§19. Optimized Thermo-mechanical Design of High Intensity Neutron Source Test Cell for Material Irradiation

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Engineering Validation and Engineering Design Activities for the International Fusion Materials Irradiation Facility (IFMIF-EVEDA) is one of the broader approach activities. IFMIF-EVEDA includes three themes: prototype accelerator, lithium target and test cells. The activities, planned over a period of six years, are shared between the Team Project located at Rokkasho (Japan) and the System Groups distributed between Europe and Japan.

The applicants have been engaged in the design of the high neutron test module (HFTM) of IFMIF so far and examined the test module plan which enabled wide irradiation temperature setting and minute control. A small capsule heater of the high output density grasps a key to realize wide irradiation temperature in the IFMIF actual machine from past numerical analysis. The capsule heater to develop in this study heats the capsule which a specimen is enclosed in permitted narrow space effectively and must control it so that total temperature becomes uniform. The conceptual design of H-I capsule is shown in Fig. 1. The main condition required of a capsule heater for HFTM is as follows.

(1) Temperature range: precision within ±4% at setting temperature of 250-1000 °C,

(2) Start-up: ±10 °C of the irradiation temperature within 30 minutes, and

(3) Cool-down: cools off to temperature equal to or less than 200 °C within 60 minutes.

Figure 2 shows the model of capsule heater. The capsule is made of alumina. The wire of a heater which is embedded in the capsule is platinum line of a diameter of 0.5mm. The output of the heater becomes 20V /148W. In present study, the experiment has been performed under a vacuum, and the maximum temperature of capsule is aimed to 1,000°C.

An example of the temperature distribution measurement of the heater inside by the thermography is shown in Fig.3 and temperature distribution in the borderline of Fig.3 is drawn in Fig.4. The temperature distribution of the capsule is fit into less than ±4% of the setting temperature except the part of the heater edge and the aim of the equalization is achieved in all cases of different temperature level.

Following the preliminary experiment with the trial manufacture heater in this study, capsule heater which is made of aluminum and tungsten heater are applied to the task for HFTM in IFMIF-EVEDA.

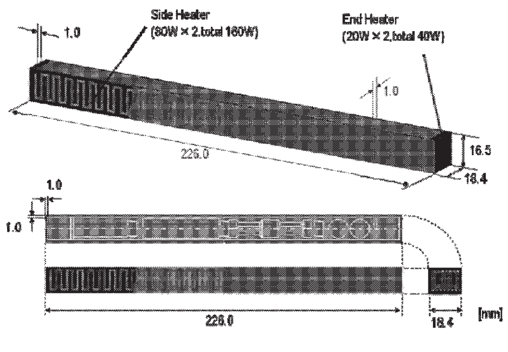

Fig.1 Conceptual design of heater-integrated capsule

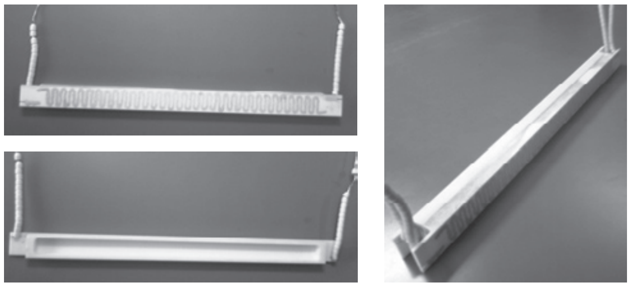

Fig.2 The model of capsule heater

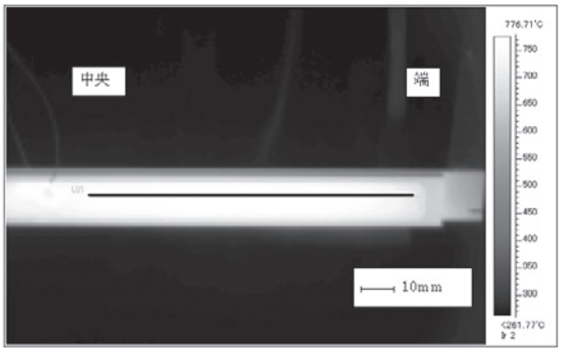

Fig.3 Temperature distribution of capsule rear side at maximum temperature of 755 °C

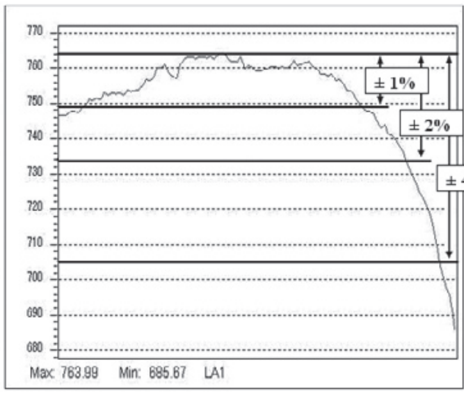

Fig.4 Temperature profile of capsule