Design of thermostatic expansion valve to increase COP of VCR system

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ABSTRACT

The thermal expansion valve is used many vapor compression refrigeration systems such as refrigerator, air-conditioner etc. Hence many techniques have been investigated on thermal expansion valve to increase COP of VCR system. COP of thermal expansion valve can be increased either by controlling the bulb pressure or by decreasing compression work. This is an attempt to design expansion valve for increased COP with respect to mass flow control of refrigerant and the particular thermal parameter which are affecting to COP. The validation of design of thermal expansion valve is planned to validate by CFD analysis.

Keyword: Thermal expansion valve, VCR system, COP, Bulb pressure.

1. INTRODUCTION

VCR system

This refrigeration cycle is approximately a Rankin cycle run in reverse. A working fluid (often called the refrigerant) is pushed through the system and undergoes state changes (from liquid to gas and back). The latent heat of vaporization of the refrigerant is used to transfer large amounts of heat energy, and changes in pressure are used to control when the refrigerant expels or absorbs heat energy. However, for a refrigeration cycle that has a hot reservoir at around room temperature (or a bit higher) and a cold reservoir that is desired to be at around 34°F, the boiling point of the refrigerant needs to be fairly low. Thus, various fluids have been identified as practical refrigerants. The most common include ammonia, Freon (and other chlorofluorocarbon refrigerants, aka CFCs), and HFC-134a (a non-toxic hydro fluorocarbon).

2. THERMOSTATIC EXPANSION VALVE

Thermostatic expansion valve or TEV is one of the most commonly used throttling devices in the refrigerator and air conditioning systems. The thermostatic expansion valve is the automatic valve that maintains proper flow of the refrigerant in the evaporator as per the load inside the evaporator. If the load inside the evaporator is higher it allows the increase in the flow of the refrigerant and when the load reduces it allows the reduction in the flow of the refrigerant. This leads to the highly efficient working of the compressor and the whole refrigeration and the air conditioning plant.

Two parts the thermostatic expansion valve elements of the body with its inner elements and the body with the inner elements. The thermostatic element motor of the valve; a sensing bulb is connected to the diaphragm assembly by the 1.5meter length of capillary tubing. Which transmit bulb pressure to the top of the valve diaphragm. The sensing bulb pressure is a function of the temperature of the thermostatic charge that is the substance within the bulb. The body is made from forged brass with a connection in angle configuration. The interchangeable orifice assembly can be replaced through the inlet connection. A steel rod, inside the body, transfers the diaphragm movement to the plug inside the orifice assembly. When the thermostatic charge pressure increase, the diaphragm will be deflected from the seat and allow the liquid passing through the orifice. Spring opposes the force underneath the diaphragm and the side spindle can adjust its tension. Static superheat increase by turning the side spindle clockwise and decreased by turning the spindle counter clockwise. The thermostatic expansion valve is hardly connected by brazing to the forged brass body avoid leakage.
3. WORKING PRINCIPLE

In thermostatic expansion valve opening and closing, condition depend on three main pressure like bulb pressure ($P_b$), evaporator pressure($P_e$), and spring pressure ($P_s$). so when the temperature and pressure variation takes place in expansion valve than is working

![Fig 3.1 working of VCR system](image)

**The opening condition of valve**

In this condition bulb pressure $P_b$ is more than the spring pressure ($P_s$) and evaporating pressure ($P_e$) so that diaphragm takes place downward direction than valve is open. In this case, throttling temperature and evaporating temperature are not same, so the valve is partially close.

$$P_b > P_s + P_e$$

**The closing condition of valve**

In this condition, bulb pressure is less than the spring pressure and evaporating pressure so that diaphragm takes place upward direction and valve are close. In this case, throttling temperature and evaporating temperature are closely same so the valve is partially open.

$$P_b < P_s + P_e$$

4. MODELING OF THERMOSTATIC EXPANSION VALVE

![Fig 4.1 Thermostatic Expansion valve](image)
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check valve with cracking pressure of 3.5–7 kPa is proposed for the expansion valve and a combination of low cracking pressure 
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on a two adsorber bed silica gel/CaCl2-water ACS and tested under different operating conditions. These designs result in reducing the 
total mass of the ACS up to 10.5 kg and the parasitic power consumption of the control valves by 50%. The results show that the 
expansion valve and control valves operate effectively under the heating and cooling fluid inlet temperatures to the adsorber beds of 70–100 °C and 30–40 °C, respectively, the coolant water inlet temperature to the condenser of 30–40 °C, and the chilled water inlet temperature to the evaporator of 15–20 °C. Also, an ACS thermodynamic cycle model is developed and compared against the 
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A.A.A Rashid Describe This paper presents a comparable evaluation of R600a (isobutane), R290 (propane), R134a, R22, for R410A, and R32 an optimized finned-tube evaporator, and analyzes the evaporator reflect on the system coefficient of performance (COP). Results concerning the response of refrigeration system simulation software to an increase in the amount of oil flowing with the refrigerant are presented. It is shown that there are optima of the apparent overheat value, for which either the exchanged heat or the refrigeration coefficient of performance (COP) is maximized: consequently, it is not possible to optimize both the refrigeration COP and the evaporator effect. The obtained evaporator optimization results were incorporated in a conventional analysis of the vapor compression system. For a theoretical cycle analysis without accounting for evaporator effects, the COP spread for the studied refrigerants was as high as 11.7%. For cycle simulations including evaporator effects, the COP of R290 was better than that of R22 by up to 3.5%, while the remaining refrigerants performed approximately within a 2% COP band of the R22 baseline for the two condensing temperatures considered.

6. CONCLUSION

The present work has undertaken with the objectives of the understanding the proper installation of the measuring devices for measurement of the accurate data. And give some basic understanding of thermostatic expansion valve. After completed design and calculation COP increase with changing the diameter of inlet and outlet.

7. REFERENCES

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