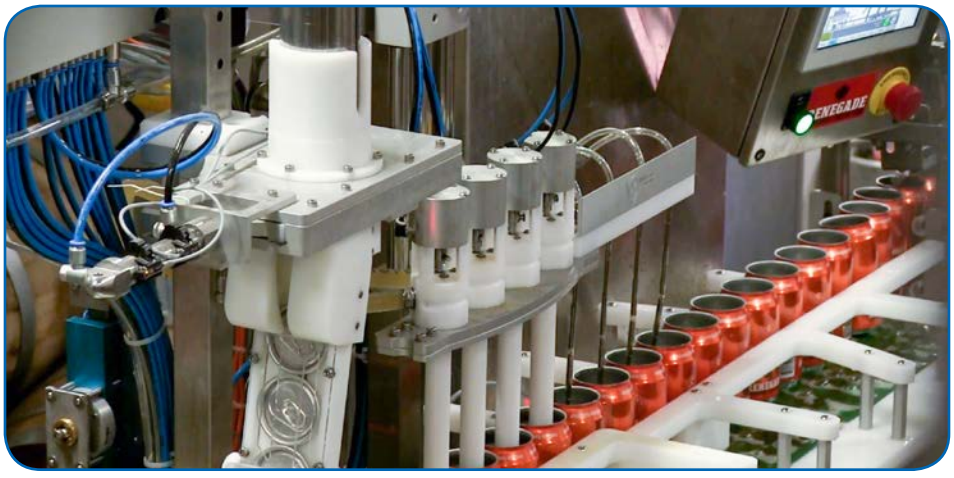
The ceramic bearings are also non-magnetic and, with the exception of silicon carbide, provide good electrical insulation. Silicon nitride offers the best electrical resistance, but is closely followed by zirconium oxide, which is readily available and fits within most budgets.

Improved performance of bearings in water and other liquids

Research has demonstrated that full ceramic bearings perform better than any alternatives when placed in water. Depending upon the material used, the lifespan can be up to 70 times longer than stainless steel bearings, a common alternative. The best ceramic materials for use in water processing environments are silicon nitride and zirconium oxide. Hybrid ceramic bearings also perform better than steel, but their lifespans are significantly shorter than full ceramic materials, which in some cases have a lifespan that's five times longer.

Resistance to corrosion

It is not feasible to use metallic bearings within industries handling water or other liquids, as they will corrode rapidly. When selecting the most appropriate material for the ceramic bearings, you should also consider the types of liquids the bearing will encounter. If the bearings will be used in environments containing corrosive materials, the lifespan will be significantly altered. Silicon nitride offers good resistance to the majority of



chemicals, so is often a good choice when the budget permits.

Temperature considerations

When deciding which material to use, it's important to consider the technical properties of each material to evaluate their suitability. One of the most important aspects to consider, particularly when working with liquids that may reach high temperatures, is the temperature of the environment in which you will be using the bearings. Silicon nitride can be used in environments reaching up to 1050°F, without loading. However, this can change significantly when used in industries handling liquids, as the bearings can encounter significant loading.

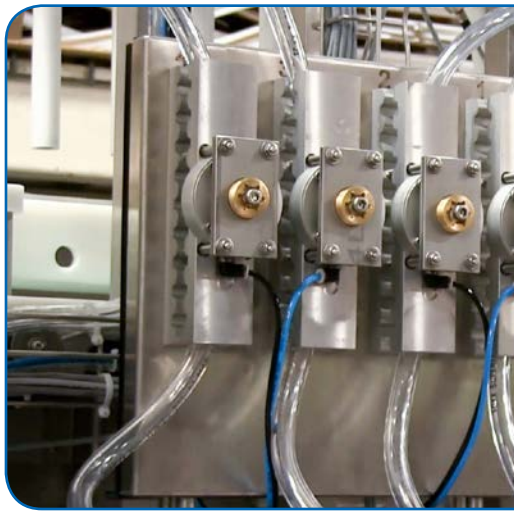
The coefficient of thermal expansion is possibly a more useful characteristic, as it provides an indication of the material's ability to cope in response to heating and cooling. Full ceramic bearings offer relatively low coefficients, compared to the non-ceramic alternatives. For example, silicon nitride has a coefficient of 3.2×10^{-6}/k and silicon carbide offers 3×10^{-6}/k. zirconium oxide and aluminum oxide are considerably higher, at 10.5×10^{-6}/k and 8.5×10^{-6}/k respectively, but both of these are much lower than bearing steel, which has a coefficient of 12.5×10^{-6}/k. In environments with considerable temperature changes, silicon nitride and silicon carbide are the best choices. They also offer good thermal shock resistance (up to 1112°F in silicon nitride, and 752°F in silicon carbide), which indicates minimal risk of fracture due to the changing temperatures.

Resistance to fracture under load

The material's ability to resist fracture is essential when used with liquids, such as water processing, as pressure is increased when submerged. Therefore, another characteristic that must be considered is fracture toughness. This indicates how capable the material is at resisting fractures in high-pressure environments. Zirconium oxide offers the best resistance, with a fracture toughness of 10 MPA*m1/2, closely followed by silicon nitride at 6.2 MPA*m1/2. These are consequently the best materials to use in a high-pressure environment, where the risk of cracks and fractures is high.

Wild Goose Engineering Success Story

Wild Goose Engineering is an engineering and machining company in Colorado. They partnered with a local brewery to develop an automated



canning line specially designed for the craft beer industry.

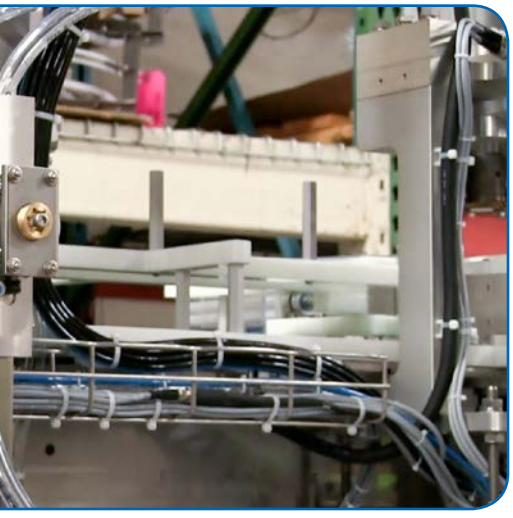
The canning system they created was not without its challenges. When you are dealing with any liquid, corrosion becomes a potential concern. Frequent washdowns and the beer itself can cause some mechanical components to corrode, gum up or fail completely. One such issue they found was that in their can lift and seamer, the constant spray of beer was causing the bearings to go bad very quickly. Downtime is a problem in any automation process.

Wild Goose Canning turned to Boca Bearing Company for help. They were able to identify the issues with their application and were able to offer the solution in the form of full ceramic bearings for the can lift and seamer. Ceramic bearings don't need lubrication, so there was no danger of chemical contamination, and they are FDA certified, and most importantly, ceramic won't corrode if it is exposed to water, cleaning chemicals, or the beer.

Boca Bearing Company and Wild Goose Canning are helping breweries to can their beers, and keep them operating safer, longer and more efficiently, so at the end of the day, they can kick back and enjoy a cold one.

Conclusion

The development of mechanical equipment for use in wet environments is no easy task, and selecting the right materials is vital to ensure the success of your business. Mistakes can be expensive, so it's important to understand the properties of the available resources. When it comes to bearings, metallic or hybrid options are simply not an option if significant contact with water is expected. Instead, full ceramic materials should be used to ensure the machinery will be built to last, and will operate efficiently for the duration of its use. **PTE**



For more information:
Boca Bearing Company
Phone: (800) 332-3256
www.bocabearing.com

For Related Articles Search
ceramic
at www.powertransmission.com