

NATURAL REFRIGERANTS CONTRA HFC – RISKS AND BENEFITS

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ABSTRACT

Natural refrigerants have been reintroduced during the last decades as substitutes for HCFCs and CFCs.

In the small household apparatus sector, the use of HC (R600) is widely spread. There is also an IEC standard for a charge of maximum 150g.

In the heat pump sector, many producers have used HC (R290), primarily as a substitute for R22, and mainly for ecological reasons. HCs as R290 are considered natural refrigerants with minimal impact on the environment.

There are two barriers to the use of HCs as refrigerants:

- low availability of components approved for flammable refrigerants
- lack of legislation concerning the use of flammable refrigerants

The heat pump equipment business has resisted the reintroduction of flammable refrigerants. There are technical, commercial, and legal barriers. The experience from Europe's biggest heat pump market, excluding air-to-air heat pumps, is that flammable refrigerants have posed no risk.

Today, except for HCs, HFCs, are the only practical choice for small- and medium-sized heat pumps. But in the long run it is very doubtful whether HFCs will survive.

Key Words: *heat pumps, flammable refrigerant, propane*

1 INTRODUCTION

The introduction of propane as refrigerant in the early 90s in refrigerators also led to the use of propane as refrigerant in heat pumps, primarily in exhaust air heat pumps. Although some medium-size heat pump manufacturers used propane for several years, the only heat pump compressor approved for medium-size heat pumps was of the semi-hermetic type.

Why only one manufacturer of medium-size heat pump compressors approved the use of propane as refrigerant is unknown. The bearing construction of this type of compressor was redesigned.

2 FLAMMABLE REFRIGERANTS

Flammable refrigerants have been used as early as in the 20s, but when the so-called "safety refrigerants" such as R12, R22, etc., were developed, the flammable refrigerants were abandoned due to the risk of explosion.

This showed to be a hasty decision as the CFC's and HCFC's turned out to be a global danger compared to the local danger of flammable refrigerants. Now the CFC's and the HCFC's have been banned in most developed countries due to the reduction of the ozone layer.

In some countries also the successor HFC has turned out to be a loser in the long run. Due to the green house effect these countries also have planned to ban HFC's. As they are members of the European Union it might end in a decision to wait until the whole of Europe can leave the HFC's for something else.

This something else might be CO₂ for some applications or back to the HC's for other applications or NH₃ for applications in bigger installations.

3.1 Risk with Flammable Refrigerants

To use a flammable gas always involves a certain risk. Flammable gases are used for cooking, propane or natural gas, or heating in many dwellings all over the world. Accident happens. Houses are burnt down. People are killed. In those cases there is a big source of flammable gas. It can be bottles or a connection to a gas net. The gas is meant to be released to the atmosphere and ignited.

In the case of a heat pump with a flammable refrigerant the intention is to keep the refrigerant in a hermetically sealed system. Compared to refrigerators with IEC standards allowing up to 150 grams of flammable refrigerant there are no practical standards for heat pumps with a charge of more than 150 grams.

Although there are in series produced heat pumps with propane as refrigerant. The only hazard so far has been the risk of being banned by a compressor manufacturer when using flammable refrigerants.

The risk of using flammable refrigerants has by some authorities been judged to be reasonable if some precautions are taken. Depending on the size of the room the charge might be limited. Ventilation of the heat pump installation room must be secured. In case of leakage there may not be any components that can ignite under normal conditions.

So far, after more than 10 years of using R290 as refrigerant in exhaust air heat pumps in Sweden, there has been no accident registered (Nowacki and Palm 2003).

3.2 Advantage with Flammable Refrigerants

Of course, there is no advantage with the flammability of a refrigerant. So let's see to the advantages although the refrigerant is flammable.

Compared to R407C R290 has its plusses

- + lower hot gas temperature
- + better thermodynamically properties
- + lower pressure losses
- + slightly higher COP
- + negligible impact to the green house effect
- + natural refrigerant

To be honest there are three major minuses

- flammable, could create an explosion
- highly dissolvable in mineral oil
- many compressor manufacturers will not approve the use of flammable refrigerants

To the manufacturers still using R290 as refrigerant, the plusses weigh much more than the minuses. As the risks have been proven not existing using common sense, efforts have been put into the elimination of the disadvantages.

3.3 Eliminating the Disadvantages

Heat pumps using R290 must have charge less than 150 g or fulfil the requirements from authorities responsible for the safety in buildings. In Sweden SRSA, Swedish Rescue Services Agency, the national authority for issues concerning flammables and explosives, has individually approved installations with flammable refrigerants. In order to simplify approval of installation of serial manufactured exhaust air heat pumps SRSA and the authority for electric safety wrote preliminary rules. These rules are still in use and they have meant a lot to create a market with more than 60.000 exhaust air heat pumps using R290 as refrigerant.

Research efforts have been taken to determine the risk of fire in a dwelling. For example (Jabbour, Clodic) has tests of rapid leakages in a room been performed. The result points out that only a minor amount of refrigerant can be used if there is a risk for a rapid leakage into a room. This might prevent the use of direct heating systems, meaning that the condenser directly heats the air in the room. The indirect type of heating systems, radiators or under floor heating would minimize the risk of a rapid leakage of refrigerant into the room.

The oil problem has been solved by using compressor oil with higher viscosity and other precautions to keep the refrigerant out of the oil in the compressor sump. A crank house heater will keep the oil sufficiently free from refrigerant.

The biggest problem is though the negative attitude from some compressor manufacturers. In the latest refrigerant equipment fair in Nürnberg last October more compressor manufacturers who could or planned to deliver compressors for flammable refrigerant were found. Still we are talking about compressors for house hold applications or similar with a swept volume of maximum 15 ccm.

4 THE RISK WITH HFC AND RISKS FOR HFC

The only risk discovered so far is that also this type of refrigerant can be banned. The impact on the green house effect is of a level that most people seem to accept. At least in the short run.

There is of course a risk that other refrigerants will substitute HFC's due to environmental decisions taken by big customers of heat pumps or refrigeration equipment. The use of CO₂ will increase. Big efforts are taken to introduce CO₂ as the ultimate natural refrigerant.

When flammable refrigerants are more accepted a big part of the market with heat pumps and refrigeration equipment might convert to for example R290. This will first of all happen with series manufactured hermetic products with a low refrigerant charge.

4 CONCLUSIONS

Today the major part of European manufacturers of refrigerators and freezers use flammable refrigerants, mostly R600. The reason to leave R134a for R600 is most of all in consideration of the environment.

In the heat pump sector only some big manufacturers use R290 for mainly exhaust air heat pumps. Although many smaller manufacturers use R290 also for medium size domestic heat pumps. This should be against the will of the compressor manufacturer which might cause some warranty problems.

The difficulty to introduce flammable refrigerants in a wider range is mainly hindered by the amount of refrigerant in the unit. This can look very peculiar to people as, for example in Sweden you are allowed to have two bottles of flammable gas, propane or butane, at 11 kg each in your home. These bottles are made to let the gas out when used. In the same way gas heating and gas cooking is quite normal almost all over the world. Also in this case the equipment is designed to let the gas out to be ignited. There is no sophisticated requirement on ventilation depending on how much gas is used. If something goes wrong the whole gas net is there to provide more gas. The refrigerant charge in a heat pump normally is 500 to 1500 grams for heating the standard single family dwelling.

The appearance of more and more refrigerating equipment for flammable refrigerants points in the direction of a broader use of flammable refrigerant for small and medium sized heat pumps.

REFERENCES

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