Tribological Testing in High Pressure Anhydrous Ammonia

Background

The External Active Thermal Control System of the International Space Station utilizes anhydrous ammonia at high system pressure as the heat transfer medium. This fluid is circulated through interface heat exchangers that gather excess heat from the inhabited environment and transfer the heat to the liquid ammonia. The warm ammonia is then circulated through large radiator panels to reject heat through radiative heat transfer to the space environment. The ammonia is circulated by means of a centrifugal pump driven by a canned motor that utilizes hydrodynamic journal bearings for non-contacting rotor support. Health monitoring of this motor-pump combination is achieved through the analysis of electrical current supplied to the motor. The data acquisition rate is 1 hertz so no dynamic data analysis is possible. However, this current monitoring is capable of detecting incipient mechanical failure of the motor-pump due to the change in friction coefficient between hydrodynamic operation of the bearing and sliding friction of the rotor shaft against the static bearing sleeve. Therefore it is critical to the safe and effective operation of the ISS to understand the tribological characteristics (friction and wear coefficients) of the wear couple operating in high pressure anhydrous ammonia at high contact speeds.

Statement of Work

The contractor shall

1. Conduct wear testing on the carbon composite bearing material in a contractor owned 'Block on Ring' tribometer according to the following phases.
    a. Surface velocity = 6 meters per second, normal loads of 10, 20, and 50 Newtons, flooded liquid conditions at the rubbing interface of 40 F and pressure greater or equal to 80 psia
    b. Surface velocity = 9 meters per second, normal loads of 10, 20, and 50 Newtons, flooded liquid conditions at the rubbing interface of 40 F and pressure greater or equal to 80 psia
    c. Surface velocity = 6 meters per second, normal loads of 10, 20, and 50 Newtons, flooded liquid conditions at the rubbing interface of -30 F and pressure greater or equal to 15 psia
    d. Surface velocity = 1 meters per second, normal loads of 10, 20, and 50 Newtons, flooded liquid conditions at the rubbing interface of 40 F and pressure greater or equal to 80 psia
    e. (Optional phase pending funding availability)Surface velocity = 6 meters per second, normal loads of 10, 20, and 50 Newtons, flooded liquid conditions at the rubbing interface of 40 F and pressure greater or equal to 350 psia.

2. Deliver a data set at the completion of each test phase that includes:
   a. Wear coefficient [(cubic millimeter) / (Normal force* sliding distance)] for each test condition
   b. Time history of temperature, pressure, and contact force
   c. Material specimens used in the test.
3. Conduct wear testing on the carbon composite bearing material in a NASA owned 'Pin on Disc' tribometer according to the following conditions: Normal loads of 20 Newtons, rotational speeds of 700 and 1500 rpm, flooded fluid conditions of 0 F and pressures greater than or equal to 35 psia.

NASA shall

1. Loan to the contractor, the NASA Extreme Environment Tribometer (EET) and temperature control system for the execution of item 3 above.
2. Provide training to contractor personnel on the operation of the NASA EET.
3. Provide as-needed support at the contractor site for EET operation