

<Elbow Grease>

“Our gearboxes have a lot of moving parts inside and are subject to some very large forces, so all of the parts need lubrication,” Verzemnieks said. “This is usually done by sealing the output side of the gearbox—our gearboxes have an oil seal and seal caps on the output—and then sealing the motor flange-motor-gearbox connection. Then, the whole cavity is filled with lubricant.” The motor flange is used to mate the motor to the gearbox.

“Any part of the robot that you see movement from will have some type of lubrication: reducers, gearboxes, pivot bushing and bearings,” said Tom Fischer, operations manager for Marion, Ohio-based industrial robot automation integrator Robotworx.

For robots, grease is normally applied through a tapped port using a grease pump with a gun attached to a compressed air line.

Robotics specialists caution that it’s crucial to apply the correct amount of grease. Too much or too little grease can do more harm than good.

Fischer explained that with “too much grease, when the temperature of the gear rises, the grease expands and can damage o-rings and oil seals, causing the grease to leak out and eventually leaving the reducer with no lubrication.” Part of New Zealand-based industrial automation company Scott Technology Ltd., RobotWorx offers and services several industrial robot brands, including Fanuc, Yaskawa Motoman, ABB and Kuka.

On the other hand, he added that too little grease may cause premature wear in the reducer, leading to gear failure. “It also changes the timeline for preventive maintenance,” he said. “A smaller amount of grease will also have a shorter life due to increased heat generated.”

Mike Ondrasek, senior project engineer for Yaskawa America Inc.’s Motoman Robotics Division, explained that using too much grease in a robot can lead to hydraulic lock of a robot’s gear reducers or ejection of lip seals. Hydraulic lock is a situation in which the internal components cannot move because they are surrounded by incompressible grease, he explained.

Fischer noted that although grease is used in most situations, it depends on the robot manufacturer’s recommendations. “For example, Motoman and Fanuc use grease,” he said. “Some Fanuc arms use grease and oil. And Kuka and ABB use gear oil.”

Extreme pressure lithium grease is the most common grease used in lubricating robots, according to Fischer. Robotworx carries its own branded line of Vigo grease, which comes in 16-ounce tubes, 5-gallon pails and 55-gallon drums.

He added that all industrial robot manufacturers offer a line of food-grade IP67 robots, and an NSF H1 registered lubricant for incidental food contact is typically used. IP67 is a standard that indicates a robot is waterproof, which is typically achieved through protective covers that seal the inside of a robot, such as its motors and connectors.

Each manufacturer recommends a specific grease or oil. The most common greases are Vigo and Molywhite, according to Fischer. For robots that use oil, JXTG's Bonnoc AX68 gear oil—a long-life, synthetic gear oil for industrial applications—is the usual, or something similar.

Older model robots rely on Molywhite, a lithium grease consisting of synthetic hydrocarbon oil, refined mineral oil and treated organic molybdenum compound. According to Robotworx, Vigo grease is a relatively new robot gear lubricant now used for Nabtesco's reduction gears on newer robots. The Vigo grease has a larger quantity of extreme pressure additives, including molybdenum and zinc.

A robot's speed reducer multiplies the amount of torque generated by an input power source. It also reduces the input power source speed to achieve desired output speeds. Aaron Barnes, regional technical manager for Motoman Robots, said speed reducers and crossed roller bearings in robots typically require regular lubrication.

Barnes said grease recommendations can vary depending on the type of speed reducer used. "Rotary vector and cyclo gear reducers have extremely high internal contact forces, so the lubricants for those—Molywhite and Vigo—have additives like molybdenum to help separate the metal components and allow for a lubrication film between," Motoman's Ondrasek explained. "Greases that are not designed with those high-contact pressure considerations will not be effective."

Nabtesco offers three types of its own brand of grease and an RV oil, each designed for use in reduction gears. Vigo grease REO and Molywhite RE No. 00. Each are lithium greases formulated with treated organic molybdenum compound.

"The lubricants that we offer have been developed to maximize performance of our gearboxes in any application, not just in robotics," Verzemnieks said. "Grease and oil are both used as lubricants in robotics, and from what I understand a lot of it comes down to preference. For example, depending on the robot manufacturer, the type of lubricant will change, and sometimes cultural differences play into this as well."

Greases used in robotics should reduce wear and improve efficiency so the robot's servo motor doesn't have to work harder than it needs to, he explained. "Ideally, we want very high efficiency over a wide temperature band and also over a wide range of torques and speeds, while keeping wear to a minimum to maximize the lifetime of the gearbox."

<Change is Good>

“Changing the grease not only renews the lubrication properties each time,” Ondrasek told *Lubes’n’Greases*, “it also allows for metal particles from wearing components to be removed.”

He explained that, unlike a car engine that has an oil filter to strain out metal particles, the grease in robot gear reducers becomes contaminated over time with those particles and can begin to act like a grinding compound, accelerating wear and reducing the part’s life. “So, it is advantageous to monitor the metal content in the grease that is removed at each exchange to help predict impending end of life of the gears,” Ondrasek noted. “It is also possible to extend the life when the metal content is rising by flushing the gear reducer with fresh grease sooner than usually scheduled.”

According to Ondrasek, every robot application is different, and a myriad of factors can cause wear in a robot’s gear reducers, leading to the need to change grease more frequently. Some factors taken into consideration include duty cycle, average revolutions per minute, temperature and impacts—meaning the robot crashed into something. He emphasized that, unlike robots in science fiction movies, robots for manufacturing are not designed to be crashed.

He noted that applications in which robots crash into things—usually a hazard in forging facilities—will have difficulty even if the robot’s grease is changed regularly. “But without crashes, the most critical greasing applications often will be in press pending and palletizing where several axes are usually running at nearly 100 percent duty cycle and averaging near top RPM,” Ondrasek pointed out. “And any application in a high heat environment is subject to premature grease degradation due just to the heat.” He added that a robot that is overloaded or used beyond its design specifications will need to be greased more frequently.

According to sources, inspections rely on a mix of scientific and mechanical factors and, ironically, human senses and intuition.

Fischer said a robot inspection typically includes steps such as getting “hands-on” with each gear of the robot, feeling and listening for any abnormal vibrations and sounds. “We also look at the current grease in the arm,” he said. “It can tell you a lot about the life of the robot.”

He explained that the most common indicators of grease condition are color, smell and metal content—either visual or lab tested. A dip stick can be used to confirm grease presence. “Standard Vigo [grease] is yellow,” he noted. “As it ages, it turns brown, and then in the worst case it blackens as it burns off.”

When replacing grease in robots, Ondrasek said, it's crucial to measure the metal content in the removed grease. "Higher metal content means you need to increase greasing frequency," he noted.

Another indication of incorrect greasing frequency is the noticeable smell of "burnt" old grease that is expelled when new lubricant is pumped into the robot part. "Usually this is also noticeably darker in color," he added.

Ondrasek observed that another concern would be the separation of grease to a "water and wax" type consistency. In this case, the expelled grease will appear to be watery and have a much thinner viscosity than the new grease.

<Service Intervals>

The versatility of industrial robots means that the amount of wear and tear on the robot varies as well, so one-size-fits-all doesn't always apply with service intervals.

Nabtesco recommends changing lubricant for its gearboxes every 20,000 hours of operation, based on ambient temperature between minus 10 and 40 degrees Celsius (14 and 104 degrees Fahrenheit). "If using in an environment different than this, we recommend testing the lubricant regularly and changing as needed due to both grease degradation as well as an increase of iron particles in the lubricant from wear inside the gearbox," he said. "If the gearbox is not properly lubricated, this will affect the performance and also the lifetime of the gearbox."

According to Ondrasek, robot operating manuals list recommended maintenance schedules. Grease servicing is generally recommended at about 6,000 servo motor power-on hours, although he noted that interval doesn't fit all situations.

"This is like saying you should change your [car] oil every 6,000 miles—it is only the average safe recommendation," Ondrasek cautioned. "If you drive very conservatively or race your car, you may need to change it less or more frequently. Our customers typically stick to a yearly maintenance schedule rather than trying to time by servo hours or adjust for a robot axis that works little versus very hard. Once a year is typical."

Robotworx' Fischer noted that in a normal scenario, annual top-off of a robot's lubrication is recommended, with full lubrication replacement every three years or 11,000 hours of operation. "In a wet environment, it's suggested to be replaced yearly," he added.