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PRACTICAL EVALUATION OF PTFE THERMAL BEHAVIOR USING THE HOT BLOWOUT THERMAL CYCLING TEST

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ABSTRACT

Differential thermal expansion between polytetrafluoroethylene (PTFE) gasket materials and metallic flange/bolt systems, combined with thermally influenced creep relaxation characteristics of all PTFEs, creates limitations in the ability of some PTFE gasket materials to provide long term, reliable sealing performance in process or thermal cycling applications. ASTM F-36 gasket recovery data is sometimes used to assess a gasket's thermal cycling capabilities; however, it is a poor means of establishing suitability for cycling performance as it is a short duration, ambient temperature test that measures recovery, or springback, of the gasket after the compressive load has been completely released. In order to provide a direct qualification of thermal cycling performance and capabilities, the Hot Blowout Thermal Cycling (HOBTC) test was developed under the guidance of the PVRC (Pressure Vessel Research Council)Bolted Flange Connection Committee as part of the 1995 PTFE Gasket Protocol. The HOBTC test results provide a practically applicable temperature limit under which the tested material, typically a PTFE, can operate safely. In addition, test data reported graphically provide additional insight about the long term behavior of the PTFE material. This paper reviews the current status of the HOBTC test, in the process of being made into an ASTM standard, and practical application of test results to achieve reliable gasket performance.

NOMENCLATURE

G_s Y-intercept of the unloading curves in a Room Temperature Tightness (ROTT) test
S_{glb1} Gasket lower bound stress at ambient temperature of the first cool down cycle
S_{glb2} Gasket lower bound stress at ambient temperature of the second cool down cycle
T_{gcd1} Temperature of the first thermal cycle
T_{gcd2} Temperature of the second thermal cycle
T_r Safe Reserve Operating Temperature

INTRODUCTION TO THE HOBTC TEST

Numerous research efforts over many years have demonstrated that the primary variable influencing a particular PTFE piping/pressure vessel gasket's behavior is temperature. PTFE gaskets do not age. In contrast to such materials as fiber/rubber bound sheets or flexible graphite materials, PTFE gaskets do not appreciably deteriorate with time due to oxidation or other failure modes. [1, 2] The manufacturing process used to form a particular PTFE significantly impacts the material's mechanical behavior; chemically similar PTFEs made with different processes can have radically different mechanical behavior. Therefore, a good understanding of how a PTFE material behaves as temperature fluctuates will provide the end-user with valuable insight to applying the material and the gasket manufacturer with information to improve the performance of their products. The Hot Blowout with Thermal Cycling (HOBTC) test provides such insight and information.

In the HOBTC test, gaskets are qualified for thermal cycling service for ASME class 150 and class 300 flange pressure