



## Materials Engineering Branch

### TIP\*



No. 070 Enhancing Lubricant Performance with TCP

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In spacecraft ball bearings lubricated with oils, the amount of lubricant usually is very limited in order to achieve and maintain a low drag torque. However, with the small amount of oil, hydrodynamic fluid films cannot be formed to separate the metal surfaces. Therefore, metal-to-metal contact occurs early in the life of the bearings with resultant wear and degradation of the bearings. The metal-to-metal contact can be minimized by the addition of 2-5% by weight of tricresyl phosphate (TCP) to the oil<sup>1</sup>. This anti-wear additive reacts with fresh metal surfaces, as they are created, to form phosphate films that provide some protection from subsequent metal-to-metal contact.

TCP is miscible with light di-ester oils, such as Bendix P10 and Windsor Lube L-245X and with the mineral oils, such as Apiezon C and the SRG series. The solubility of TCP in the silicone oils, such as F 50, is only about 1% by weight. It is not soluble in the Krytox oils and the similar Brayco 815z oil. The TCP was obtained from the Fisher Scientific Co., was composed of 80% of the para and 20% of the meta isomers, and identified as grade T342. Some companies market a synthetic TCP that might not have this composition and, therefore, not the same performance. The addition of TCP to the oil is recommended over the lengthy and costly TCP coating treatment for bearings via prolonged heated immersion in the TCP<sup>2</sup> because it is less costly and requires less complex application facilities.

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<sup>1</sup> A. J. Babecki, W. G. Grenier and C. L. Haehner, "An Evaluation of Liquid and Grease Lubricants for Spacecraft Applications", Materials Technology Report MTR#313-003, December 1976.

<sup>2</sup> H. B. Singer, "The Effect of TCP Treatment on the Low-speed Performance of Ball Bearings", MIT/ILE-2317, September 1968