Thermal Treatments for Neo-Cortical Epilepsy

by

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Abstract

Thermal Treatments for Neo-Cortical Epilepsy (May 2007)

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Two experimental investigations were conducted on cooling applications for the use in the treatment of individuals with epilepsy. The first investigation sought to cool a subsection of a subdural electrode sheet used in presurgical evaluations of epileptic seizure patients. The second investigation was the refinement of a flat, bendable heat pipe for use as a heat spreader for dissipation of waste heat from a cortical implant to be used for arresting epilepsy induced seizures.

The main requirements for cooling of the subdural electrode sheet were to reduce the surface temperature of the brain from the nominal temperature of 37°C to 20°C, use water or saline solution as the working fluid, and preserve as much flexibility of the subdural electrode as possible. Three designs were investigated: the M-Shape configuration, the Manifold, and the Coil Configuration.

The M-shape cooling device provided good temperature uniformity, but had a slow cooling response time. The Manifold device had a fast response time, but poor temperature uniformity. The Coil configuration provided the best temperature uniformity with reasonable cooling response time. After validation of the test setup, it was determined that one of the reasons for the slow response time was due to the high thermal conductivity of the aluminum heating block used in the test facility.

Nevertheless, the Coil configuration demonstrated the most promise and satisfied all design requirements.

Development of the heat pipe was based on the requirements of transporting 5 watts of power with an associated temperature differential of less than 0.5°C. A copper heat pipe with a sintered copper powder wick structure had an overall geometry of 60 mm in length, 30 mm in width, and 0.6 mm in thickness. This heat pipe was tested against others as well as a solid copper plate.

Unlike traditional heat pipe testing with the evaporator located on one side and the condenser located on the opposite side, a new test fixture was designed that positioned the evaporator at the center and condenser to the periphery to simulate a two dimensional flow. The entire test fixture and samples were completely encased in Agar and both steady state power heating and pulse power heating at intervals of 10, 15, and 20 seconds were tested. The results indicate that the current geometries may be too optimistic and an increase in surface area and working fluid may be required to increase heat transport capacity as well as decrease the temperature differential across the heat pipe surface.