6 - 7 Helium Recovery and Purification System

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In the early stage of the construction for the Accelerator Driven Sub-critical (ADS) program, there are a series of tests for superconducting cavity (RFQ + HWR). And each of test consumes about 3000 L liquid helium or even more. So a new cryogenic helium recovery and purification system has been built by Institute of Modern Physics (IMP) to reduce the waste of helium, shown in Fig. 1. It contains recovery part, storage part, purification part. The recovery part includes high and low pressure pipes, low pressure buffer balloon, 3 diaphragm compressors with capacity of 40 m/h, and other equipment. The storage part includes 5000 m^3 dirty helium tanks, 3000 m^3 higher purity helium tank, 500 m^3 gasbags and other equipment. The helium purification equipment consists of degreasers, dryers, helium purity analyzer and so on[1]. The maximum Helium recovery rate of the system is designed to 100 m^3/h, and the helium purity can be improved to 99.999%.

Helium evaporated from experimental equipment passes from the heater where gas is heated from 10 to 300 K then flows to the gas bag for a ordinary pressure required as the inlet presser of diaphragm compressor. After improved to 150×10^{-4} Pa the helium is pulled by compressor into demister and dryer then to the higher pressure purification system. The high purity helium is stored in the 3000 m^3 tank preparing to be liquid.

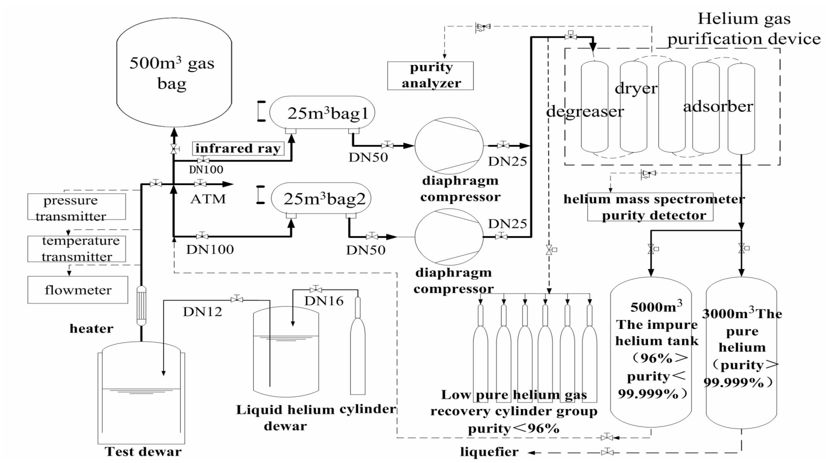

Fig. 1 Flow charts of helium recovery and purification system.

Table 1 Leave-factory check and acceptance dates of helium purification device

Time	Inlet pressure (MPa)	H_2O (vpm)	N_2 (vpm)	CxHy (vpm)	Inlet purity (%)	Outlet purity (%)
14:38	11.5	2.4	2.1	0.4	96.57	99.9994
14:39	10.5	2.4	1.8	0.4	96.52	99.9994
14:40	10.0	2.3	2.0	0.4	96.53	99.9994
14:41	9.6	2.3	2.2	0.4	96.53	99.9994
14:42	9.2	2.2	2.2	0.4	96.53	99.9994
14:43	9.0	2.2	2.3	0.4	96.54	99.9994
14:44	8.6	2.2	2.2	0.4	96.54	99.994
14:45	8.2	2.1	2.1	0.4	96.54	99.9994
14:46	8.0	2.1	2.0	0.4	96.54	99.9994
14:47	7.7	2.1	2.0	0.4	96.54	99.9994

Now most of the Recovery and Purification equipment are installed. The Helium purification device is the most important equipment in the system. Gas from the recovery system at a lower purity about 98% is pulled into purification device, where most of nitrogen, oxygen, carbon dioxide and other gas are absorbed by activated carbon in liquid nitrogen[2], and the purity can be improved to 99.999% here. Table 1 is the experimental dates when the helium purification device was leave-factory checked and accepted.. It shows when the inlet purity is about 96.5%, the outlet purity can get to 99.999%.

References

[1] Li Zhun, Wang Hongjun, Wang Zezhang, et al., Cryogenics & Superconductivity, 10(2012).
[2] Wan Xiaogang, Fu Jian, Zhao Linhua, Research on Application of Aerostat Helium Purification Method, 39, 4(2011).

6 - 8 Thermoanalysis of Thermal Shield in Test Cryomodule Project

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The test cryomodule is used to improve the experimental environment for superconducting equipments, which is the important part in linear accelerator system. In the cryomodule project, there has a thermal shield which is used to decrease the consumption of liquid helium. The thermal shield can reduce the radiation heat between room temperature and superconducting low temperature, and reduce the heat conduction of pipe system. It consists of copper wall and pipe, stainless steel support and rod. Because of low temperature and easy to be obtaied, liquid nitrogen is used to cool down thermal shield in the test cryomodule. For optimal test cryomodule design, it's necessary to analysis the distribution of temperature in thermal shield.

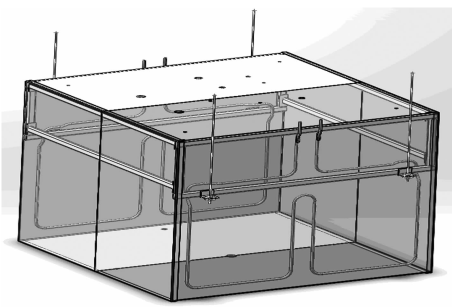

Fig. 1 The structure of thermal shield.

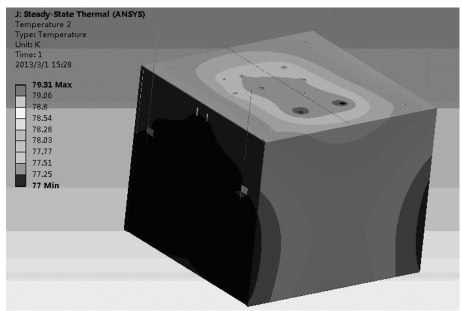

Fig. 2 The temperature distribution on the surface.

It adopts the thermal analysis software-ansys to get the result. The basic structure diagram of thermal shield shown in Figs. 1 and 2 reveals the temperature distribution. According to the overall design of the cryomodule, the initial conditions of thermal shield model include: the radiant heat flux between room temperature and the surface temperature of thermal shield 1.5 W/m^2, the intercepts of the pipe system in the cryomodule produce heat to the model, as well as the cooling circuit temperature is set 77 K. It can get the temperature difference on the model less than 5 K from Fig. 2, and in general, the temperature distribution is evenly. Based on the result, the structure design can meet cryomodule requirement in theory.

Reference

[1] Wang Li, Tang Hongming, Journal of Huazhong University of Science and Technology (Nature Science), 35, 2(2007).