THERMAL DESIGN OF THE TROPOSPHERIC EMISSION SPECTROMETER INSTRUMENT

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Abstract

The Tropospheric Emission Spectrometer (TES) is a cryogenic instrument which will be launched on NASA's Earth Observation System (EOS) Chemistry Platform in the year 2002. The overall mission lifetime for the instrument is 5 years with an additional period of 2 years required for ground test and calibration. The EOS Chemistry Platform will be placed in a sun-synchronous near-circular polar orbit with an inclination of 98.2 degrees and a mean altitude of 705 km. The overall objective of TES is the investigation and quantification of global climate change, both natural and anthropogenic. It is an infrared (2.4-15.4 μm), high resolution (0.025 cm^{-1}), imaging (1x16 pixels) Fourier Transform Spectrometer intended for the measurement and profiling of essentially all infrared-active molecules present in the Earth's lower atmosphere ($0\text{-}30^{+}$ km).

The thermal design provides four temperature zones required by the instrument, namely 65K, 180K, 230K and 300K. The detectors are cooled by pulse tube mechanical coolers to 65K and a two-stage passive cooler provides cooling for the interferometer optics at 180K. Detector pre-amplifier electronics requires 230K as well as the optics filter wheel actuator. The remaining electronics including the mechanical cooler compressor requires ambient temperatures near 300K.

The thermal control system (TCS) consists of passive and active elements to maintain the instrument within allowable flight temperature (AFT) limits. Passive thermal control includes multi-layer insulation blankets, thermal straps, and surface coatings to manage the transfer of waste energy from sources through structures and ultimately to radiators. Active thermal control employs constant conductance heat pipes (CCHPs), loop heat pipes (LHPs) and both open-loop and close-loop heater control systems. Operational and replacement heaters are used in the instrument operational science mode and survival heaters are used in the survival mode. LHPs are used to transport waste heat from components to the heat rejecting radiator surfaces. While in survival mode, the instrument is not operating and a limited amount of spacecraft power is available to maintain equipment temperatures within the allowable non-operating limits. In survival mode, the spacecraft attitude is such that the effective sink temperature for the radiator panels drops from -30°C to -100°C. To maintain equipment temperatures within non-operating cold limits, the LHPs are shutoff to prevent heat transport from the components to the cold radiator panels.

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