

Tgrease 880 Reliability Report

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Section: 1 Overview

<u>Purpose</u>: To test the **reliability** of Tgrease 880 as well as confirm that the thermal resistance of Tgrease 880 does not degrade as a result of thermal cycling, high temperature baking, or baking in a high humidity environment

Reliability is defined as:

- 1. The ability of an item to perform a *required function* under stated conditions for a specified period of time.
- 2. The probability that a functional unit will perform its required function for a specified interval under stated conditions.

The *required function* of Tgrease 880 is to transfer heat from a hot component to a heat-dissipating device. Its functionality is measured by testing its thermal resistance. The thermal resistance range that defines the functionality of the Tgrease 880 is 0.005° Cin²/W to 0.015° Cin²/W at 50psi as measured by modified ASTM D5470

Conditions:

Thermal bake @ 125°C for 1000 hours

Thermal bake @ 150°C for 798 hours (1000 hours to be completed)

Thermal cycling 130°C to -40°C for 250 cycles (1000 cycles to be completed)

Thermal cycling 23°C to 100°C for 1000 cycles

HAST @ 85°C and 85% relative humidity for 1000 hours

After each 250 hour/cycle interval, sample disks from each condition were evaluated for thermal resistance, and dry out of the grease between the disks.



Section: 2 Thermal Bake

- The bake samples were tested for thermal resistance (using a modified ASTM D5470) prior to baking and after baking.
- During testing and baking, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During baking, clamps were used to hold a constant pressure on the samples. See Appendix: Picture 1-4

Results:



The thermal bake results at 150°C show almost no change within the statistical limitations of the testing device, therefore it could be said that there is no difference between the resistance numbers measured during this testing.

The thermal bake results at 125°C show a small decrease in thermal resistance over time.

Dry out evaluation: For all intervals at both125°C and 150°C bakes, the squeeze out from in between the disks is soft and spreadable. The disks were slid apart by hand with medium effort. The grease was easily cleaned from the disks.



Section: 3 Thermal Cycle

TEST #1

- The cycling samples were tested for thermal resistance (using a modified ASTM D5470) prior to cycling then again at 250, 500, 750, and 1000 cycles.
- During testing and cycling, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During cycling (-40°C to 130°C in an environmental chamber) clamps were used to hold a constant pressure on the sample. See Appendix: Picture 1-4

Results:



The thermal cycling results from -40 C to 130 C show almost no change after the 1000 cycles within the statistical limitations of the testing device, therefore it could be said that there is no difference between the resistances measured after this point.

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<u>Test #2</u>

- The sample were thermally cycled using the PC Simulator.
- The sample was spread onto an aluminum heat sink at approximately 5 mils in thickness and approximately 17mm x 17mm in area.
- The PC Simulator consists of a copper platen base 14 by 14 mm heated with two 75-watt heaters that are powered by a variable power supply. On top of the base a fan cooled die cast aluminum heat sink, 60 mm by 60 mm, removes heat. Thermal interface material is placed between the copper base and the heat sink. Thermocouples are located in holes drilled just below the center of the surface of the copper base and heat sink. A data logger records temperatures, voltage, and power every 15 seconds, and calculates thermal resistance. A timer controls the heating and cooling functions. See Appendix: Picture 5

Test Condition: Room Temperature to 100°C cycle every 20 minutes

The thermal cycle unit power was adjusted to cause the copper base to reach 100°C. The tester was held in heating mode for 8 minutes, and cooled for 10 minutes. Temperature of the copper base remained slightly above 100°C for 2 minutes during each cycle. Pressure was maintained at 20psi.



Results:



The thermal cycling results from 23 C to 100°C show an overall decrease in the thermal resistance of Tgrease 880.

Visual observations/inspection:

There was no pump out or separation of the grease throughout the testing. The grease was soft and could be spread. It easily wiped away off the heat sink and copper heater after testing. See Appendix: Pictures 6 and 7.

Section: 4 HAST Thermal Bake

- The HAST samples were tested for thermal resistance using a modified ASTM D5470 at prior to HAST conditions and after HAST conditions were completed
- During testing and HAST conditions, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During HAST conditions (85°C and 85% relative humidity in a HAST chamber), clamps were used to hold a constant pressure on the sample. See Appendix: Picture 1-4

Results:

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Thermal Bake - HAST





The HAST results show almost no change after 1074 hours within the statistical limitations of the



testing device, therefore it could be said that there is no difference between the resistance numbers measured after this point.

Dry out evaluation: For all intervals

The squeeze out from in between the disks is soft putty and spreads however it is drier than that of the original material and the material from the 125 C and 150 C bake tests. The disks were slid

apart by hand with medium effort. The grease between the disks was soft and spreadable. It was easily cleaned from the disks.



Section: 5 Pump Out Resistance

Rheology testing was performed on Tgrease 880. This test was performed by an out side lab.

Both the elastic modulus (G') and plastic (viscous) modulus (G'') of the grease were measured using a rheometer to help predict if and or how much the grease would pump out during use. Frequency, time, and temperature sweeps were performed.

Results



In all tests the G' or the elastic component is the dominating factor in that it is much higher than G". This provides strong evidence that the grease will resist pump out. The G' increases during the time, temperature, and frequency sweeps adding further evidence that the grease has good resistance to pump out. Even though these tests provide strong evidence of resistance to pump, real in situ testing is always recommended for each application.



Section: 6 Conclusion

Tgrease 880 demonstrates consistent thermal performance after over 250 temperature cycles from -40°C to 130°C and 1000 cycles on the PC simulator, 1000 hours under HAST conditions of 85°C and 85% relative humidity and a 1000 hour bake at both 125°C and 150°C.

Neither thermal cycling nor thermal bake causes degradation of this product under the test conditions described.

Tgrease 880 does not dry out in any of the conditions tested. Tgrease 880 exhibits resistance to pump out as shown by the Pc simulator 1000 cycle testing.

Evaluating Tgrease 880 rheological characteristics predicts that the grease should remain in the interface, resisting pump-out providing long term reliability.



Appendix



Picture #1 Aluminum disk used for reliability testing



Picture #2 Aluminum disks clamped with grease between them



Appendix



Picture #3 Close-up of the aluminum disks in the thermal tester



Picture #4 ASTM D5470 thermal resistance tester





Picture 5 – Photograph of thermal cycling apparatus



Picture 6: PC simulator heat sink after 1000 cycles, room temperature (23°C) to 100°C Tgrease 880 has not hardened or dried out.





Picture 7: The PC Simulator copper heater: 1000 cycles, room temperature (23°C) to100°C Tgrease 880 has not hardened or dried out.