Refrigeration, Air Conditioning
and Heating

Courseware Sample

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Lab-Volt®

REFRIGERATION, AIR CONDITIONING AND HEATING

COURSEWARE SAMPLE

by
the Staff
of
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Introduction

The Lab-Volt Industrial Refrigeration Training System, Model 3406, introduces trainees to the principal components of industrial refrigeration systems through hands-on practice. It enables students to gain experience with both commercial and industrial equipment that use water-cooled condensers, electric and hot-gas defrost systems, and hot-gas bypass for variable load control. Lockable fault-insertion switches introduce various electrical faults, allowing students to develop their skills in maintenance and troubleshooting.

Courseware Outline

INDUSTRIAL REFRIGERATION

We Value Your Opinion!

Sample Exercise

Extracted from

Industrial Refrigeration

Exercise 4-2

Hot Gas Bypass Pressure Regulating Valves

EXERCISE OBJECTIVE

When you have completed this exercise, you will be introduced to the operation of hot gas bypass pressure regulating valves. You will learn how they prevent the compressor from operating at excessively low suction pressures. You will also learn where they are installed in a refrigeration circuit.

DISCUSSION

Hot gas bypass pressure regulating valves, also called discharge bypass valves, are designed to deliver an artificial load to the compressor to replace a decrease in load at the evaporator. The artificial load is produced by injecting hot gas at the evaporator inlet. This prevents the compressor from operating at excessively low suction pressures that could result in oil pumping, short cycling and temperature variations which, in turn, could lead to compressor failure, lack of oil return and frosted or iced evaporators.

Hot gas bypass pressure regulating valves open on a decrease in suction pressure. They are set to maintain a minimum evaporating pressure automatically, whatever the decrease in evaporator load. The minimum evaporating pressure of the hot gas bypass pressure regulating valve of your training system is set at 45 psi (310 kPa) approximately.

As Figure 4-7 shows, the hot gas bypass pressure regulating valves respond to changes in downstream or suction pressure. When the evaporating pressure is above the valve setting, the valve remains closed. As the suction pressure drops below the valve setting, the valve begins to open. The opening is proportional to the change in suction pressure. As the suction pressure continues to drop, the valve continues to open farther until the limit of the valve stroke is reached. The pressure change available from the point at which it is wanted to have the valve closed to the point at which it is to be opened varies with the type of refrigerant used and the evaporating temperature.

Hot Gas Bypass Pressure Regulating Valves

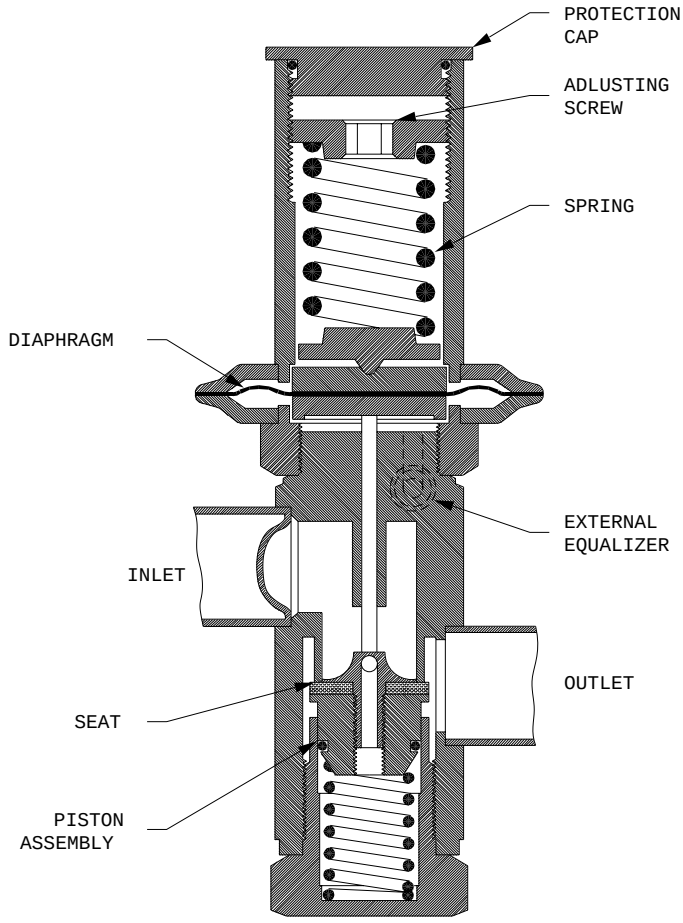

Figure 4-7. Cross sectional view of a hot gas bypass pressure regulating valve.

The minimum pressure setting of hot gas bypass pressure regulating valves may be either direct or pilot operated. They are usually equipped with an external equalizer connection which operates as the external equalizer of a thermostatic expansion valve to compensate for pressure drops in the lines. The external equalizer should be attached to the suction line at the point where it is wanted to control the suction pressure.

As Figure 4-8 shows, the hot gas bypass pressure regulating valve is located between the compressor output and the low side of the evaporator inlet (between the thermostatic expansion valve and the distributor at the inlet of the evaporator). By inputting the hot gas at this location, the thermostatic expansion valve will respond to the increased superheat of the vapor leaving the evaporator and will provide the liquid required for desuperheating. Also, the evaporator serves as an excellent mixing chamber for the bypassed hot gas and the liquid-vapor mixture from the thermostatic expansion valve. This ensures a dry vapor reaching the compressor suction. Oil return from the evaporator is also improved since the velocity in the evaporator is kept high by the hot gas.

Hot Gas Bypass Pressure Regulating Valves

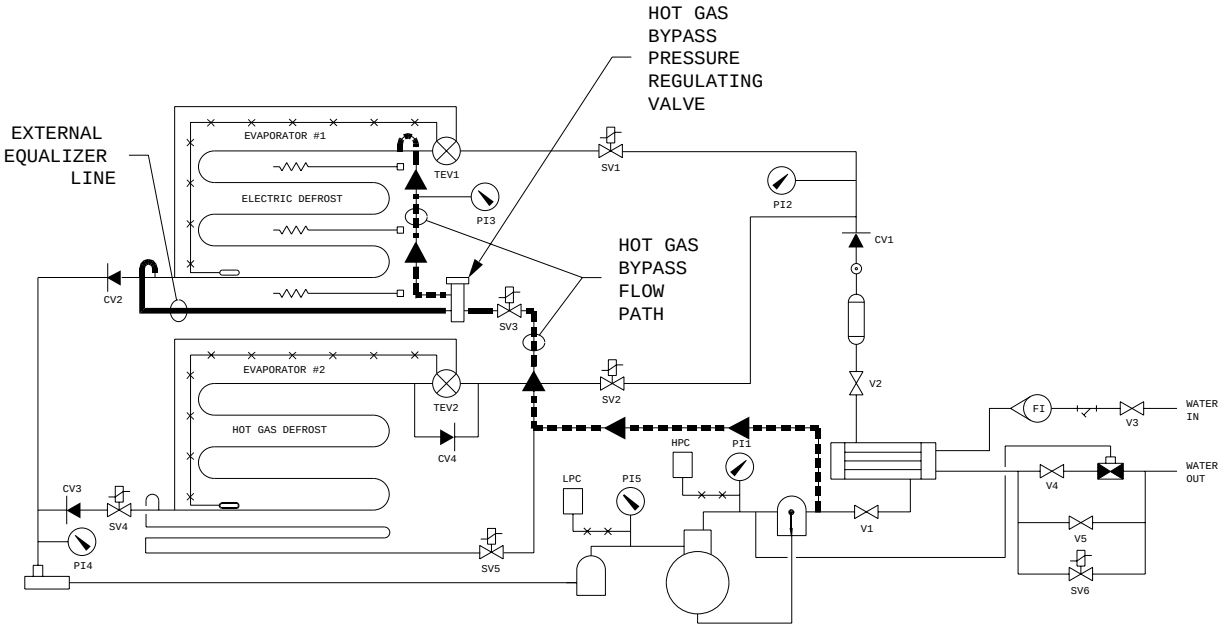

Figure 4-8. Location of the hot gas bypass pressure regulating valve in a refrigeration circuit.

Note: *The location of the ports of the hot gas bypass pressure regulating valve shown in Figure 4-8 does not correspond to the current location on the valve. The location was modified to simplify representation in the schematic circuit.*

Procedure Summary

In the first part of the exercise, *System Setup,* you will set up the system.

In the second part of the exercise, *Load Variation without Hot Gas Bypass Regulation*, you will observe how the suction pressure varies when the load is reduced without hot gas bypass regulation.

In the third part of the exercise, *Load Variation with Hot Gas Bypass Regulation,* you will observe the suction pressure variation with hot gas bypass regulation.

PROCEDURE

System Setup

☐ 1. On the CONTROL PANEL, set the controls as follows:

POWER switch	O
COMPRESSOR switch	O
EVAPORATOR switch	#1
EVAPORATOR #1 FAN SPEED control knob	HIGH
EVAPORATOR #2 FAN SPEED control knob	OFF
HOT GAS BYPASS switch	O
DEFROST TIMER switch	O

On the SCHEMATIC PANEL, set the switch S_1 at O (off).

On the dual PRESSURE CONTROLLER, set the controls as follows:

HIGH PRESSURE CUT-OUT	250 psi (17.2 bar)
LOW PRESSURE CUT-IN	35 psi (2.4 bar)
DIFFERENTIAL	20 psi (1.4 bar)

Valves V1, V2, V3 and V4	OPEN
Valve V5	CLOSED

Note: *Figure 4-9 shows the refrigerant and bypass flow paths for the circuit used in this exercise.*

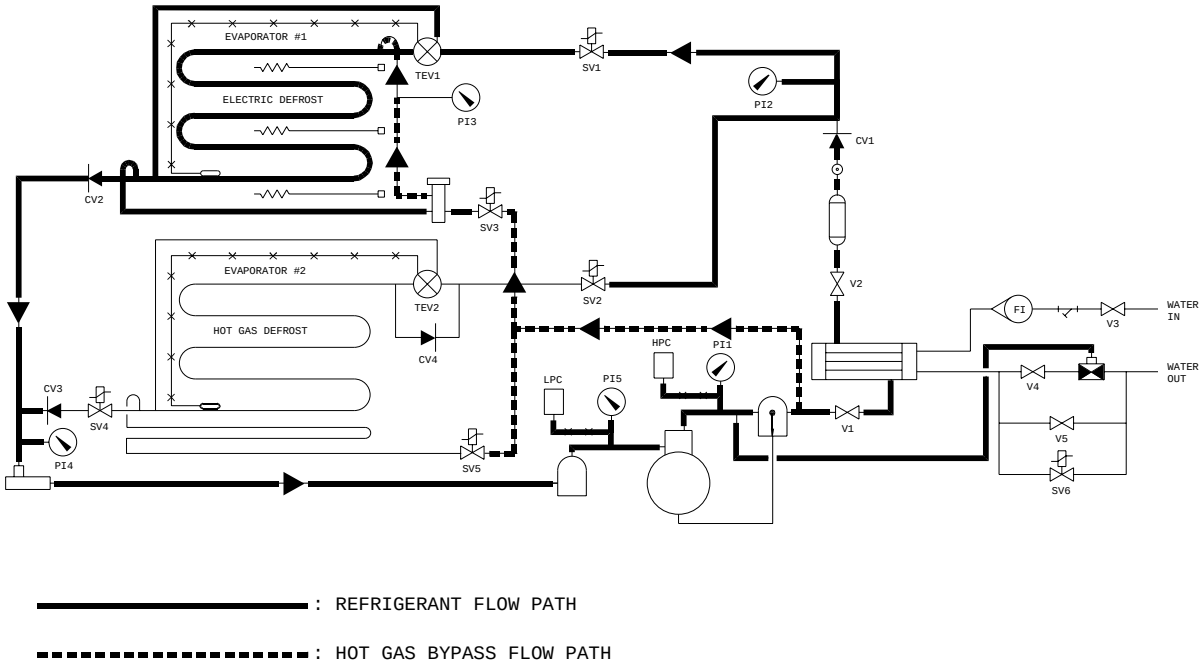

Figure 4-9. Refrigerant and bypass flow paths.

Load Variation without Hot Gas Bypass Regulation

☐ 2. Turn on the training system by setting the POWER and COMPRESSOR switches at I (on).

Operate the compressor for approximately 5 min. This will allow the system to stabilize before any readings are taken.

☐ 3. Measure the pressure at the locations indicated in Table 4-2. Record your results in the column *WITHOUT HOT-GAS BYPASS* and *EVAPORATOR FAN SPEED* at *HIGH*.

SYSTEM MEASUREMENTS	EVAPORATOR FAN SPEED			
	HIGH	OFF	HIGH	OFF
	WITHOUT HOT-GAS BYPASS		WITH HOT-GAS BYPASS	
PRESSURE [psi (kPa)]				
Compressor discharge (PI1)				
Evaporator inlet (PI2)				
Equalizer line (PI3)				
Evaporator outlet (PI4)				
Compressor suction (PI5)				

Table 4-2.

☐ 4. Stop the EVAPORATOR #1 fan by setting the EVAPORATOR #1 FAN SPEED control knob at OFF to simulate a decrease in load.

After 3 minutes, measure the pressure at the locations indicated in Table 4-2 and record your results in the column WITHOUT HOT-GAS BYPASS and EVAPORATOR FAN SPEED at OFF.

Note: *Do not let the compressor operate with a very low suction pressure for long periods.*

Does the suction pressure decrease to a low value of approximately 30 psi (207 kPa)?

☐ Yes ☐ No

Load Variation with Hot Gas Bypass Regulation

☐ 5. Set the EVAPORATOR #1 FAN SPEED control knob at HIGH.

On the CONTROL PANEL, set the HOT GAS BYPASS switch at I (on).

Operate the compressor for approximately 5 min. This will allow the system to stabilize before any readings are taken.

☐ 6. Measure the pressure at the locations indicated in Table 4-2. Record your results in the column *WITH HOT GAS BYPASS* and *EVAPORATOR FAN SPEED* at *HIGH*.

Note: *The pressure values with and without hot gas should be similar for this load condition.*

☐ 7. Stop the EVAPORATOR #1 fan by setting the EVAPORATOR #1 FAN SPEED control knob at OFF to simulate a decrease in load and observe the suction pressure at PI5.

Wait 5 min approximately while hot gas is injected into EVAPORATOR #1. This will allow the system to stabilize before any readings are taken.

Measure the pressure at the locations indicated in Table 4-2. Record your results in the column *WITH HOT-GAS BYPASS* and *EVAPORATOR FAN SPEED* at *OFF*.

☐ 8. Does your observation confirm that the hot gas bypass pressure regulating valve prevents the compressor to work at excessively low suction? Explain.

_____

_____

_____

☐ 9. On the CONTROL PANEL, set the HOT GAS BYPASS switch at O (off), and observe the suction pressure at PI5. How does the suction pressure vary?

_____

☐ 10. Explain how the hot gas bypass pressure regulating valve prevents the compressor to work at excessively low suction.

_____

_____

_____

☐ 11. Turn off the training system by setting the COMPRESSOR and POWER switches at O (off).

CONCLUSION

In this exercise, you were introduced to hot gas bypass pressure regulating valves. These valves deliver an artificial load to the compressor to replace a decrease in load at the evaporator to prevent the compressor from operating at excessively low suction pressure. Hot gas bypass pressure regulating valves respond to changes in downstream or suction pressure.

Hot Gas Bypass Pressure Regulating Valves

REVIEW QUESTIONS

1. What is the purpose of the hot gas bypass pressure regulating valves?

2. How do the hot gas bypass pressure regulating valves deliver an artificial load?

3. Where is located the hot gas pressure regulating valve in your training system?

Instructor Guide Sample
Extracted from
Industrial Refrigeration

EX. 4-2 HOT GAS BYPASS PRESSURE REGULATING VALVES

ANSWERS TO PROCEDURE QUESTIONS

☐ 3.

SYSTEM MEASUREMENTS	EVAPORATOR FAN SPEED			
	HIGH	OFF	HIGH	OFF
	WITHOUT HOT-GAS BYPASS		WITH HOT-GAS BYPASS	
PRESSURE [psi (kPa)]				
Compressor discharge (PI1)	190 psi (1310 kPa)	186 psi (1282 kPa)	190 psi (1310 kPa)	185 psi (1276 kPa)
Evaporator inlet (PI2)	189 psi (1303 kPa)	185 psi (1276 kPa)	189 psi (1303 kPa)	185 psi (1276 kPa)
Equalizer line (PI3)	72 psi (496 kPa)	43 psi (296 kPa)	70 psi (483 kPa)	70 psi (483 kPa)
Evaporator outlet (PI4)	61 psi (421 kPa)	33 psi (228 kPa)	57 psi (393 kPa)	47 psi (324 kPa)
Compressor suction (PI5)	50 psi (345 kPa)	23 psi (159 kPa)	48 psi (331 kPa)	44 psi (303 kPa)

Table 4-2.

☐ 4. Yes

☐ 8. Yes. Because of the injection of hot gas at the evaporator inlet, the suction pressure was maintained to a secure level for the compressor when the load was decreased.

☐ 9. The suction pressure decreases rapidly to a low value of approximately 30 psi (207 kPa).

☐ 10. By inputting hot gas directly in the evaporator, the hot gas bypass pressure regulating valve creates an artificial load to the compressor to replace the decrease in load at the evaporator.

ANSWERS TO REVIEW QUESTIONS

1. The purpose of the hot gas bypass pressure regulating valves is to prevent the compressor from operating at excessively low suction pressures that could lead to compressor failure.

2. They deliver an artificial load by injecting hot gas in the evaporator to replace a decrease in load.

3. It is located between the compressor output and the low side of the evaporator.