**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI**

**COLLEGE OF ENGINEERING**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**ME 396-MECHANICAL ENGINEERING LABORATORY III**

**A REPORT ON REFRIGERATION**

**BY GROUP J1**

**NAMES:**

**BAAH BISMARK-4837610**

**BANS-AKUTEY ASIWOME-4837710**

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**TITLE:** DOMESTIC REFRIGERATION

**OBJECTIVE**

Select measuring points needed for testing refrigeration equipment

Run cooling and heating cycle tests

**INTRODUCTION**

Refrigeration technology is the art of cooling matter below the temperature of the environment by applying energy in order to reverse the normal path of heat transfer for the removal of heat from a cold medium and reject it to a hotter environment. Refrigeration is essential in the production of beverages such as concentrated fruit juice, beer and wine. The taste of many can be improved by serving them cold. Industrial refrigeration may be divided into three main groups; chemical and process industry, food production and distribution, and special applications of refrigeration.

**THEORY**

COOLING AND HEATING CAPACITY:

The amount of heat transfer a system is capable of producing. It is measured in Joule/sec=Watt or Btu/hr.

HEAT AND TEMPERATURE OF DRY AIR

∆Ha =maCa(T2 -T1)

∆Ha–kJ heat content of air

+ Sign for heating

-Sign for cooling

ma–kg mass of air

Ca–kJ/ (kg°C) specific heat of air

T1-°C temperature at the beginning of process

T1-°C temperature at the end process

HEAT AND TEMPERATURE OF MOIST AIR

∆Hw=mw(Cw(T2 -T1) +hfg)

∆Hw–kJ heat content of water

+ Sign for heating

-Sign for cooling

mw–kg mass of air

Cw–kJ/ (kg°C) specific heat of water

T1 -°C temperature at the beginning of process

T1 -°C temperature at the end process

hfg-kJ/ kg latent heat of phase change

HEAT CONTENT AND TRANSFER RATE

Q=∆H/t

Q –kW heat transfer rate (power)

∆H –kJ heat content

t –sec time

q=∆h/t

q –kW/kg specific heat transfer rate

∆h –kJ/kg specific enthalpy difference between the beginning and end of the process

HEAT TRANSFER RATE (DRY AIR)

Qair= mairCa  (Ta2-Ta1)

Qair –kW heat transfer rate

Mair-kg/sec mass flow rate

Ca -kJ/ (kg°C) specific heat of air

Ta1 -°C temperature at the beginning of the process

Ta2 ­-°C temperature at the end of the process

HEAT TRANSFER RATE (REFRIGERANT)

Qref= mref (hr2-hr1)

Qref –kW heat transfer rate

mref-kg/sec mass flow rate

hr1 -kJ/kg enthalpy at the beginning of the process

hr2­-kJ/kg enthalpy at the end of the process

HEAT BALANCE: AIR-REFRIGERANT

Qref =Qair

**APPARATUS**

Dar-2100 Basic Refrigeration Test Module

Logarithmic P-h chart for HFC-134a refrigerant

Writing pad

Pencil and ruler

Stopwatch

**SAFETY AND PRECAUTIONARY MEASURES**

1. Verify that the test module DAR-2100 is installed on the basic module DAR-2001. If not change to module DAR-2100 according to the instructions in the installation/installation manual

2. Check connection of system communication cable to computer printer port LPT1. Connect if not attached.

3. Connect the test system to the power line and sat the main switch to the “ON” position.

4. Press the green START button on the basic module to the start the system.

5. Ensure that no liquid comes in into the working area and especially in contact with the electrical parts of the system.

**PROCEDURE**

1. Activate the SETUP button in the upper right corner of the control panel.

2. Click the SYSTEM OFF button in the window to start.

3. Activate the T.E.V and RT. CONTROL buttons

4. Click the CLOSE button of the window. The system starts operation.

5. Activate the CONTROL button in the control panel. This opens a new window.

6. Click the number at the right bottom of the room thermostat (RT) set point (SP) column and reset it to -15°C.

7. Click the CLOSE button of the window to return to control panel.

8. Activate the LOAD…Watts’s button in the evaporator field by clicking on the number. This opens a dialog box.

9. Set the load in the dialog box to 20 Watts and check entry. Press LOAD to activate the heating coil. Close the dialog box.

10. Verify that the heater coil in the evaporator field glows red. Repeat steps 5-7 necessary.

11. The refrigeration system is now in steady state operation. Gauges on the control panel indicate pressure and temperature.

12. Elements on the control panel colored green are active and the colored yellow are inactive.

13. Enlarge the screen.

14. Wait about 15 minutes until test data becomes steady and then start reading the gauges every 10 minutes.

15. Record your readings.

16. Readings are normally carried out until equilibrium is reached (i.e. after the last two consecutive readings are nearly equal)

17. Calculate the absolute pressure (PABS= TGAGE + 1)

18. Find the saturated temperature corresponding to pressure.

REFRIGERATION CYCLE TEST WITH THE CAPILLARY TUBE

1. 1.Activate the SETUP button on the right side of the control panel.

2. Activate the CAPILLARY button and verify that RT. CONTROL button is still on.

3. Click the CLOSE button of the setup window to return to the control panel.

4. Take two readings and wait 5 minutes between readings.

5. Prepare the test unit for shutdown and possible module changeover at the beginning of the next exercise.

6. Activate the SETUP button on the right side of the control panel.

7. Click the MODULE CHANGE button. The systems prepares automatically for module changeover or shutdown.

**DATA**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Time/s | T1 | P1 | T2 | P2 | T3 | P3 | T4 | P4 |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Time/s | T1 | P1 | T2 | P2 | T3 | P3 | T4 | P4 |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |

COOLING CYCLE TEST

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Time/s | T1 | P1 | T2 | P2 | T3 | P3 | T4 | P4 |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No. | Time/s | T1 | P1 | T2 | P2 | T3 | P3 | T4 | P4 |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |

**ANALYSIS AND CONCLUSION**

The pressure reading on the gages of the test unit and on the control panel are gage pressure. Thermodynamic tables and charts use absolute pressure for listing the state condition. Therefore gauge pressure of the test reading has to be converted to absolute pressure by Pabs=Pgage + 1. After the absolute pressure is established, the refrigeration cycle is drawn in the P-h chart of the refrigerant. This allows us to examine the appropriate location of the test points. The enthalpy readings are used to find relationship between the heat absorbed in the evaporator, the heat rejected in the condenser and the work input to the compressor.

**REFERENCE**

Tech. Prep. Lab. (DAGEM SYSTEMS, Air-conditioning and refrigeration department)

YUNUS A. CENGEL 1998 Heat Transfer: A Practical Approach International Edition, McGraw Hill