The Test of Permeable by Expansion Valve in Cooling Compressor

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Abstract**—** *Current article describes the HFC test, which the measure the amount of impurity in cooling compressors, which they could cause damage to them. In introduce of the article describes the process of cooling cycle in cooling equipment. In the tab. 1 are summarized the basic advantages and disadvantages of use natural based refrigerant, which are used in producing the compressors designated for equipment's as refrigerators, air conditions, cooling rooms. In the article are describe the media, which it may occur in compressor, but their presence can may cause the problems with the operation of compressor possibly its damage. We say about media respectively the products, which they are not miscible with oil. It is water, paraffin, silicone and alkali products. Test HFC discovers and measurements the presence these components and on the basis of their quantity decides on the quality of production of refrigeration compressors. The article describes the test procedure and in the end the evaluation of the maximum value of the given incompatible respectively unwanted products.*

Keywords**— compressor, HFC test, refrigerant, refrigeration equipment.**

I. INTRODUCTION

In the past the cooling was used in particular to cooling of food. At present, the demand for refrigeration technology is the much larger. Households use refrigeration not only for food storage but also in air conditioning units. In the chemical industry, refrigeration is used to extract rare gases. In the medical environment, cooling is an essential aspect of storing transfused blood. Mechanical engineering uses cooling in various work processes, such as cutting. Thanks to cooling, the performance of cutting tools up to 100%. This could be continued and mention many industries for which refrigeration is an integral part [1].

One of the main parts of the refrigeration equipment is the compressor, which ensures the circulation of the refrigerant. The cooling circuit consists of four basic processes (fig. 1):

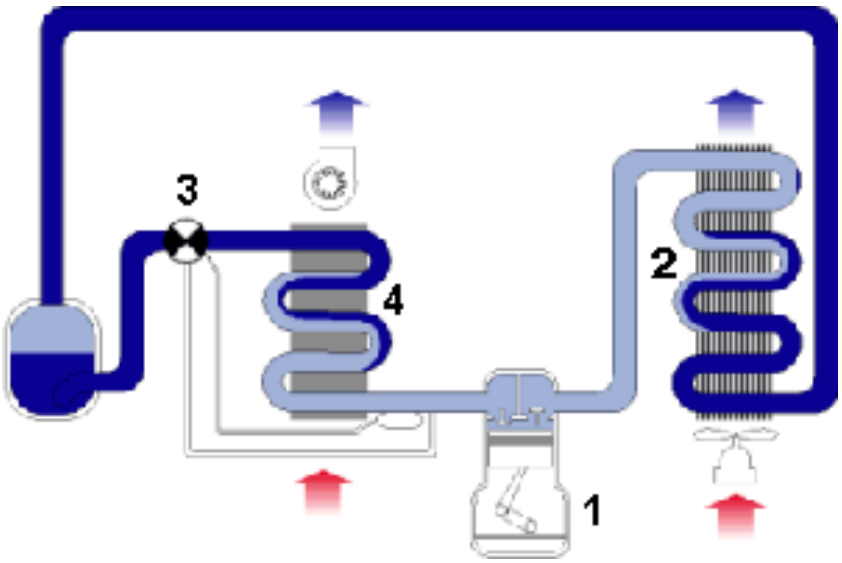


FIGURE 1: Compressor cooling circuit

Refrigerant flows through the refrigeration system, which changes its state, temperature and pressure.

1) The heart of an air conditioner is a compressor that "pumps" the refrigerant in the circuit.

2) Before the compressor, the refrigerant vapors have a low pressure; the compressor compresses these vapors to a high pressure, while the vapors also heat up.

3) High temperature and pressure vapors flow to the condenser, where they transfer heat to the surrounding air and liquefy. Liquid refrigerant leaves the condenser.

4) Liquid refrigerant still at high pressure flows through the expansion valve, which reduces the pressure and thus the temperature of the liquid refrigerant to a lower temperature than the refrigerated space.

5) Cold liquid refrigerant with low pressure flows into the evaporator, where it removes heat from the environment by evaporation. The refrigerant evaporates completely and the low-pressure refrigerant vapours are sucked in by a compressor, which ensures its circulation (Fig. 2).

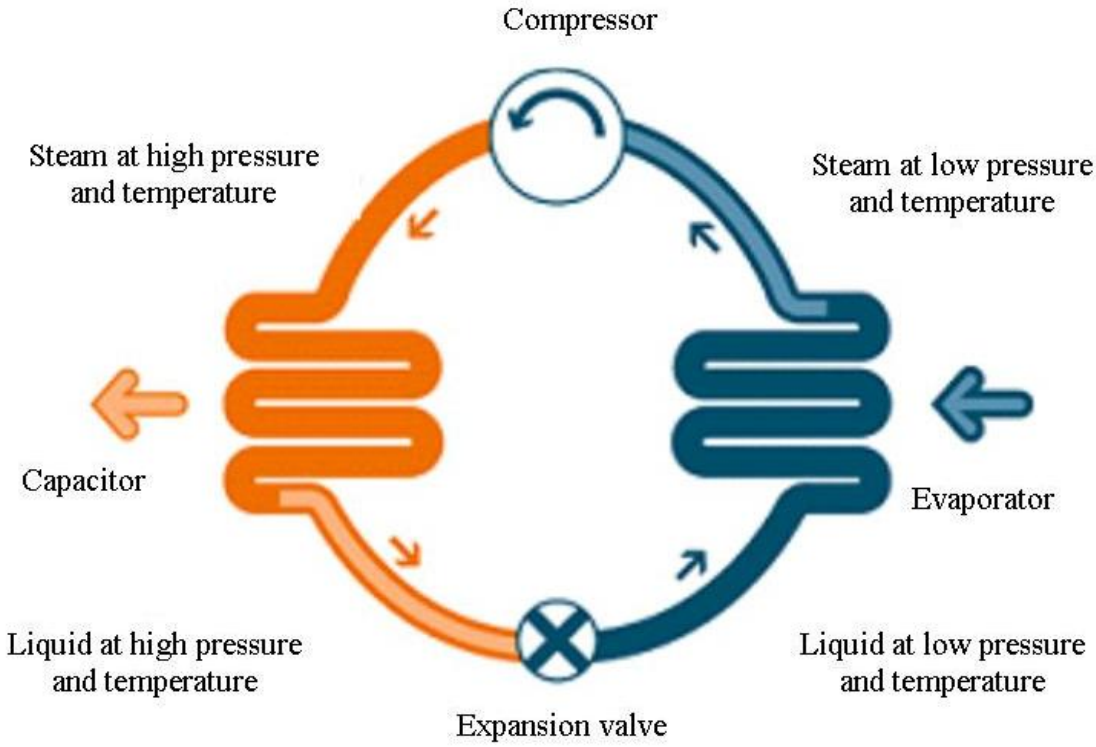


FIGURE 2: Schematic representation of the cooling circuit [3]

II. COMPRESSORS OVERVIEW

Fixed and variable speed hermetic compressors are available on the market for domestic refrigerators, freezers and mini-refrigerators, as well as refrigerated display cases and industrial refrigerated boxes, walk-in refrigerators, ice makers, refrigerated counters, tables, rooms and much more.

When choosing a refrigerant for a certain type of compressor, its thermodynamic properties, physical and chemical properties are decisive, including solubility with water and oils, impact on construction materials, impact on the human body, ecological properties and last but not least price and availability[2].

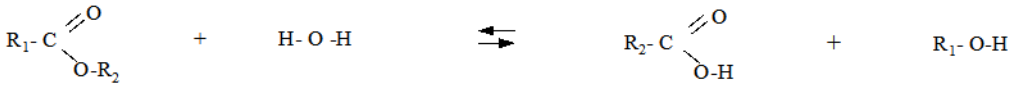
Currently, the company places great emphasis on ecological operation with the least possible impact on the environment. Most compressors are designed to use natural refrigerants, with the least possible environmental impacts such as ozone depletion, the greenhouse effect and various photochemical reactions. Therefore, the types of refrigerants belonging to the group of fluorocarbons are used for the production of compressors, namely refrigerant R 134a a R 600a. The following Tab. 1 summarizes the characteristics of the selected oils.

TABLE 1
TYPES OF OILS AND REFRIGERANTS USED IN THE MANUFACTURE OF REFRIGERATION COMPRESSORS

Oil type	Cooling	Advantages	Disadvantages
Mineral oil - paraffinic	Ammonia	Medium thermal stability, viscosity index is higher.	High flocculation point, low viscosity and miscibility, wax separation.
Raftenic mineral oil	R12, R22, R403, ammonia, R290, R600a	Good viscosity, lower viscosity index, low flocculation point, good miscibility, good heart rate. chem. stability, low foaming.	2x more expensive than mineral oils.
Alkyl benzene oil	R12, R22, R403	Good thermo-chemical stability, low foaming, high viscosity index.	Poor miscibility. 5 times more expensive than mineral oils.
Polyalkylene glycols (PAG)	Ammonia	Good lubricity, high viscosity index.	High hygroscopicity
Polyol ester (POE)	HFC cooling: R134a, R507, R23, R404a	Low flocculation point, good thermochemical stability, low foaming, medium to high viscosity index.	Limited miscibility at low temperatures, higher hygroscopicity.

The biggest problem for introducing these oils and refrigerants into the production process is the effect of the adaptation of industrial residues to gas. Residues such as oil, which protects the components used in the manufacture of compressors against oxidation, moisturizer used by production workers and other incompatible products, endanger the quality of refrigeration products because they are not miscible with the oil and refrigerant. They react or form products that react with the refrigerant, oil, compressor components, and compressor residues and thus change its operating characteristics, negatively affecting the performance of the compressor. It reacts or forms products that react with the refrigerant, oil, compressor components, and compressor residues and thus change its operating characteristics, negatively affecting the performance of the compressor.

III. PRODUCTS THAT ARE NOT MISCIBLE WITH OIL COOLING MEDIUM



Ester **Water** **Organic carboxylic acid** **Alcohol**

3.1 Water

- Induces the formation of acids by reaction with oil (organic carboxylic acid) or with refrigerant (hydrochloric acid), then reacts with the metal components of the compressor, minerals are formed, insulating materials in the compressor are degraded.
- Freezes like an ice drop.

3.2 Alkaline products (degreasers)

- They cause the formation of salts of carboxylic acids by reaction with oil.
- They cause the reverse reaction of the polyester oil synthesis, thus creating an acidic environment in the compressor.

3.3 Paraffin

- At higher temperatures it is soluble in refrigerant and in polyester oil, at lower temperatures it is insoluble and clogs the expansion valve.

3.3.1 Sources

- Preservative oils.
- Oils used in pressing,

- Paraffin was used as a slip driver on the wire for winding electric motors.
- Protective hand creams.
- Grease machining emulsions.
- Maintenance products e.g.vaseline.

3.4 Silicone oils

At higher temperatures they are soluble in refrigerant and polyester oil, at lower temperatures it is insoluble and clogs the capillary.

3.4.1 Sources

- They are part of molding separators.
- Parts are of adhesives, sealants.
- They are used as modeling agents in the production of plastic components.
- Maintenance products.

IV. TEST HFC

HFC stands for H-hydrogen, F-fluorine and C-carbon. This special test is performed to determine the amount of contamination of the mechanics and the compressor space. Chemical reactions of several substances can also occur during compressor operation. The cleanliness of the compressor production line is very important for this test. During the operation of the compressor, chemical reactions of several substances occur, which can affect the life and quality of the compressor. It is the HFC test that determines the type and amount of residues (residues) in the expansion valve and in the evaporator.

During the test, three compressors are tested at the same time (Fig. 3). For new types of compressors that have not yet been tested, it is necessary to subject the compressor to measurements on a calorimeter, where the dependence of the stator winding temperature and the casing is determined. When the whole system is ready, the compressor is cleaned in a chemical laboratory. Here, the entire pipe, together with the evaporator and condenser, is flushed with petroleum ether. At the same time, the analysis of soluble and insoluble residues is processed. This procedure removes cutting residues or other contaminants that could contaminate the compressor system. The components, including the exchanger, are dried at 100 ° C for 3 hours. Follow, the diameter measurement of the expansion valve with nitrogen. Subsequently, the system is assembled and welded without borax additives. A leak test and vacuuming follow. If no leaks are detected in the system, the compressor starts running for 500 to 1000 hours. In Fig. 4 the compressor in the test device is connected.

FIGURE 3: Refrigeration compressor testing equipment

FIGURE 4: Compressor connection in the test rig

At the end of the test, the system is cut near the compressor and an oil sample is taken immediately. The bottle to be sampled must be completely filled to prevent contamination of the oil with air. Subsequently, the expansion valve is carefully removed so as not to damage its inner diameter. The capillary diameter is then measured using nitrogen. Other components, including the capillary, are again tested in a chemical laboratory. The expansion valve is cleaned again to measure the diameter after the test.

V. CONCLUSION

All results are processed in a capillary flow restriction report. It is developed a chemical control and work with wear analysis. In Fig. 5 shows a section through a capillary where the deposition of paraffin in the capillaries is affected and also the grey deposited dust, which may affect the life of the compressor.

The HFC test is designed to detect the effect of various components on cooling. Chemical reactions that occur during compression can cause it to fail. It is therefore necessary to ensure such conditions in the manufacture of the compressor that contamination of the internal parts of the compressor did not occur. It is very important to pay attention not only to the cleanliness of the plant, but also to work equipment and protective equipment, which should not have substances that can cause an undesirable chemical reaction with refrigeration or oil. The HFC test detects the amount of increasing impurities in the expansion valve and in the evaporator.

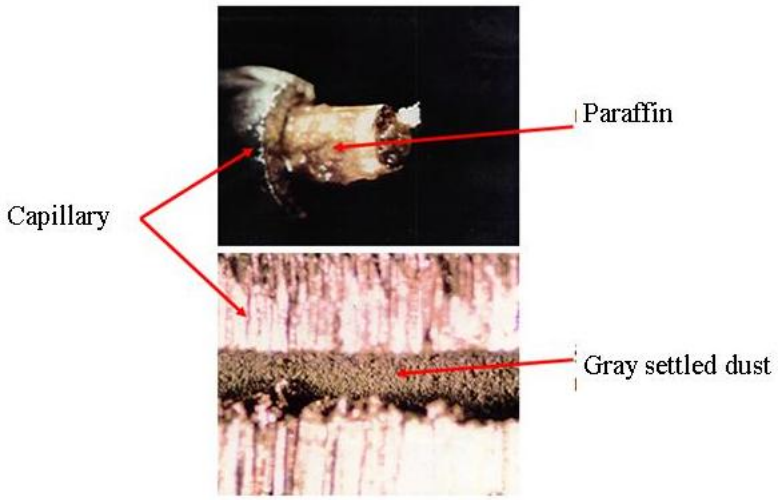


FIGURE 5: Section though a capillary

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