Thermal Simulation For 35kW Powered Prototype Radio Frequency Quadrapole

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Abstract

As part of the accelerator augmentation program at IUAC, a high current injector (HCI) is being developed to inject highly charged ions into the superconducting LINAC. The HCI consists of a superconducting (High T_C) ECR source operated on a high voltage deck, producing the high currents of highly charged ions. The ion beams produced by the ECR (PKDELIS) source will be injected into a **Radio Frequency Quadrupole accelerator (RFQ)** and be accelerated to 180 keV/u. RF power of about 100 kW at 48.5 MHz will be fed to the RFQ during it's actual working. Most of the power fed is dissipated in the system as heat. So a continuous removal of this heat is necessary to maintain tuning parameters and normal running of the RFQ. The IUAC RFQ is a four rod cavity structure consisting of individual, demountable vanes on vane posts. All the components are made of copper except the high vacuum chamber. High vacuum chamber is made of stainless steel and electroplated with 100 microns copper on the inner surface. To take out the heat from the system cooling holes for water circulation are provided in the design of the vanes and vane posts, which together form cooling circuits. There are fourteen vanes in three different lengths and these are mounted on five vane posts. Water enters and exits from the vane posts base. From each post it enters into two or three circuits in parallel and exits into the next vane post and the flow combines again. In effect five cooling circuits are further divided into fourteen circuits. Thermal design of the system is analyzed and optimized using a computational fluid dynamics (CFD) software. The CFD software simultaneously solves the equations of mass, momentum and energy with the given structure, material, fluid and applied boundary conditions . An actual 3- dimensional model of the assembly was made using Solidworks modelling software. To save on simulation time, small holes and minor components were suppressed during analysis. The software used for thermal simulation is Solidworks Flow Simulation. The distribution of total heat load among different components of the assembly was obtained through CST Microwave Studio software. Thermal simulation of a 35 kW powered Prototype RFQ is described in the paper. The RFQ assembly has been tested upto 18 kW power and comparison of the simulated results is presented in the paper.

Power	**Simulation [18 kW]**	**Actual Test [18]**	**Simulation [35 kW]**
	Temp (^oC) Avg. / Max.	Temp (^oC) measured.	Temp (^oC) Avg. / Max.
Vanes	33/37	--	44/52
Vane Posts	38/49	40	53/72
Base Plate	48/53	40	71/82
Chamber	51/73	60	64/98
Fluid In /Out	20/27	20/24	20/35