CO2 as a Refrigerant – R-744 Advantages/Disadvantages

by emersonadmin on July 30, 2015

This is post number seven of a series.

Weighing the Advantages and Disadvantages of R744

Table 1 outlines the advantages and disadvantages of R744 as a refrigerant. The list of disadvantages appears smaller than the advantages list, but these issues should not be overlooked, as they have a significant impact on the safety and reliability of R744 systems.

Advantages	Disadvantages
High refrigeration capacity due to high volumetric cooling capacity (e.g., it is approximately up to 5 times that of R404A). This has a positive impact on compressor displacement and the sizing of heat exchangers and pipe work. Lower pressure drops in pipe work and heat exchangers. For example, the impact of long suction and liquid lines is less. High heat transfer in evaporators and condensers due to the high-pressure and density. This will either allow lower temperature differences between the refrigerant and the air; therefore improving efficiency, or allow the use of smaller evaporators and condensers. Tubing wall thickness may need to be increased to handle the higher pressures, so careful design is required to take advantage of the R744 properties. The pressure drop across an expansion valve is greater than with other refrigerants, so the minimum setting for head pressure control can be lower. This improves efficiency. Lower compression ratios leading to higher compressor isentropic efficiency. Non-corrosive with most materials. There are very few differences to the materials used in HFC systems. Good miscibility with compressor lubricants for oil return. Polyolester type lubricants can continue to be used as with HFCs. Low toxicity and nonflammable. Negligible GWP so that, in the event of a leak, the direct impact on climate change is very low. Inexpensive to produce and widely available, although the purity of the R744 should be 99.99% for use in a refrigeration system with hermetic and semi-hermetic compressors, i.e., refrigerant grade. High discharge temperatures due to the high index of compression. This provides good potential for heat reclaim. Note – the discharge temperature is excessively high in transcritical systems with a large difference between evaporating and heat rejection temperatures. Stable molecule leading to a low potential for decomposition within the refrigeration system. There is no impending legislation phasing down or phasing out R744 so it can be viewed as a long-term refrigerant.	High operating and standstill pressures are more hazardous and increase the leak potential. Specially designed components are required. Special compressors are required because of the higher refrigeration capacity (different motor / displacement combination). R744 systems are more complex – either cascade or transcritical. This leads to higher costs in components and installation. Pipe working on-site potentially includes steel or stainless steel, the need for specially licensed welders, and different jointing techniques due to higher pressure and different materials. The greater complexity also increases the probability of poor performance and reliability, particularly if commissioning is not done well. For transcritical systems two stage compression is required for frozen food applications because of the high discharge temperature of R744. R744 transcritical systems are not suitable for high ambient areas (e.g., Southeast Asia) where the system will always run above the critical point because of the inefficiency of transcritical operation. R744 is not controlled by any regulation such as the European Fluorinated Gas Regulation, so its use is not as carefully monitored as HFCs and leak detection is not as rigorous. However, the high-pressures make the system leak prone, and performance will suffer if the leak rate is high. Very sensitive to water contamination and can form unusual compounds when there is a leak in a cascade heat exchanger.

Table 1: Advantages and disadvantages of R744 as a refrigerant

Future articles in this series will cover additional topics concerning R744 in more detail, including the general aspects of R744 systems; more specific information about the design of R744 cascade, transcritical booster and secondary systems; and key points about their commissioning, operation and service.

Andre Patenaude
Director – CO2 Business Development, Emerson Climate Technologies

Visit our website for additional information on CO2 Solutions from Emerson.
Excerpt from original document; Commercial CO_2 Refrigeration Systems Guide for Subcritical and Transcritical CO_2 Applications.

To read all posts in our series on CO2 as a Refrigerant, click on the links below:

1. Series Introduction
2. Criteria for Choosing Refrigerants
3. Properties of R744
4. Introduction to Trancritical Operation
5. Five Potential Hazards of R744
6. Comparison of R744 with Other Refrigerants
7. R744 Advantages / Disadvantages
8. Introduction to R744 Systems
9. Introduction to Retail Transcritical Systems
10. Retail Booster Systems
11. Introduction to Retail Cascade Systems
12. Introduction to Secondary Systems
13. Selecting the Best System

Related

CO2 as a Refrigerant – Selecting the Best System

May 3, 2016
In "Refrigerants"

CO2 as a Refrigerant — Comparison of R744 with Other Refrigerants

July 16, 2015
In "Refrigerants"

CO2 as a Refrigerant — Series Introduction

CO2 offers refrigeration with low global warming impact, but with new application and handling considerations This is post number 1 of a series.

April 16, 2015
In "Refrigerants"

TAGS: ADVANTAGES, ANDRE PATENAUDE, CO2, DISADVANTAGES, NATURAL REFRIGERANTS, R-744, R744, REFRIGERANTS, REFRIGERATION

FROM: REFRIGERANTS, REFRIGERATION

← What Are E360 Forum Attendees Saying?
Convenience Store Chain Enhances Environment and Experience With Electronic Improvements →

No comments yet

Leave a Reply

Enter your comment here...