

Improvement of Coefficient of Performance of Ice Plant

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Abstract - The project aims to design experiment test set up for commercial as well as experimental purpose in Refrigeration and Air conditioning laboratories. The ice plant test rig is used to evaluate capacity of the ice plant, calculate coefficient of performance (COP) of the system, to reduce the refrigeration time and plot the system performance on P-H chart. The model is analyzed for its cooling capacity assumed per unit mass flow rate of refrigerant. As per the study of research paper, physical and chemical properties of different refrigerants, we concluded that R134a is best suitable refrigerant for the proposed system. Brine is better suited as a secondary refrigerant for the requirements of the system due to its excellent properties over conventional secondary refrigerant.

Key Words: Refrigeration, Compression, refrigerant, Ice Plant, Evaporation, Coefficient of performance (COP).

1. INTRODUCTION

Refrigerator is treasured as one of the best innovations of the 20th century. It has become one of the prime necessities of the 21st century. In over a span of three decades, there has been a surge in the energy demands due to the ever-increasing population esp. in India. This has led to increased pollution and energy costs. The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. The idea of this project explores the possibility of improvement in COP of an ice plant test rig and the technique can also be used in commercial ice plants. R134a, the most common and eco-friendly refrigerant was adopted as the refrigerant for this project. We are using a copper header and an accumulator and trying to improve the COP of the system.

2. THEORY

Modified vapour compression system consists of compressor, condenser, expansion device, evaporator, accumulator and the copper header.

2.1 ACCUMULATOR

At the entry of the compressor we require dry and saturated refrigerant. But sometimes the liquid refrigerant passing through the evaporator is not completely evaporated, it

contains some amount of liquid droplets. If the compressor is supplied with liquid along with vapour refrigerant, the compressor must do some additional work. As the compressor work increases there will be drop in the coefficient of performance (COP) of the system because,

$$\text{COP} = \frac{\text{Refrigerant Effect}}{\text{Compressor Work}}$$

In order to avoid this, an insulated vessel known as accumulator is introduced in the system. The accumulator receives liquid and vapour refrigerant from the expansion valve and supplies liquid refrigerant to evaporator. Similarly, discharge from evaporator is again sent to accumulator which removes liquid entering the compressor.

Thus, accumulator supplies only dry and saturated vapour to compressor which ensures dry compression in compressor.

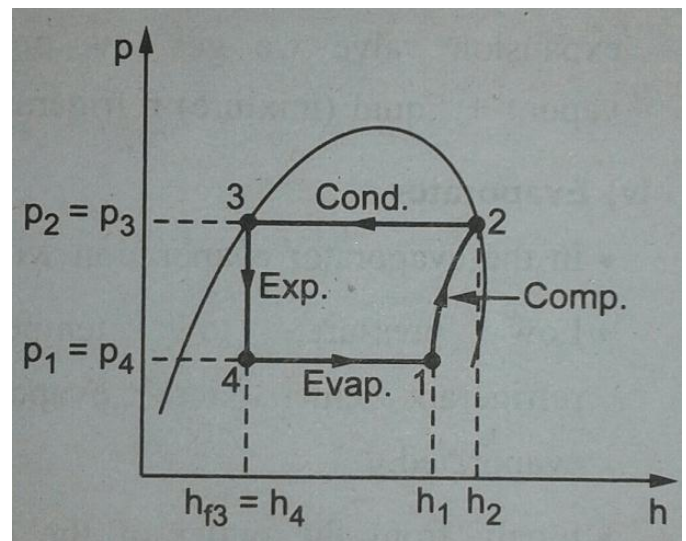


Fig -1: p-h diagram for simple VCC

The above figure is the p-h diagram for simple vapour compression cycle (VCC) without using an accumulator where COP is given by,

$$(\text{COP})_{\text{without accumulator}} = \frac{(h_1 - h_4)}{(h_2 - h_1)}$$

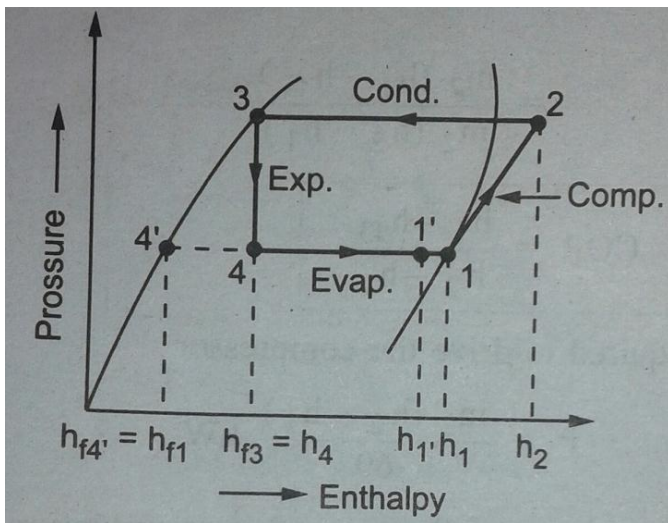


Fig -2: p-h diagram for VCC with accumulator

Figure 2 shows the p-h diagram for VCC with the use of the accumulator

Let,

m_1 = mass of liquid refrigerant flowing through the evaporator and,

m_2 = mass of refrigerant flowing in the condenser

Also,

$$\text{Refrigerating Effect} = m_2 (h_1 - h_{f3})$$

$$\text{Work of compressor} = m_2 (h_2 - h_1)$$

Therefore,

$$\text{COP}_{\text{with accumulator}} = \frac{\text{Refrigerant Effect}}{\text{Compressor Work}}$$

$$= \frac{[m_2 (h_1 - h_{f3})]}{[m_2 (h_2 - h_1)]}$$

$$\text{COP} = \frac{(h_1 - h_{f3})}{(h_2 - h_1)}$$

2.2 COPPER HEADER

A common accessory used on many refrigeration systems is the liquid receiver. It is basically a storage vessel designed to hold excess refrigerant not in circulation. Refrigeration systems exposed to varying heat loads, or systems utilizing a condenser flooding valve to maintain a minimum head pressure during low ambient temperatures, will need a receiver to store excess refrigerant.

Our Ice Plant Test Rig set-up is as shown in the figure below having the accumulator and copper header installed



Fig -3: Ice plant test rig

3. CONCLUSION

We are going to repair the system and add new components in the system for achieving our aim that is to Improve COP of the system and reducing the pull down and freezing cycle time. Due to this task we get to know the detail study of ice plant and refrigeration cycles used for that. and due to the handful practical exposure to the setup, we got the practical facts and knowledge about the system. We are going to check and evaluate the system for both before and after value addition. It will show the effects of our work and value addition as compared to the previous setup. Finally, we achieved our aim

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