

Research Article

Effect of Compressor Outlet Pressure on Liquefaction and Refrigeration Capacity

Nishigandha Patel^{†*}, Supriya Gambhire[†], Chetan Waykole[†] and Mangesh Saraf[†]

[†]Mechanical Department, MITCOE, Pune, India

Accepted 02 March 2016, Available online 15 March 2016, **Special Issue-4 (March 2016)**

Abstract

The main components of a helium liquefier which determines the performance of the HRL for a given compressor flow rate are Turbine, Heat exchanger and JT valve. Turbine and JT valve produces cooling effect of helium gas by isentropic and isenthalpic expansion process respectively. Different components can be made to have different thermodynamic cycle configuration. For each configuration main components can have different operating process parameters leading to different performance of HRL. This project involves the analysis and optimization of these process parameters for a given configuration. This analysis and optimization work will also involve different practical factors and in efficiencies of main components.

Keywords: Liquefaction, Helium, process parameters, Optimization, Turbine, heat exchanger.

1. Introduction

Helium liquefier as the name suggest is used for the liquefaction process of Helium gas. The cold box shown below is used for the cool down and liquefaction purpose of Helium gas coming out of the Tokomak. Cold box contains total 8 heat exchangers and 3 turbines which expand isentropically and one JT valve which expands isenthalpically. Process parameters of heat exchanger are effectiveness or UA, mass flow rate, Temperatures and for turbine are temperatures, mass flow rate, inlet outlet pressure; efficiency has to be optimized to get maximum liquefaction of LHe with minimum refrigeration load.

Normally JT valve is kept at the lowest temperature followed by the performance of other components and hence optimization of its process parameter is not considered here. One of the optimum cycle configurations is provided here that gives the higher cooling effect with a lower capital investment and operating cost of different HRL components. This configuration has three turbines and eight heat exchangers which produces liquid helium at 4.5 K. 1st and 2nd turbines operates at warmer temperature compared to 3rd turbine which has process flow paths connected in series. Helium stream coming out of the 1st turbine passes to the heat exchanger which will reduce its temperature before entering the 2nd turbine. Helium mass flow rate supplied by the compressor system is 140 g/s at pressure of 14 bars and 310 k temperature. A part of this mass flow rate passes

through a 1st and 2nd turbine for isentropic expansion and then this low pressure helium stream comes back to compressor suction through different heat exchangers to transfer cooling effect to the hot stream coming from the compressor. 3rd turbine will expand the remaining part of the main helium stream will further passes through a heat exchanger before entering the JT valve for liquid helium production.

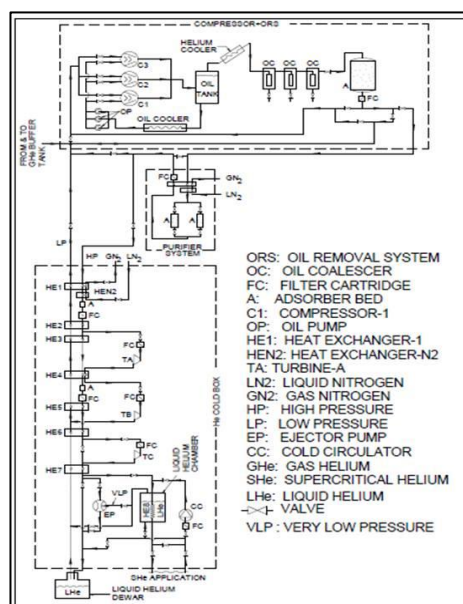


Figure 1.1 Typical Schematic of the cold box along with the warm and cold end components for Helium plant of Tokamak

*Corresponding author: Nishigandha Patel

