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SCHAEFFLER TECHNOLOGIES GMBH & CO. KG, LANDSHUT/HERZOGENAURACH

Optimization of hydraulic power units

Modifications of Details Make Systems More Efficient

With its customer Sauer-Danfoss, Schaeffler Group Industrial has optimized a number of bearing positions in the newly developed H1-series axial piston pumps and motors and thus provides the most efficient bearing solutions currently available. As a result, the overall efficiency of both the pumps and the motors has increased by approx. two percent, resulting in a significant improvement in the systems' level of energy efficiency.

Considerable savings possible

Equipped with a new H1 hydraulic pump and two H1 hydraulic motors, a wheel loader having a drive power of 140 kW can save about 9 kW. Projected on to 1,000 wheel loaders operating eight hours a day, there is an annual saving potential of some 26,000 MWh. This equates to the average energy consumption of more than 6,500 three-person households. So, about €5 million (€0.21/kWh) or approx. 16,000 tons of CO₂ can be saved. The latter is equivalent to the annual emissions of 4,200 Golf-category cars, each travelling 25,000 km a year.

The modifications in detail

Ever more stringent emission standards and rising energy prices are boosting the demand for efficient machines that optimally use the power output of diesel engines and thus reduce fuel consumption. In non-road applications, various hydraulic units take over the power transmission function. Adjustable axial piston pumps and motors have been designed especially for the use of electric machine controls.

In addition to the electro-hydraulic system itself, the development of the Sauer-Danfoss H1 series was focused especially on optimizing the base components in the hydraulic pumps and motors. The bearing positions were scrutinized down to the latest detail and examined for improvement potential. New, friction-optimized rolling bearing solutions from Schaeffler Group Industrial have had a significant influence on reduced power loss, installation space and weight.

The adjustment option for H1 axial piston pump in swashplate design has been realized with new swashplate cradle bearings. Compact and friction-optimized cylindrical roller bearings were used for supporting the drive shaft. Compared to the previous model, the installation space and weight have been substantially reduced. The efficiency has increased by about two percent.

Cylindrical roller bearings with optimized rib contact

The new X-life cylindrical roller bearings with optimized rib contact make an important contribution to these improvements. The special curvature of the roller end faces improves the contact geometry between roller end faces and the bearing ribs and minimizes the maximum contact pressure. This enables the formation of a load carrying lubricant film – end faces and ribs are separated by the lubricant. The rollers now slide on the lubricant film under axial load. Therefore the new cylindrical roller bearings can operate at an F_a/F_r ratio of 0.6. This means that the permissible axial load can amount to 60 percent of the radial load. Conventional cylindrical roller bearings can tolerate a maximum value of only 40 percent. At the same time, the frictional torque is up to 50 percent lower, depending on the magnitude of the axial load. The benefits are lower operating temperatures, higher efficiency and reduced energy demand.

H1 axial piston motors in swashplate design feature friction-optimized X-life tapered roller bearings. In addition, a newly developed steel sealing ring improves the sealing behavior of the hydraulic motor piston to a considerable degree. In this way, the length and weight of the axial piston motor have been reduced. Furthermore, the power losses have been cut by approx. two percent compared to the previous model.

Up to 75 percent lower frictional torque in the tapered roller bearing

In the tapered roller bearing, too, the optimized rib contact is particularly important. Especially under axial load, the frictional torque of conventional tapered roller bearings increases very markedly. Therefore the Schaeffler Group has redesigned the bearing geometry, surfaces and materials as well as the dimensional and running accuracies of the new X-life tapered roller bearings. As a result, these offer up to 20 percent higher basic dynamic load ratings and an increase of about 70 percent in basic rating life. At the same time, the higher dimensional and running accuracies, in combination with the improved surface topography, reduce the frictional torque by up to 75 percent compared to conventional bearings. The contact geometry of the inner ring rib and the roller end face has also been redesigned for lower friction. This reduces the stress on the lubricant in the bearing. The maintenance intervals have been extended. All in all, the X-life tapered roller bearing thus operates at a much lower noise level.

• Press picture "212022_aaa_rgb.jpg"

The optimization of the bearing geometry, surfaces and materials as well as of dimensional and running accuracies has led to an increase in the basic dynamic load rating and the basic rating life of tapered roller bearings. At the same time, the frictional torque has been clearly reduced.

- Press picture "113459_aaa_rgb.jpg"

The axial load capacity of cylindrical roller bearings has been increased significantly thanks to the improved roller end face/rib.

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