



Selection of Bearing in Starch Confectionery with Washdown Applications

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ABSTRACT

Bearings are an integral part of any machinery that helps to reduce friction and assist moving parts during operation. They help restrict metal-to-metal contact between two components in relative motion. There are various types of bearings like Ball bearings, Roller bearings, Spherical roller bearings, etc. All these different bearings have one common point, i.e., Lubrication. It is the most critical aspect for selecting the correct type of bearing used in specific conditions in a manufacturing domain. For a food or pharmaceutical manufacturer, cleanliness and maintenance of processing equipment are critical requirements per food regulatory bodies like the National Sanitation Foundation (NSF) and Safe Quality Foods (SQF). In food-grade applications and harsh environments with starch dust and constant water usage for cleaning, selecting proper bearings will provide high performance and durability with frequent maintenance, thus reducing downtime due to bearing failure and increasing productivity. This study includes a data-driven comparison analysis of different types of bearings used in the food manufacturing sector to determine the best-suited type of bearings for the required application.

Key words: Solid lubricant bearing; Confectionery; Washdown applications

1. INTRODUCTION

Solid lubricant bearing is a game-changer product in the field of bearings used in the industrial sector, which aims to improve productivity, reduce downtime, and save costs as the scope of improving reliability and efficiency is constantly growing, creating more opportunities every day. These bearing classes have become a must in aerospace engineering for past years and have also been used in Food manufacturing industries to reach optimal performance. The benefits of solid lubricant bearings are not only restricted to reliability and optimal performance but also include contamination resistance, the ability to withstand high loads and temperatures, and their regular operation in washdown applications. The advantages of a solid lubricant bearing over a traditional regular bearing are no need for frequent lubrication, which eliminates the Maintenance downtime to re-lubricate, reduces the frequency of replacement, and further optimizes cost. This paper focuses on various factors affecting the bearing's quality and life in a confectionery environment and why using solid lubricant bearings instead of regular bearings is beneficial by performing the statistical analysis of the data captured during the production run.

2. PROCESS EQUIPMENT

For this study, we have considered a NID starch molding machine designed explicitly for molding, depositing, and drying jellies, gummies, and other confectionery products. Starch is a vital ingredient in the process used for molding cavities and removing moisture from the product. In some cases, it is mixed with different concentrations of oils to provide a binding characteristic to hold the mold cavities during the deposition process. The other areas of the machine are shown in Fig. 1 and Fig. 2. There are several moving parts in the machine, and the load-bearing parts are designed to transmit any overload to the nearest automatic overload clutch. The clutch reset itself automatically after the load is removed. The tray transport, depositor head, pump, buck, tipper arms, and print table are driven through a single fully automatic synchromesh gearbox. At the end of the line, various conveyors also take the completed production product to the packaging area. All these areas have different types of bearings installed, which helps in continuous and smooth motion.

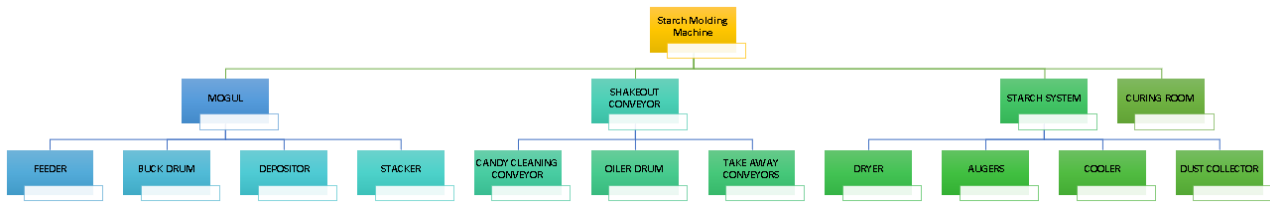


Fig. 1. Major sections of a starch molding machine

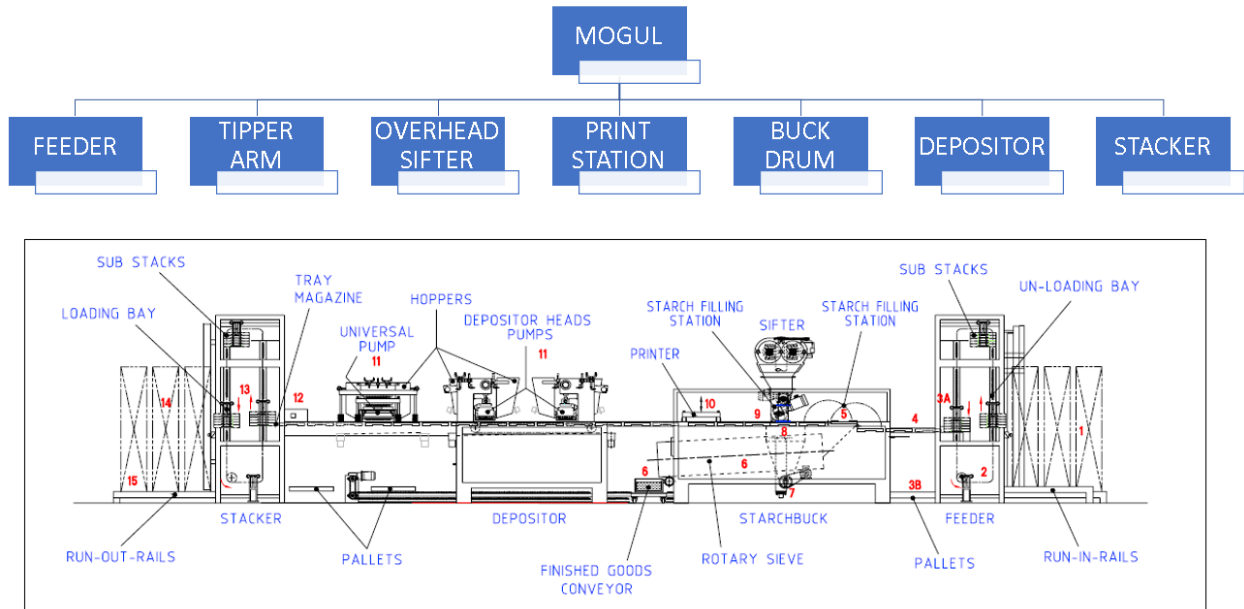


Fig. 2. Mogul layout

3. PROBLEM STATEMENT

In a confectionery environment, starch is one of the essential ingredients for molding and curing purposes. Most of the machinery is always covered with residue starch, which forms a layer on the bearing units. During washing application, water gets mixed with starch, forming a paste-like structure which eventually goes into the bearing and starts affecting it. The significant applications of bearings in confectionery are affected by factors like hot water used during cleaning, starch dust, humidity, high temperature, and load. This leads to frequent breakdowns of the machines and causes unplanned downtimes to get them repaired or replaced. It also leads to potential failure on other parts of the machines in contact with the bearings, like shafts, collars, etc. The conveyors are usually washed with hot water during product change to reduce the risk of contamination. This severely affects the bearings and other components, causing premature failure and emergency breakdowns of the equipment, leading to a loss in production uptime.

4. ADVANTAGES- SOLID LUBRICANT BEARING

In addition to reducing friction and wear, solid lubricants offer the advantage of permanent lubrication with no leakages. They generate low amounts of heat and provide low startup torque.

Solid lubricants are ideal for the food industry, as they are NSF-certified for food processing. This lubrication will keep contaminants out and is compatible with acids and other corrosive chemicals. As such, it functions well in wash-down applications. When a solid lubricant bearing is coupled with stainless steel for the outer material and housing of the bearing, it provides added protection against corrosion. It protects the internal components of the bearing during washdowns and leads to longer production times between maintenance procedures and fewer bearing failures. It also eliminates the need for re-lubrication, significantly allowing food-grade bearings to perform exceptionally.

As per the table below released by NTN, in Fig. 3, Fig. 4, and Fig. 5, it is evident that various types of lubricant bearings can be used in a confectionery food environment. The ideal one should withstand high operating temperatures of up to 80-100 degrees Celsius because of the continuous motion of various machine sections.

Comparison of Rolling Bearing Characteristics for Food Machinery					
⊙ : Excellent ○ : Good △ : Fair × : Poor					
Item	Lubricant Type	Solid Grease for Food Machinery	General-purpose Grease for Food Machinery	General-purpose Solid Grease	Plastic Rolling Bearing
	Product Code	LP09	L791	LP03	—
Permissible operating temperature range (bearing outer ring)		-10 to 100°C (80°C max. for continuous operation)	-20 to 110°C	-20 to 80°C (60°C max. for continuous operation)	-20 to 80°C (60°C max. for continuous operation)
Applicable bearings	Standard type SUJ2	Not permissible*	Permissible	Permissible	PPS or polyimide
	Stainless steel SUS440C	Permissible	Permissible	Permissible	
Cost	Short-term	△	⊙	△	△
	Long-term (incl. maintenance)	⊙	△	⊙	○
Lubricant life		○	○	⊙	○
Oil loss, leakage		○	△	⊙	⊙
Food sanitation safety		⊙	⊙	×	⊙

1. Spot-pack Solid Grease.
 2. Applicable bearing configurations are deep groove ball bearings and bearing inserts.
 3. Contact with organic solvents, wash oils, or other chemicals may degrade the performance of Solid Grease.

* Food grade Solid Grease doesn't contain rust inhibitor and therefore is recommend for use in stainless steel bearings.
 NTN also fabricates bearing units fitted with austenitic stainless steel covers.

Fig. 3. NTN comparison of bearing

Comparison of Housing Characteristics for Bearing Units				
⊙ : Excellent ○ : Good △ : Fair × : Poor				
Housing Specification	Corrosion Resistance	Food Sanitation Safety	Cost	
			Short-term	Long-term
Standard painted type	×	×	⊙	×
Thermoplastic	⊙	⊙	△	○
Stainless steel	⊙	⊙	×	⊙

Fig. 4. NT comparison of housing

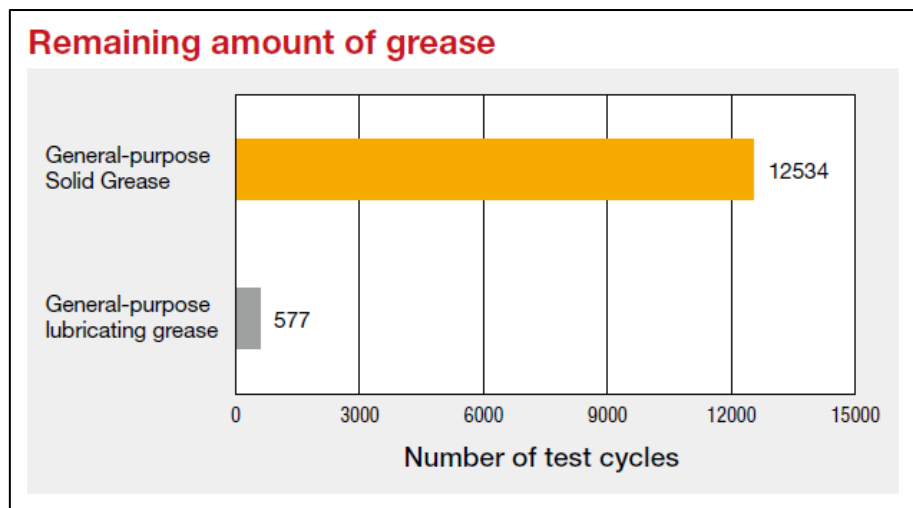


Fig. 5. NTN comparison of lubricant retention

Even the housing selection for bearing is an essential decision for the food and beverage industry. A stainless-steel housing with sealing is more reliable and safe than thermoplastic and standard painted types. It helps reduce the risk of contamination through food and reduces cost as they last longer without needing Maintenance.

The above study done by NTN provides an overview of the effect of the washdown application on the amount of grease remaining in a bearing. Solid lubricant grease was maintained in the sealed bearing even after multiple washdown cycles. All this information certainly helps to identify the correct bearing that should be used for specific applications in the food industry.

5. DATA COLLECTION AND RESULT

In this study, we collected data from a starch molding machine. We identified some areas exposed to starch dust and washdown applications like Feeder, Stacker, Depositor, and Buck systems. We consolidated the information for all kinds of bearings installed in this area. Then, we contacted two different bearing suppliers and bought solid lubricant bearings from them. We installed them on the machine and measured the failure time and the amount of maintenance activity needed to keep them issue-free. Fig. 6 shows the replacement frequency of the bearing in 2022 vs 2023 on specific areas of the machine. As you can see, the frequency of bearing replacement went up. This also led to less downtime required for replacing the bearing and, in turn, increased the machine's operation time. It has helped reduce the cost of buying bearings annually by 25 %. We have started standardizing this structure for other machines as the results have been groundbreaking.

Section	Qty	Bearing	Repaclement Frequency 2022	Repaclement Frequency 2023 (with solid lube)
Buck	4	6006 - LLU	12 weeks	36 weeks
Buck	4	6204 LLU	4 weeks	36 weeks
Buck	2	6206 LLU	10 Weeks	36 weeks
Depositor	8	6006 LLU	12 weeks	36 weeks
Depositor	4	6007 LLU	10 Weeks	48 weeks
Depositor	2	6205 LLU	10 Weeks	48 weeks
Depositor	3	6206 LLU	10 Weeks	40 weeks
Depositor	1	6207 LLU	12 Weeks	36 weeks
Feeder	8	6003 ZZ	4 weeks	36 weeks
Feeder	12	6005 LLU	4 weeks	36 weeks
Feeder	4	6204 LLU	4 weeks	40 weeks
Feeder	4	6304 LLU	6 Weeks	40 weeks
Stacker	8	6003 ZZ	4 weeks	40 weeks
Stacker	12	6005 LLU	4 weeks	48 weeks
Stacker	10	6204 LLU	4 weeks	40 weeks
Stacker	4	6304 LLU	6 Weeks	40 weeks

Fig. 6. Frequency of replacement of bearing



Fig. 7. Condition of bearings installed in 2022

In Fig. 7, we can see the state of the bearing that was removed from the machine. Most of the bearings had white paste around the seals that were starch mixed with water. Also, it is evident that regular lubricant leads out from the seals and leads to damage, causing breakdown.

6. CONCLUSION

Confectionery manufacturers need to deliver premium products; they need machines running at complete optimal performance levels without unnecessary breakdown and damage. Solid lubricant veering can help them achieve this by reducing the cost of investment in replacing the bearings after a specific interval and saving labor costs for changing and performing preventive maintenance activities on the bearings. These also help comply with dietary regulations set by SQF and NSF guidelines and help protect the consumer through adverse situations. It reduces unplanned downtime and saves the cost of expensive shutdowns due to bearing failure affecting other critical machinery components.

In summary, using solid lubricant bearing in a confectionery has tremendous potential to increase productivity while maintaining the superior quality of the product without risk of contamination and safety incidents.

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