Rotation Gearbox

Component design and maintenance

If the hydraulic system is the heart of your drill rig, then the feed and rotation gearbox components are the muscle. This discusses the rotation gearbox with regard to component design and maintenance.

The rotation gearbox has been designed to provide the drilling speed and torque characteristics required for conventional and reverse circulation tri-cone rotary bits or down-the-hole hammers. The gearbox applies the hydraulic motor speed and torque through a single 3.5:1 reduction of spur cut pinion and bull gears. Spindle thrust forces are handled by large tapered roller bearings mounted in a heavy fabricated steel housing.

This taper bearing application is similar in design to that of a typical automotive wheel spindle in the sense that you are capturing the housing between opposing tapered roller bearings that are mounted on the spindle. The difference is that the automotive application is horizontal and allows for floating inner races and some end play clearance in the bearings. The vertical application with heavy axial loads requires that the inner faces must have an interference fit on the spindle and are adjusted tight enough to cause a perceptible drag between the spindle and housing.

Schramm recommends that the spindle be examined every 1,000 hours for axial end play. This inspection can be performed by bringing the gearbox to the table and applying a slight load to the spindle against a sufficient steel plate bridging the table to cause the lower bearing cone on the spindle to seat in the lower cup of the housing. At this stage clean the mating joint between the spindle and housing then apply ink at the joint with a marker. Lift the gearbox off of the table and observe any separation of the ink mark. With tapered roller bearings, you will have a .0015 inch (.0381 mm) of radial motion for every .001 inch (.0254 mm) of axial motion. The maximum suggested bearing end play is 1/16 inch or .0652 inch (1.656mm)

This increase of end play will also cause the three-piece rotary seal application of certain rotation gearboxes to separate and eventually leak drilling fluids. You should make certain that both lower and upper seals are tight in their assembled positions. The rotary seals will have a standard nominal thickness of .1875 inch (4.7625mm) once in the assembly under crush if there is no bearing play. When installing new seals they are installed dry, you lube the steel bushing on both sides with a little dap will do you of lubrication. This seal design depends on the intermediate steel bushing to split the soft

seal surface contact in half between the upper and lower surfaces. The high-pressure rotary seal assemblies used in oil and gas applications are not dependent on the spindle end play to maintain sealing. However spindle endplay is still critical to the life of the entire assembly and with the greater vertical loads in these applications, it may require inspection more frequently.

The spindle is hollow with an internal diameter ranging from 2.6875 inches (68.2625 mm) in the small shafts to 5.25 inch (133.35 mm) in the largest shaft to allow maximum flow of circulation fluids or the addition of wear sleeves when drilling in reverse circulation. The housing is fitted with magnetic plugs at the oil drain location and under the hydraulic motors. All of these plugs should be removed and inspected at every service interval. It is normal for these straight-cut gears to yield a small amount of metal which will be collected on these plugs. Periodically the oil fill plug should be loosened to inspect the oil. If the gearbox oil is found milky that means it is contaminated with water, and the oil should be replaced immediately. Water contamination of the gearbox oil has been found to significantly reduce the life of the bearings.

The factory fill for lubricant is an ISO grade 320. The lubricant must meet API service GL-5 or SAE J2360. If operating in sub-freezing conditions, it is recommended to use an ISO grade 220 synthetic gear lube. The synthetic oils are preferred due to their surface tension properties when the equipment is parked for long periods of time. The high ISO grade is recommended for the high-pressure loads that are applied to the bearings when drilling to greater depths.