Improvements on Cyclotron Gas Target Cooling System Using COMSOL Multiphysics® Software

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Abstract

Medical Cyclotrons are used in hospitals to manufacture radiopharmaceuticals. The nuclear reaction between the Cyclotron charged particles and a material takes place inside the so-called targets. In particular, gas target is used when a specific gas is bombarded with proton particles to produce radioactive gas [1]. For successful reaction and good production yield, heat generated due to bombardment of protons and gas must be removed. The process of heat transfer between the gas and the inner surface of target body is simulated using COMSOL Multiphysics® software[2].

The existing gas target system uses deionized water as a cooling method for removing heat from target body. The latter is made from Aluminum (Al). The temperature of water is 18oC at flow rate of 3 L/min. Although the gas target produces sufficient production yield, yet, improvement on cooling parameters will lead to increase heat removing and consequently, increasing production yield.

In order to study the impact of varying water temperature and its flow rate on gas temperature, a conjugate heat transfer module was used in this study. A 3D model was designed and imported into the COMSOL software environment. The heat source was calculated from alternative software called SRIM that can calculate the stopping power (MeV/cm2) induced by cyclotron protons inside the gas [3 and 4]. Data was imported and interpolated into COMSOL.

A significant improvement was seen on cooling temperature of the gas and on the target body as the water temperature was decreased gradually. Results are reported in this work.

Reference

[1]P.W. Wojciechowski, et. al. "A Semi-Quantitative Approach to the Design, Analysis and Operation of a Gas Target System," Radionuclide and Cyclotron Operations Department, King Faisal Specialist Hospital and Research Centre, 1987.

[2] www.comsol.com

[3] M.A. Avila-Rodriguez, et.al."3D Modeling and Simulation of the Thermal Performance of Solid Cyclotron Targets", Excerpt from the Proceedings of the COMSOL Conference, 2007.

[4] SRIM Enterprises LLC, www.srim.com

Figures used in the abstract

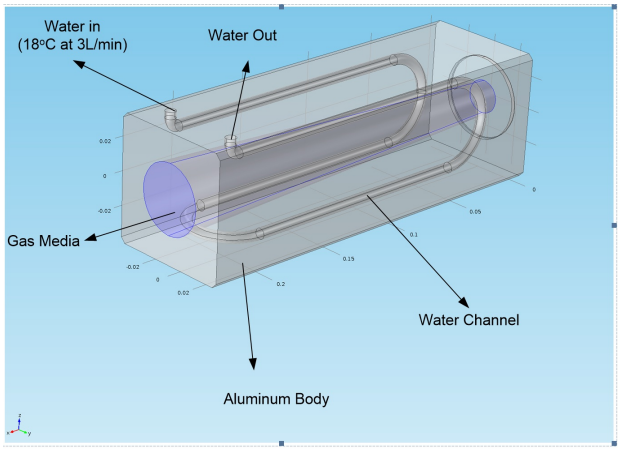

Figure 1: 3D model of gas target

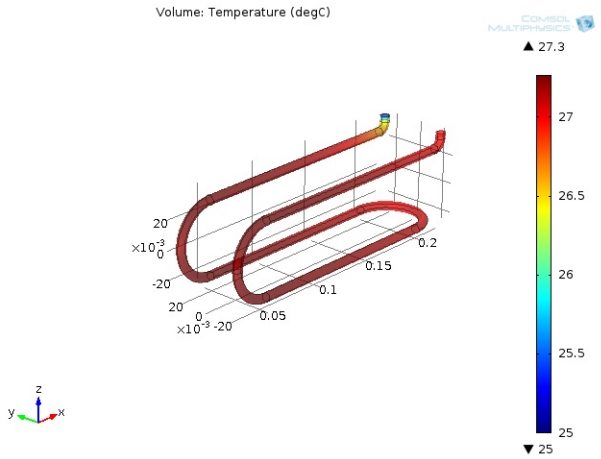

Figure 2: Plot of the simulated cooling pipe

Water temp. at const. flow rate of 2 L/min	Body Temp(°C) .	Pipe Temp (°C) .
25	25.03	25.01
20	22.07	22.02
15	15.03	15.01
10	10.034	10.01
5	5.01	5.002
1	1.01	1.002

Figure 3