THERMO MECHANICAL DESIGN OF GA ECH LAUNCHER STEERING MIRROR FOR LONG-PULSE OPERATION*

C.B. Baxi, M.E. Friend, E.E. Reis, R. Prater, R.W. Callis, and R.A. Legg

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

GA ECH Launcher mirrors are used to transmit 800 kW of power. About 0.15% of the transmitted power is absorbed during transmission and is distributed on the surface of the mirror in a highly peaked distribution (Jo^2) with a peak to average ratio of 3.7. In addition, the losses increase with temperature (proportional to the square root of the resistivity). The mirrors are made from Glidcop. It is desirable to cool the mirrors passively by radiation heat transfer to the vessel surfaces in between pulses at a rep rate of 10 min. Till 2000, the pulse length was limited to 2 s due to high temperatures of the mirrors resulting from 1) a high ratcheted bulk temperature due to low emissivity (ε) of copper, and 2) a large increase in temperature at the center of the mirror during the pulse due to the small thickness of the mirror (limited due to electromagnetic forces).

A new design was proposed which extended the capability of the mirror to 10 s while still retaining the passive cooling. The important features of the new design were 1) increase the emissivity and radiating area and 2) a boss of about 2 cm diam and 1.7 cm height at the center of the mirror at back. Since the increased mass is at the center, there is a minimal increase the electromagnetic forces on the mirror, while providing an additional thickness for thermal diffusion at the location of highest heat flux.

The emissivity of the backside of the mirror was increased to about 0.9 from 0.15 by machining grooves and oxidizing the backside. Increase in emissivity was verified by an experimental measurement. In addition to the transmission losses, an additional heat load is imposed on the mirror by radiation from the plasma. This quantity was calculated from the temperature rise of the mirror during operation. A 3-D finite element analysis was performed to analyze the thermal performance of the mirror. The radial distribution of the losses and effect of temperature on the losses was taken into consideration in this analysis. The analysis shows that, the peak temperature of the mirror will be about 500°C after several 10 s pulses with 10 min cool down.

The new mirrors have been installed in DIII–D and have been used for the last few months. Temperature measurements done on the mirror in DIII–D confirm the design calculations.

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C.B. Baxi
General Atomics
P.O. Box 85608
San Diego, CA 92186-5608
(858) 455-3150
FAX (858) 455-2838
e-mail: baxi@fusion.gat.com

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