Thermal Analysis of a Thick Ti Target for D-D Neutron Generation

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1. Introduction

A D-D neutron generator is being developed at Seoul National University [1,2]. Ti drive-in target is used for D-D neutron generation. Since the Ti target is irradiated by the energetic deuteron beam, efficient cooling is required. In this study, the thermal analysis of a thick Ti target was performed. The distribution of target temperature was obtained and the target stability was discussed.

2. Method and Result

2.1 Target System

Figure 1 shows the target system which is used for D-D neutron generator. The thickness of Ti is 1 mm. The coolant water is injected into the inner annulus and contacts the Ti. A cone-shape structure is located at the center position of the Ti in order to prevent jet impingement.

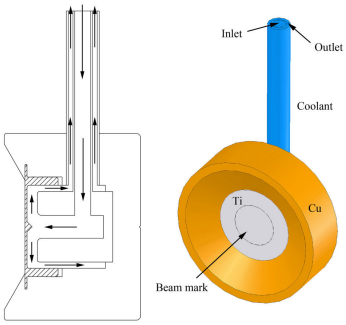

Figure 1. Schematic diagram of Ti bulk target system.

2.2 Thermal-hydraulics calculation

Computational fluid dynamics (CFD) code CFX-5 [3] was applied in this study and the geometry was meshed into tetras and prisms by using ICEM CFD [3]. Input parameters of CFX-5 code are shown in table 1.

Table 1. Input parameters of CFX-5 code.

Simulation type	Single-phase steady-state
Coolant temp. at the inlet	17 °C
Mass flow rate	0.183 kg/sec (11 lpm)
Heat flux at Ti wall	5.73×10^5 W/m^2 (65.6 keV, 4.5 mA)
Wall (except interfaces, heat flux wall, inlet, outlet)	No slip, adiabatic
Turbulence model	Shear stress transport
Advection scheme	High resolution
Convergence criteria	RMS residual (< 10^{-6})

Figure 2 shows the calculated results when the target is irradiated by 65.6 keV, 4.5 mA deuteron beam. The maximum temperature of the front area of the target is about 90 °C. The surface temperature rises slightly in Cu and Ti except heat flux wall boundary. The velocity of the coolant which contacts the target is about 2 m/s.

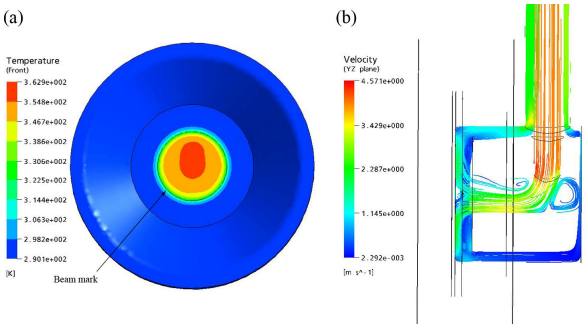

Figure 2. Results of CFX-5 calculation; (a): temperature distribution, (b): streamline velocity on YZ plane.

3. Conclusion

Thermal-hydraulic calculation about Ti target was performed by using CFX code. When 65.6 keV, 4.5 mA deuteron beam irradiated the target, the maximum temperature of the target is about 90 °C. From a temperature point of view, D-D neutron generator can run without a trouble on the target at this beam condition.

ACKNOWLEDGEMENTS

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