DESIGN OF CSNS R DUMP WINDOW

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Abstract

The China Spallation Neutron Source (CSNS) accelerator systems will provide a 1.6 Gev proton beam to a target for neutron production. The extraction dump is used to incept the waste beam in the Ring-Target transport line. At the end of the beam pipe, we adopt a thin window to ensure the accelerator vacuum. When beam gets across the window, temperature of the window will be elevator because of the energy deposit. So, the study on structure and thermal stress analysis is necessary. This article expatiates the way on calculating the energy deposit and thermal stress analyses.

INTRODUCTION

The vacuum window of beam dump separates the inner of beam pipe from air, R-dump in CSNS is designed to incept the waste H+ which energy is 1.6 Gev, and the beam power is 7500 watt. There will be a part of beam energy deposits in the vacuum window when the beam through the window, this deposit energy will make the temperature up and affect the stress of vacuum window. So, it is necessary to study the structure and thermal stress analyses of the vacuum window.

STRUCTURE DESIGN

The distribution of the beam which through the vacuum window is gauss distributing, and the beam diameter is 0.2 meter. Because of one side face of the window is vacuum and air on the other side, we choose sphere as the centre structure of the window to improve the stress. Fig.1 is the structure of the vacuum window; it is a very important work to make sure the parameter *A*. The material of the window is stainless steel 304; the parameters are listed in Table 1.

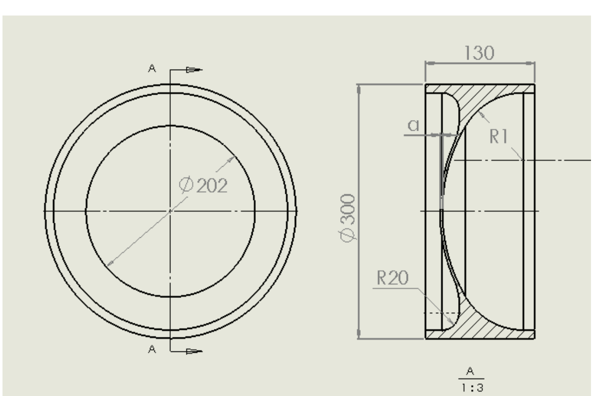

Figure 1: The structure of vacuum window.

Table 1: The material parameters

Material	Stainless steel	Air
Density(kg/m^3)	8000	1.2
Specific heat(J/(kg*K))	500	1.4
Conductivity(W/(m*K))	16	0.03
ALPX(/K)	1.8e-5	
EX(N/m^2)	1.9e11	
PRXY	0.29	

THERMAL STRESS ANALYSIS

Calculation of the Deposit Energy

Because the beam energy is too high to through the window, we adopt SRIM to find that the relation between deposit energy and depth that beam rip into the window is linear approximatively within 0.335 meter; table 2 is the parameters, and the average deposit energy is *W*=5.61w/mm.

Table 2: The relation between deposit energy and depth

Fe 304	Depth (mm)	82	167	252	335
	Deposit energy (Mev)	100	200	300	400

The diameter of the beam is 0.2 m, we can get the energy distribution function.

$$G = 820305 * \exp[-(x^2 + y^2)/0.0022]$$

Thermal Stress Analysis

We adopt ANSYS to analyze the thermal stress of the vacuum window; we regulate the range of parameter *A* between 0.5 mm and 3 mm, the results are listed in Table 3. According to those results, we can see that the temperature of window will be up when the parameter *A* augments, but the stress will be lowest when the parameter *A* is 0.9 mm. So, we believe that 0.9mm is the best value for parameter *A*. Fig.2 and Fig.3 are the transformation trend lines.

Table 3: Results of thermal stress analysis

material	Parameter A （mm）	The most stress value (MPa)	The highest temperature (K)
Fe 304	3	46	362
	2	37	354
	1	29	342
	0.9	26.4	340
	0.8	28	338
	0.5	31	331

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When the parameter *A* is 0.9 mm, the temperature distribution of the vacuum window is shown in Fig.4, and the thermal stress distribution is shown in Fig.5.

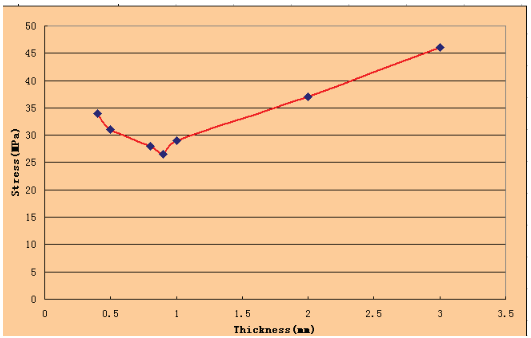

Figure 2: The trend line for thickness and stress.

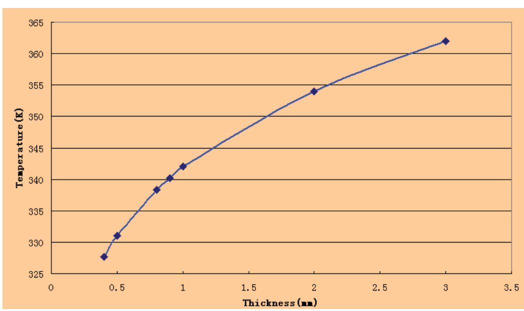

Figure 3: The trend line for thickness and temperature.

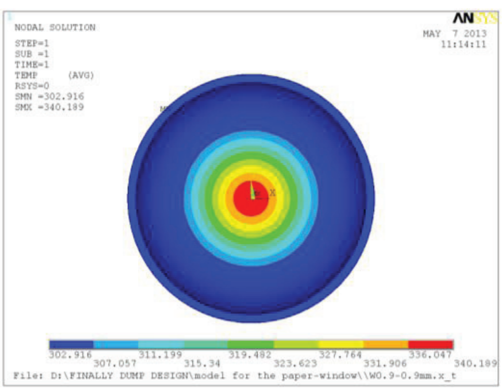

Figure 4: The temperature distribution.

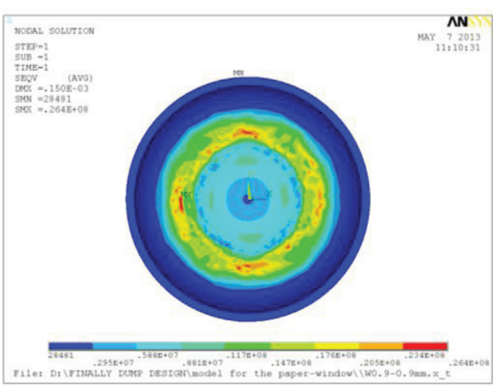

Figure 5: The thermal stress distribution.

CONCLUSION

This article studies on the structure and thermal stress analysis of CSNS-R beam dump vacuum window. Due to the beam energy is 1.6 Gev and the thickness of the window is thinner, we think the distribution of the deposit energy in the window along with depth is average. The window is thicker, the stress is better, but the deposit energy is more, vice versa. So, under the condition that the beam diameter is 0.2 meter, we make sure the value of the parameter A, here, the highest temperature of the vacuum window is about 340 K, and the most stress is 26.4 MPa, the values are those we hope to get.

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