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RHIC PROJECT

Brookhaven National Laboratory

Performance Requirement for the RHIC Circulating Compressors

K. C. Wu

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PERFORMANCE REQUIREMENT FOR THE RHIC CIRCULATING COMPRESSORS

K. C. WU

RHIC Project, Brookhaven National Laboratory
Upton, New York 11973-5000

INTRODUCTION

The RHIC 24.8 kilowatt helium refrigerator was originally designed to provide cooling for ISABELLE. It has a cold compressor capable of circulating 4000 g/s, gram per second, of single phase cold helium for the 24 parallel cooling passages in ISABELLE.[1]

The RHIC cryogenic distribution system has three cold helium pipes inside every magnet cryogstat and a total of 72 recooler heat exchangers in the CQS cryostat. The cold helium stream through the magnet can be recooled after passing through each recooler. The flow rate for the RHIC circulating compressor is small since the cooling loop for the magnet is connected in series. Two circulating compressors will be used for the two cooling loops in RHIC and these compressors will be located in the six o'clock valve boxes. With the latest pressure drop estimation as of January 1993, this report describes the requirement for the circulating compressors.

FLOW RATE AND PRESSURE DROPS

The flow requirement for the cooling system was obtained from the heat load and the allowance of temperature increase between recooler heat exchangers. In RHIC, the nominal flow rate for single phase helium is 100 g/s. A high flow condition of 150 g/s is needed in case actual heat load exceeds the design value. The corresponding pressure drops at steady state condition are 0.42 and 0.88 atm, atmospheres, for 100 and 150 g/s respectively.[2]

It should be noted that the above pressure drops are obtained from straight forward calculation and there is no safety margin incorporated. Safety factors of 1.5 and 2.0 are introduced in the compressor requirements given below.

PERFORMANCE REQUIREMENTS

The base line design conditions for the circulating compressor is given in Table 1.

Table 1. The based line design condition for the circulating compressor

	Baseline	1.5 Margin	2.0 Margin
Adiabatic Efficiency (%)	0.60	0.60	0.60
Flow Rate (gm/sec)	100	100	100
Input Work (watts)	54	82	110
Inlet			
Pressure (atm)	4.58	4.37	4.16
Temperature (K)	4.80	4.80	4.80
Density (gm/cc)	0.131	0.130	0.129
Volume flow (liter/sec)	0.76	0.77	0.77
Outlet			
Pressure (atm)	5.00	5.00	5.00
Temperature (K)	4.889	4.934	4.981
Pressure rise (atm)	0.42	0.63	0.84

The high flow conditions for the circulating compressors are given in Table 2.

Table 2. The high flow conditions for the circulating compressor

Adiabatic Efficiency (%)	0.60	0.60	0.60
Flow Rate (gm/sec)	150	150	150
Input Work (watts)	173	263	354
Inlet			
Pressure (atm)	4.12	3.68	3.24
Temperature (K)	4.80	4.80	4.80
Density (gm/cc)	0.129	0.127	0.125
Volume flow (liter/sec)	1.16	1.18	1.20
Outlet			
Pressure (atm)	5.00	5.00	5.00
Temperature (K)	4.988	5.084	5.182
Pressure rise (atm)	0.88	1.32	1.76

REFERENCES

1. D.P. Brown, A. P. Schlafke, K. C. Wu and R. W. Moore, Cycle Design for the ISABELLE Helium Refrigerator, in "Advances in Cryogenic Engineering", Vol.27, p509, Plenum Press, New York, 1982.

2. A. Nicolletti, private communication.