Polymer-Based bearings in Food and Beverage applications

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With easier cleaning, installation, and increased corrosion-resistance, plastic bearings and wear rings are a suitable alternative for industrial food production machinery.

With high degrees of chemical resistance, excellent load-bearing abilities, the potential to be self-lubricating, and minimal maintenance requirements, polymer-based bearings and wear rings are an excellent option for designers of food and beverage production and transportation equipment.

With stainless steel and other metals so predominant in industrial food manufacturing equipment, it may seem unusual to suggest a more significant role for plastic wear rings and bearings. But for a broad range of food production and transportation machines, advanced polymers are an effective way to reduce friction and handle load instead of traditional metal bearings.

We'll describe the wear rings and bearings commonly used in the food and beverage industry, delve into their chemical compatibility, discuss material choices for them, and show examples of current use.

Wear rings

Wear rings, also called guide rings, are single-element bearings. Typically used in linear, reciprocating applications, they provide a robust method for guiding two elements over a long linear distance. Note that some wear rings are designed to wear out, serving as the sacrificial element in a design in which two surfaces rub against one another.

When created from PTFE or a high-modulus plastic, wear rings are suitable for many food and beverage applications because:
1. The material is biologically inert.
2. Wear rings are a single element, which means fewer places for microbes to grow.
3. Their design makes them easier to install and replace than bearings containing balls.
4. Their low-friction properties make them well-suited for applications with high loads but relatively low speeds, such as in industrial mixers.

Wear rings can be designed as sleeve bushings, flange bushings, or thrust bearings. When a flange is added to the wear ring design, it can be used as a guide for mounting or as a thrust washer to accommodate loading that is parallel to the machine shaft.

Design variations can be achieved by changing the type of plastic used. Fillers and additives improve performance — for example, increasing heat resistance or reducing friction. Plastic sleeve wear rings can be self-lubricating and are also lightweight.

Rolling element bearings

Usually, these types of bearings consist of seven parts: three circular rings (the outer ring, the cage, and the inner ring), the rolling elements (spherical balls composed of stainless steel, glass, or plastic), a shield, and two seals. They are typically used in high radial, rotary load applications, with or without side load or thrust.

In many cases, a plastic bearing can be molded to combine parts, increasing integrity and reducing assembly time.

In general, rolling element bearings create less friction than wear rings, especially at low speeds. They can also take more side load than wear rings. However, their complexity makes cleaning and maintenance more difficult.

Bearing materials

Although bronze was historically the popular choice for bearings, today's PTFE and high-modulus plastics can have certain advantages over bronze. Importantly, they are less subject to chemical degradation. Additionally, both PTFE and high-modulus plastic are internally lubricated, have a high degree of component integration (e.g., with housing and seats), and run with less noise than bronze bearings.

Another key benefit of these plastics is their design flexibility. In many cases, a plastic bearing can be molded to combine parts, increasing integrity and reducing assembly time. Plastics can be injection molded into an infinite number of shapes, making them suitable for many production line applications.

A variety of components can be manufactured from a polymer base, including gears, integral rollers and bearings, valve balls, ball seats, impellers, chemical mechanical planerizers, lead nuts, ribbed bearings, tensioning pads, and poppets.

Of course, plastics are not the solution to all bearing needs. Temperature and load can create issues. For example, PTFE can only be used at temperatures below +260 °F. Therefore, bronze or more expensive high-modulus plastics must be used in high-temperature applications. Similarly, PTFE can only handle a medium level of load, whereas bronze and high-modulus plastics can both handle a high load.

Another consideration when choosing a bearing material is tribology, which is the science and engineering of interacting surfaces in relative motion, including the study and application of the principles of friction, lubrication, and wear. Generally speaking, thermoplastics such as PEEK have low friction, considerably raising their tribological status.

Chemical compatibility

Both cleaning and disinfecting are critical in food and beverage applications. Cleaning is the act of removing residual materials from equipment; disinfecting protects against internal and external bacterial growth on equipment. It is not realistic to expect cleaning alone to eliminate all chances of bacterial growth as microscopic traces of material capable of growing bacteria are often left behind.

The sanitization process helps ensure that the remaining microorganisms are reduced to levels not considered harmful. Carbohydrates, like starches and sugars, are relatively easy to remove from equipment. Proteins, such as milk and meats, present more of a challenge.

A wide variety of chemicals are used in cleaning (detergents) and sterilization (disinfectants). Acids, alkalis (bases), chelates, and solvents are the base chemicals typically used. Common alkalis used include sodium hydroxide and potassium hydroxide. Common acid chemicals include inorganics like phosphoric, nitric, sulfamic, and hydrochloric acid, as well as organics like hydroxyacetic, citric, and gluconic acids. Sanitizing chemicals include chlorines and peroxides.

The combinations of chemicals used in cleaning and disinfecting are the reason polymer-based bearing and wear rings perform better in many food and beverage applications. The chart below shows the compatibility of several polymers and bronze with common cleaning and sanitizing chemicals.

	Bronze	PTFE	High modulus plastic	Thermoplastic/PEEK
Nitric Acid	Poor	Moderate	Good	Good
Hydrochloric Acid	Moderate	Good	Good	Good
Acetic Acid	Moderate	Good	Good	Good
Chlorine	Poor	Good	Poor	Poor
Hydrogen Peroxide	Good	Good	Good	Good

Current use

Industrial food mixers are an excellent example of food and beverage machines in which the sealing element and low-friction bearings and wear rings are critical. With larger shaft diameters, the side loads, (thrust loads) and the radial loads, tend to be high, and the chemicals used in cleaning are incredibly caustic. Because metal bearings would suffer a negative impact (etching) from the chemicals, and low friction materials are ideal, polymer-based bearings and wear rings are common in spiral mixers, inline mixers, bottom mixers (also called slurry mixers), and horizontal (ribbon) mixers.

Motion-control components can also benefit from polymer-based wear rings and bearings. Whether moving thousands of cookies down a conveyor belt to packaging, controlling the flow of cakes as they receive glaze from overhead, or sliding finished pies into boxes, linear actuators, slides, and glides contain roller bearings that need to be thoroughly cleaned regularly. Polymer-based bearings provide a low-friction option that can stand up to a variety of chemicals.

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