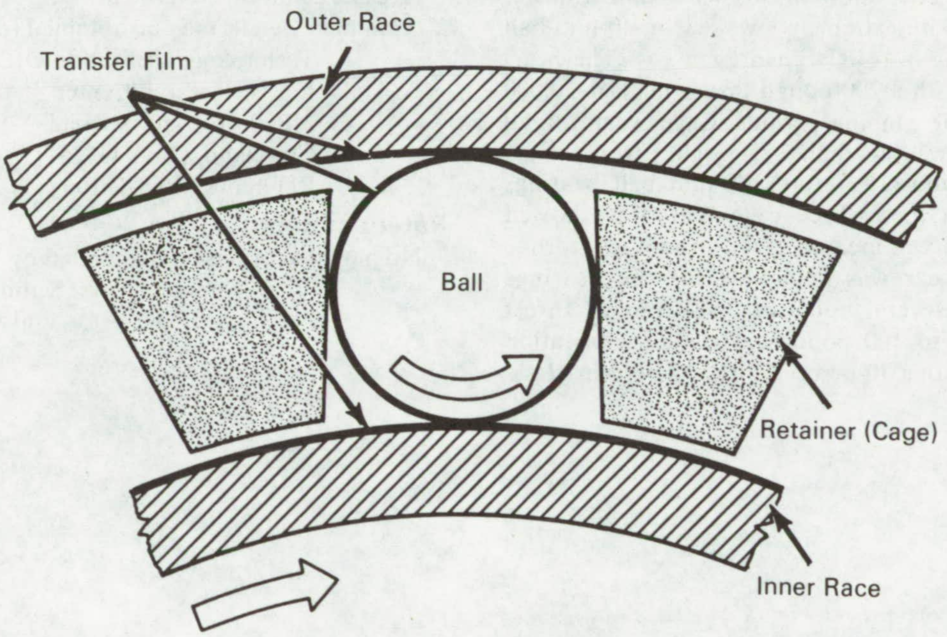
NASA TECH BRIEF

Bearings Use Dry Self-Lubricating Cage Materials



The problem:

Rolling element bearings are required in spacecraft and satellite mechanical systems to support and to locate accurately their rotating or oscillating components. These systems operate at ambient pressures below 10^{-6} torr. The inertial loads on the bearings are negligible when the orbiting mechanisms are operating in a zero-gravity environment. Bearing dynamic loads, however, such as those resulting from power transmission forces, will be present.

Effective lubrication of the bearings in these mechanisms may be provided by a self-contained system, where the bearing cages function as the lubricant reservoir. The cages are impregnated with liquid lubricants. These lubricants have comparatively high evaporation rates, and therefore, may not be as desirable for some space applications as solid lubricants. Direct exposure of the bearings to the low pressures of space results in excessive evaporation of the lubricant, and its subsequent condensation on nearby instrumentation may obscure light transmission through optical elements and provide short circuit paths in electronic components.

The solution:

Use solid lubricant composites of TFE (polytetrafluoroethylene) which have evaporation rates lower than liquid lubricants above 350°F at ambient pressures of about 10^{-6} torr. The solid lubricant is utilized by building it into the bearing cage; thus the cage not only functions to space the rolling elements equally

(continued overleaf)

but also provides the lubricant at the bearing load-carrying surfaces.

How it's done:

The lubrication technique for a ball bearing operating with a self-lubricating cage is illustrated in the figure. Thin films of retainer material are transferred from the cage pockets to the balls and subsequently by the balls to the race grooves. Since only minute quantities of lubricant are necessary, transfer films a few millionths of an inch thick are adequate. The TFE was compounded with additives, such as glass fibers, molybdenum disulfide, and bronze to provide the required physical properties and good wear life.

In recent tests, three cage materials, consisting of a glass-fiber-filled TFE, a glass-fiber-MoS_2-TFE, and a bronze-filled TFE showed excellent film transfer characteristics with extremely low wear in 40-mm ball bearings running in −400°F hydrogen gas. The bearings operated with a 200-pound thrust load at 20,000 rpm for 10-hour running periods. Cage wear for all three materials was less than 0.25 weight percent.

In high vacuum (10^{-7} torr), 20-mm ball bearings lubricated with these three cage materials showed good performance as measured by constant low-torque values. Cage wear was negligible for the bearings which ran for several hours at 3600 rpm at thrust loads from 35 to 100 pounds. The best lubrication was achieved with a 70-percent-TFE, 15-percent-glass-fiber, 15-percent-MoS_2 retainer material. Initial bearing runs with this material indicated that a run-in period was required before good lubrication could be achieved. In an endurance test, a 20-mm bearing, lubricated with a similar glass-fiber-MoS_2-filled TFE cage, completed 200 hours continuous running with 3.4 weight percent wear.

These results indicate that bearings using dry self-lubricating TFE composite cages have potential applications in a wide range of both temperature and pressure conditions.

Notes:

1. Suggested special applications for the bearing cages are in food processing equipment and textile machinery where contamination from oils or greases cannot be tolerated.
2. Complete details may be obtained from:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10165

Patent status:

No patent action is contemplated by NASA.

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