Chilling unit (CU) specifications- cascade refrigeration system

Introduction

A chilling unit needs to be made for conditioning the nitrogen gas at the lower temperatures (up to -40°C) in two stages of compression involving usage of two refrigerants. The cold nitrogen gas will be the input to the window burner setup to conduct the experiments. The design of the CU shall be compact.

Product Description and Operating Principle

The CU comprises compressor, plate heat exchanger (PHE 2 no's), air-cooled condenser, drier, LSV, LP, HP, auto controls. The CU will work in two stages, as the desired temperature for the nitrogen gas is too low. Two compressors must be incorporated for cooling the nitrogen gas utilizing two refrigerant, R404A in 1st stage of compression and R23 for 2nd stage of compression to bring the nitrogen gas temperature form 30°C to -50°C. Air-cooled condenser must have copper tubes and aluminium fins.

The cascade refrigeration system is a freezing system that uses two kinds of refrigerants having different boiling points, which run through their own independent freezing cycle and are joined by a heat exchanger.

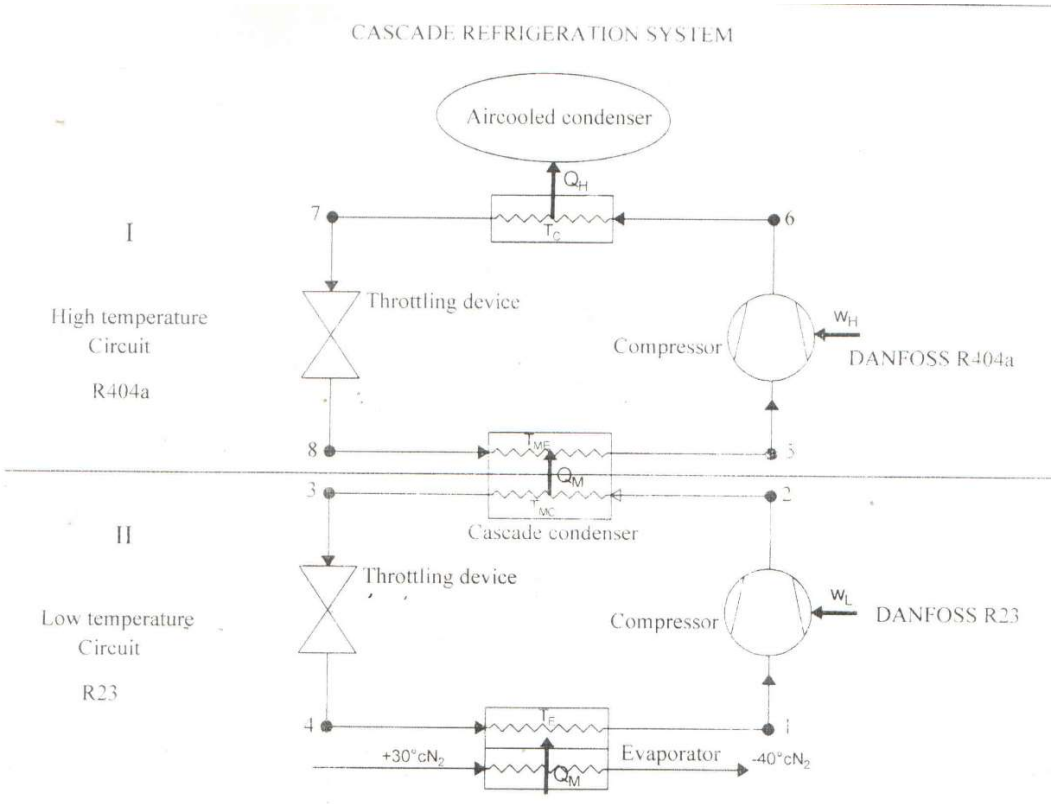

Figure 1: Typical cascade refrigeration system schematic.

The absorption of the amount of heat necessary for the change of state from a liquid to a vapor by evaporation, and the release of that amount of heat necessary for the change of state from a vapor back

to the liquid by condensation are the main principles of the refrigeration process, or cycle. Once the CU is toggled on, R404A refrigerant in the 1st stage of compression will remove the heat from the R23 refrigerant from the 2nd stage as R23 absorbs heat from the inflow nitrogen at 30℃. The main refrigerant (R23) is precooled prior to being introduced into the main exchanger. The main refrigerant (R23 in low temperature circuit) is pre-cooled during the 1st stage of compression using the precooling refrigerant (R404A in high temperature circuit). This reduces the main refrigerant circulation rate and main exchanger size. The main refrigerant at temperature of –50°C (after thermal expansion) is passed to PHE along with the nitrogen gas at 30°C to bring the temperature of the nitrogen gas to -40°C. The desired temperature of the nitrogen shall be set and monitored using the digital controller and the flow rate of the refrigerant should be regulated using the feedback loop control so as maintain the desired temperature of the nitrogen gas. Nitrogen gas temperature also to be displayed. The cooled nitrogen gas will be supplied to the window burner chamber to conduct the experiments. The suitable piping arrangement shall be provided so as to connect the nitrogen outflow from the PHE to the inlet of the window burner which has quarter inch connections. Flow control valves shall be provided to regulate the flow rates up to 20 lpm.

Specifications

- The heat exchanger (HX) should be suitable for the working pressures up to 30 bar nitrogen with proper safety relief valve to avoid any accidents.
- Other safety devices as required to be installed with manual or electrical warning indicators- like high oil temperature, oil level
- Plate type HX should be used in the CU.
- The CU must be capable to provide the cooling load up to 1.34TR.
- Incoming nitrogen gas from the cylinder at room temperature (30℃) to the HX should be brought to -40℃ ± 5℃ at 20 lpm.
- Provision to control the flow rate should be provided in the CU.
- To have proper hold on the effective cooling of the nitrogen gas, controls should be provided to monitor the gas temperature with proper feedback to regulate cooling when and as required (using PID along with thermocouple).
- R404A and R23 refirgerant must be used in CU.
- The maintenance should be minimal.
- The size of the CU shall not be more than 6 ft x 3 ft x 3.5 ft.
- Port connection to the window burner is quarter inch, usage of appropriate reducer from HX to window burner must be supplied.

Figure 2: HX for the reference.

Terms and Conditions

- Vendor should adhere to all the specifications mentioned above.
- Technical certificates, specifications are needed for all the components used.
- System integration and proving of proper functioning of the equipment should be provided at location of installation of the system (IIT Madras).
- On-site warranty service for the duration of the warranty period. Warranty period should be for 1 year.
- Vendor should provide continuous technical support and maintenance of work done.
- Vendor must have previous work experience in the field of HVAC. Vendor must submit references of at least 3 HVAC installations with contact details of the buyer.
- Vendor should follow all safety standards.
- Any maintenance must be addressed within 3-4 working days.
- Delivery within the specified duration as mentioned in the quotation.
- For any clarification please contact Mr. Rajendra Rajak (raj11.11.87@gmail.com, 044 2257 5033).