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Simulation of VCR System Using DAQ

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ABSTRACT: The simulation of vapour compression refrigeration systems using data acquisition in LabVIEW describes a study that aims to develop a virtual platform for the analysis and design of refrigeration systems. The study involves the simulation of a vapour compression refrigeration system using the LabVIEW software and the acquisition of experimental data through a data acquisition device. The simulation model considers values of temperature and pressure while experimentation on water cooler test rig. The data acquisition system captures information such as temperature, pressure at different points in the system. The study provides an efficient and cost-effective method for designing, testing, and optimizing refrigeration systems using LabVIEW-based simulation and demonstrates the usefulness of LabVIEW as a tool for modelling and analysing complex systems, and highlights the importance of data acquisition in understanding the behaviour of refrigeration systems. The simulation model was created using LabVIEW, which is a powerful graphical programming language widely used for data acquisition, analysis, and control. The simulation model was validated using experimental data collected from a refrigeration system.

KEYWORDS: LabVIEW, COP, Simulation in Excel.

I. INTRODUCTION

Simulation of vapour compression refrigeration systems using data acquisition in LabVIEW is an effective approach for understanding the behaviour and performance of these systems under different operating conditions. LabVIEW is a powerful software platform for data acquisition, signal processing, and control applications, which allows for real-time monitoring and control of refrigeration systems. The vapour compression refrigeration system is a widely used refrigeration technology that consists of several components such as a compressor, condenser, expansion valve, and evaporator. The system operates on the principle of the refrigeration cycle, which involves the compression and expansion of refrigerant, resulting in the transfer of heat from one location to another. Simulation of a vapour compression refrigeration system using LabVIEW involves the analysis of the graphical model of the system, which describes the behaviour of each component and the overall system under different operating conditions. The model is then implemented in LabVIEW, where data acquisition hardware is used to measure and record various parameters such as temperature and pressure. Real-time monitoring and control of the system can be achieved through LabVIEW's user interface, which allows the user to visualize the system's performance and adjust the control parameters accordingly. The simulation can be used to optimize the system's performance, evaluate the impact of different operating conditions, and identify potential problems or faults in the system. Overall, simulation of vapour compression refrigeration systems using data acquisition in LabVIEW is a valuable tool for improving the design and operation of these systems. It allows for a better understanding of the system's behaviour and performance, leading to more efficient and reliable refrigeration systems.

II. LITERATURE REVIEW

"Design of data acquisition system based on LabVIEW for industrial process monitoring" by J. H. Liu and C. C. Chen: The paper describes the design and implementation of a data acquisition system using LabVIEW for industrial process monitoring. The system includes sensors, signal conditioning circuits, a data acquisition module, and LabVIEW software for data acquisition, analysis, and visualization. The results show that the system can accurately acquire and analyse process data in real time.

"Real-time data acquisition system based on LabVIEW for engine performance analysis" by S. S. Kim, Y. B. Kim, and K. H. Lim: The paper presents a real-time data acquisition system using LabVIEW for engine performance



analysis. The system includes a dynamometer, sensors, signal conditioning circuits, a data acquisition module, and LabVIEW software for data acquisition and analysis. The results show that the system can accurately measure and analyse engine performance parameters in real time.

"Development of a LabVIEW-based data acquisition and control system for a vapour compression refrigeration test rig" by A. K. Shukla et al. (International Journal of Refrigeration, 2013) In this paper, the authors describe the development of a LabVIEW-based data acquisition and control system for a vapour compression refrigeration test rig. The system was used to collect data on various parameters such as temperature, pressure, and flow rate, and was found to be accurate and reliable. The results showed that the LabVIEW-based system was able to monitor and control the refrigeration system effectively, and could be used for further research and development.

"Data acquisition and analysis of a domestic refrigerator using LabVIEW" by S. S. Patil et al. (International Journal of Mechanical Engineering and Technology, 2017) .In this paper, the authors describe the use of LabVIEW for data acquisition and analysis of a domestic refrigerator. The system was used to collect data on various parameters such as temperature, compressor speed, and refrigerant flow rate. The results showed that the LabVIEW-based system was able to accurately measure and analyse the performance of the refrigerator, and could be used for further optimization of the system.

"Development of a data acquisition system for a solar-powered refrigeration system using LabVIEW" by S. M. Haris et al. (Renewable Energy, 2016), In this paper, the authors describe the development of a data acquisition system using LabVIEW for a solar-powered refrigeration system. The system was used to collect data on various parameters such as solar radiation, ambient temperature, and refrigerant flow rate. The results showed that the LabVIEW-based system was able to accurately measure and analyse the performance of the solar-powered refrigeration system, and could be used for further optimization of the system.

III. OBJECTIVE

- To simulate the VCRES using LabVIEW and Excel Formulation.
- To acquire the data from the VCRES using sensors and data acquisition devices.
- To analyze the performance of the VCRES by comparing the theoretical COP with the actual COP.

IV. CALCULATIONS

Theoretical COP:

From P-H chart of R134a

enthalpy at compressor suction

= 414.2695 kJ/kg

enthalpy at compressor discharge

= 418.9846 kJ/kg

enthalpy at condenser outlet

= 253.0104 kJ/kg

Suction Pressure = 0.1034 bar

Discharge Pressure = 1.1859 bar

Design Consideration:

Capacity of evaporative tank: 7 liters of water

Suction pressure of water: 0.1034 bar

Outlet pressure of compressor: 1.1859 bar

Refrigerant used: R134a (Tetra-fluoro-ethane), CH₂FCF₃

Initial water temperature: 31.2°C

T₁ = Compressor Inlet Temperature= 6.2°C

T₂=Compressor Outlet Temperature= 48.86°C

T₃ = Condenser Outlet Temperature = 39.94°C

T₄ = Evaporator Inlet Temperature = 4.15°C

$$\text{COP} = \frac{h_1 - h_4}{h_1 - h_2} = \frac{408.3661 - 256.1643}{425.4698 - 408.3661}$$

COP = 8.89



Actual COP:

Initial temperature of water = 31.2 °C

Final temperature of water = 6.2 °C

Mass of water, m = 1 kg (for our setup)

Specific heat of water = 4.187 KJ / Kg K

$$COP = \frac{Q}{EMR}$$

$$Q = m.Cp .(Tf - Ti)$$

$$= (1)(4.187)(31.3-6.2)$$

$$= 105.0937 \text{ KJ}$$

$$\text{For 2289 sec, } Q = \frac{105.0937}{2289}$$

$$= 0.0459 \text{ KW}$$

Energy meter initial reading (Y) = 31.1 Wh

Energy meter final reading (X) = 34.9 Wh

Actual Energy Meter Reading (z)=X-Y
=3.8 Wh

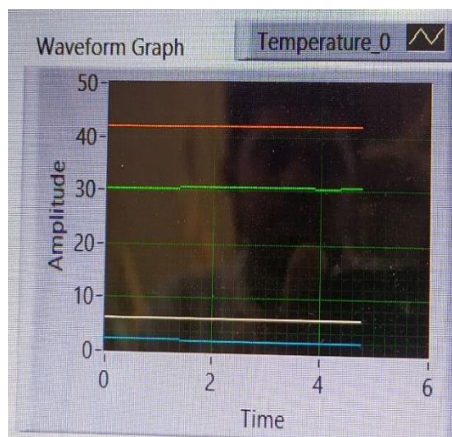
$$\text{Energy Meter Reading (EMR)}$$

$$= \frac{3.8}{(2289/3600)} = 5.9764 \text{ W}$$

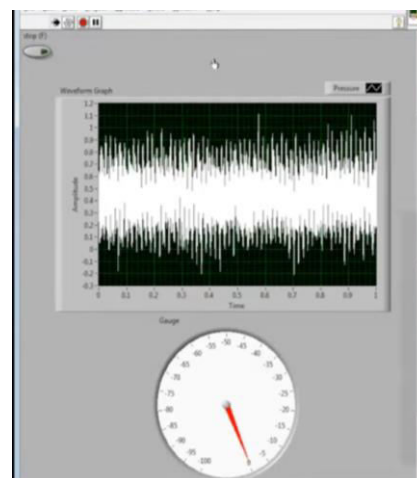
$$COP = \frac{0.0459}{5.9764} * 1000$$

COP = 7.68

V. WORKING



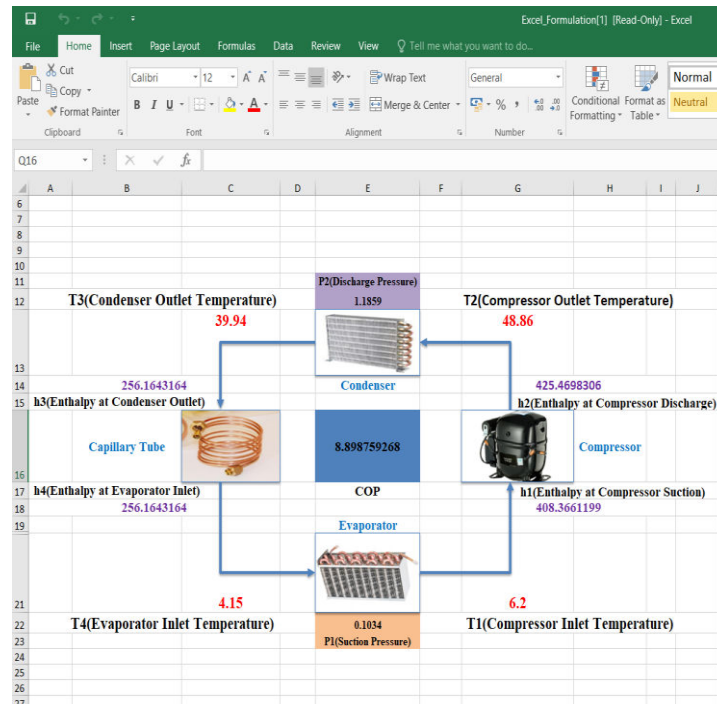
Temperature Sensor Testing



Pressure Sensor Testing



VI. EXCEL TOOL



Excel Flowchart

Excel uses a large collection of cells formatted to organize and manipulate data and solve mathematical functions. Users can arrange data in the spreadsheet using graphing tools, pivot tables and formulas. The spreadsheet application also has a macro programming language called Visual Basic for Applications.

The VLOOKUP function consists of three required arguments, in the following order: lookup value, table array, and column index number. The lookup value is the value for which you want to find matching data and must appear in the first column of the lookup table; it can be a value, a text string, or a cell reference.

In its simplest form, the VLOOKUP function says: =VLOOKUP(What you want to look up, where you want to look for it, the column number in the range containing the value to return, return an Approximate or Exact match – indicated as 1/TRUE, or 0/FALSE).

Min and Max to determine the smallest and largest values in a field based on the specified aggregation, or grouping. For example, you could use these functions to return the lowest and highest freight cost. If there is no aggregation specified, then the entire table is used.

The AND Function in excel is a logical function that tests multiple conditions and returns “true” or “false” depending on whether they are met or not.

The formula of AND function is “=AND(logical1,[logical2]...)”, where “logical1” is the first condition to evaluate. Additional functions for use in Excel include subtract, multiply, divide, count, median, concatenate and other logical functions similar to AND, such as OR.

VII. CONCLUSION

Data acquisition vapour compression refrigeration system in LabVIEW is an excellent system to compare theoretical coefficient of performance and actual coefficient of performance. An attempt is made to record temperature and pressure data by data acquisition in LabVIEW. Experimentation is done on water cooler test rig. As indicated in project



data acquisition gives and theoretical COP with the help of excel formulation. Hence one can find COP of any refrigerating unit.

The study provides following conclusions:

- The actual COP of water cooler test rig is 7.68
- The theoretical COP of water cooler test rig is 8.89

The experimentation has shown that data acquisition system is feasible to find COP of any refrigeration unit.

VIII. FUTURE SCOPE

Proposed system is designed for industrial purpose that is to be used to compare theoretical coefficient of performance and actual coefficient of performance of refrigeration system like water cooler test rig, Ice plant, refrigerator. This data acquisition system can be incorporated in testing department of industries such as chiller plants, ice plants where lager refrigeration systems are used for cooling purpose. It can also be incorporated in HVAC laboratories, where innovations in refrigeration are done. Same system can be used for multiple refrigerants.

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