USE OF NATURAL REFRIGERANT – HYDROCARBONS FOR REFRIGERATED VENDING MACHINES

Daniele Barbierato – SandenVendo Europe spa

The demand in usage of natural refrigerant, such as hydrocarbons, in various commercial refrigerated applications as well as vending machines, is continuously increasing. This is also due to the fact that the current HFC refrigerants, such as R134a and R404A must be phased out in the very short term, according to the current European F-gas legislation.

Currently in the vending sector the use of highly flammable refrigerant, such as R600a and R290 is considered a very high risk, due to high presence of electrical components inside the vending machines, which can create electric arcs during normal operation, thus seriously compromising safety.

Thus, the question is, why choosing a refrigerant like R290 (Propane) in a sector where the safety risks are very high?

Because R290 is a commercially available natural gas and it is a well-known and proven refrigerant in the industry for several decades.

It has excellent thermodynamic properties, it is not toxic, zero ODP and very low GWP (about 3), therefore replacing the current HFC gas is an ultimate and long-term solution.

It is not a chemically synthetic substance created in the laboratory, of which we do not know the long-term environmental risks.

Being a natural substance, it is not patentable, therefore enable to obtain with affordable cost and available to all.

However, consequently, the R290 classified in safety class A3, therefore highly flammable, therefore finds a greatest obstacle in the application in commercial refrigeration and even more in the vending sector, due to the high risk related to safety.

Just to give an example, in a modern spiral vending machine, for selling the products such as sandwiches, drinks, snacks, there could be more than 80 motors inside the refrigerated cell, one for each single spiral/selection; generally, they are all DC brushed motors controlled by the same number of micro switches. At each delivery of a product, the motor power supply creates an electric arc between the brushes and the rotor.

As for the traditional direct expansion refrigerant system operating with the R290, being the evaporator positioned in the product storage cell and almost hermetically sealed, in case of leakage of R290 from the evaporator it could easily create potentially flammable atmosphere. Therefore, the application of conventional components such as brush motors for vending machines should certainly be avoided.

We could foresee the use of new components such as brushless motors or those which are approved under ATEX specification, and currently some manufacturers of these components are already working on this way to propose new products suitable for the

vending sector. Nevertheless the costs to be incurred in order to replace all the electrical components inside a vending machine is estimated increasing by approx. 300-400%, would bring the cost of the finished product out of the market price.

To overcome this problem, it has been studied a quite simple and certainly interesting solution, maintaining the component currently used inside the vending machine, but to change only the refrigeration system.

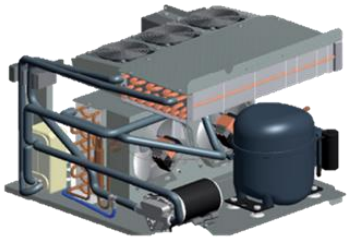
The solution described below is based on the use of Propane (R290) in the cooling system, which consists of two separate circuits; aid of a glycol as a carrier fluid ensuring the maintenance of controlled temperature of the products stored inside a vending machine in total safety.

In this case, only the components of the refrigeration system must comply with the safety regulations in force, such as compressors, fans, electronic controllers and sensors. However, in this respect there are not many issues, because those are widely available and tested for several years in the commercial refrigeration sector.

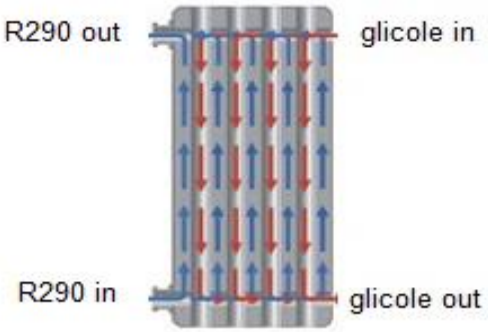
Like a traditional air condensed medium/small power cooling system, the first circuit is composed of: a compressor, a condenser, a dehydrator filter, capillary and an evaporator. The latter, unlike a traditional finned packed coil exchanger, it is the braze welded plate type used for liquid coolant (glycol).

The second circuit consists of a circulation pump for the glycol and a finned pack heat exchanger positioned inside the refrigerated cell.

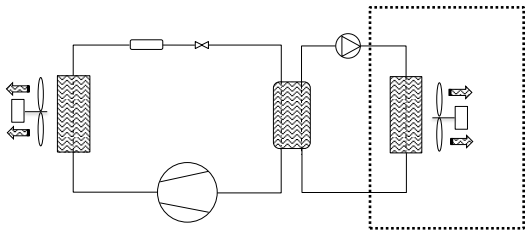
The cooling system thus composed (fig.1) functions as a classic liquid cooling chiller, but applied in the vending machine.



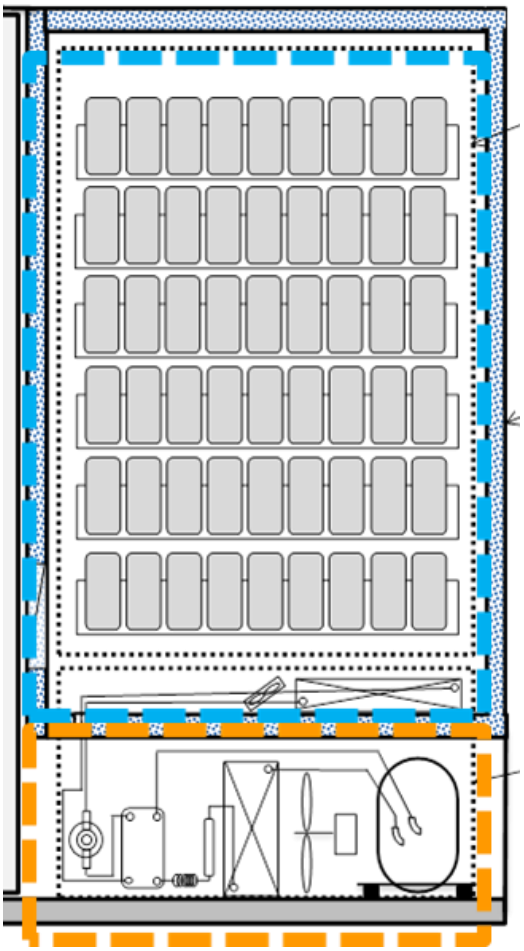
In this case, the refrigerant (R290) circulating in the first circuit is used exclusively for cooling the glycol through the plate heat exchanger, which is made of two separate circuits. (Figure 2)



The cooled glycol in the plate exchanger is then sent through a circulation pump, in a finned pack exchanger positioned inside the cell of the vending machine for the products stored at a controlled temperature.
(Fig.3)



The cooling system created is placed in the lower part of the vending machine in an area well ventilated by the condenser fan, and even if there was a leakage of R290 from the primary circuit, it would not be entering in an area confined inside the refrigerated cell.



Here on the right, you can see a section of a vending machine where the product storage cell is indicated in blue in which only the cooled glycol circulates, and below the cooling system containing the R290 in orange.

The advantages of this solution are many:

It solves the main problem in the application of hydrocarbons in vending machines.

The additional costs are limited only for the replacement of few components.

The powers involved are limited and by designing the refrigeration system well, it is possible to cover all the needs of vending machines, enduring within the maximum charge of 150 grams, as per current legislation.

It is easy to apply because apart from the cooling system, it does not require any modifications to the main components of the finished product.

It can also be used as a retrofit of existing vending machines, considering the fact that almost all refrigeration systems in vending are "removable" type, mono-block type.

So, when it comes to the refrigerants and long-term sustainability, there are three main parameters which need to be considered in order to achieve a sustainable balance:

Regulatory compliance, long-term investment and low environmental impact.