NATURAL REFRIGERANTS STUDY
CASE APPLICATION

G. M. Tarlea\textsuperscript{(b,a)}, A. Tarlea\textsuperscript{(a)}, M. Vinceriu\textsuperscript{(a)},
I. Zabet\textsuperscript{(a)}

\textsuperscript{(a)}Romanian General Association of Refrigeration
\textsuperscript{(b)}Technical University of Civil Engineering

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Romania signed Kyoto (1997) and Montreal Protocol (1987) and in the same time as a new member of EU. Minimizing the presence in the atmosphere of F-gases deriving from activities in the field of refrigeration, air-conditioning and heat pumps, can only be carried out by observing the F-Gas Regulations, namely the (CE) 517/2014 Regulation and its relevant Subsidiaries, along with the European (and Romanian) refrigeration safety standard SR EN 378. In the future it is necessary to retrofit HFC refrigerant with an ecological refrigerants R717 , R744 or HC which has the advantage of a lower GWP.
ECOLOGICAL ALTERNATIVE R – 717

During the last four years in Romania, the following commercial, industrial and domestic refrigeration fields: pork slaughterhouses, storage rooms, logistic parks, warehouses, farms, beer factories, poultry slaughterhouses, soft drinks factories, diary factories, wine factories, ice rink, supermarkets etc.
• Each industrial refrigeration plant was made in one/two compression stage, cascade with conventional equipment as: evaporators, pumps, heat exchangers, evaporative condensers, tanks, vessels for high pressure and low pressure, stainless steel tubes, valves and automatic systems and worked with R404A, R134a, R744 and R717 (NH$_3$).
• Examples of such objectives: Ianca Slaughterhouse, Agrisol Scaieni Prahova, Keller Logistic Brasov, Avicola Brasov, Transavia, Warehouse Tulcea, Scandia Sibiu, Parmafood Bucuresti; Avicola Buzau and many others.
• In 2016, the biggest logistic Megaimage Stefanesti Ilfov was built using NH$_3$, and covering over 4 MW cooling capacity.

The industrial refrigeration systems of those objectives were built 50% using European financial support.
Food Industry

- Fruits: 2%
- Vegetables: 2%
- Poultry Farms: 3%
- Diary: 2%
- Slaughterhouse: 5%
- Warehouse: 3%
- Chemicals: 1%
- Drinks: 2%

Storage: 80%
ECOLOGICAL ALTERNATIVE R - 744

• In the last years in Romania, the commercial refrigeration field was developed.
• Each supermarket refrigeration plant used cascade (hybrid more than 70%) or booster (about 30% transcritic) CO₂ systems with conventional equipment as: air evaporators, pumps, plate heat exchangers, condensers cooled by air, tanks, vessels for high pressure, stainless steel tubes, valves and automatic systems and worked with 134a and R-744.
Romanian Supermarkets working with R134a / R744 (CO₂) Cascade System

<table>
<thead>
<tr>
<th>City</th>
<th>Surface [m²]</th>
<th>Refrigeration Capacity [KW]</th>
<th>Freezing Capacity [KW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buzau</td>
<td>550</td>
<td>65</td>
<td>10</td>
</tr>
<tr>
<td>P.Neamt</td>
<td>450</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Lugoj</td>
<td>800</td>
<td>80</td>
<td>10</td>
</tr>
<tr>
<td>Campina</td>
<td>700</td>
<td>115</td>
<td>15</td>
</tr>
<tr>
<td>Rm.Valcea</td>
<td>800</td>
<td>80</td>
<td>15</td>
</tr>
<tr>
<td>Moinesti</td>
<td>450</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>Brasov</td>
<td>650</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Tg.Mures</td>
<td>650</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Mioveni</td>
<td>550</td>
<td>55</td>
<td>10</td>
</tr>
<tr>
<td>Slatina</td>
<td>450</td>
<td>55</td>
<td>10</td>
</tr>
</tbody>
</table>

The first supermarket cascade systems were built in Romania with Carrier Hauser and EPTA products, between 2012 and 2013, with German Design. Today there are more than fifty (100) such systems, designed and built in Romanian companies as: Frigotehnica, Pro Refrigeration, DAAS and Erromed etc. Some examples of such objectives working with R134a / R744 (CO₂) are in the Table 1 and in cities as Galati, Petrosani, Navodari ; Medgidia ; Bucharest and Iasi, Constanta, Craiova Auchan (Auchan).
ECOLOGICAL ALTERNATIVE R - 744

- The first Romanian supermarket booster system was built in 2013 by Frigotehnica and belonged to Carrefour Hypermarket Galati. In 2014 and 2015 DAAS and Frigotehnica built and improved with transcritic CO₂ systems Carrefour Constanta, Ploiesti and Megamall, Vulcan Bucharest. In the present, many companies and owners are retrofitting, improving and building these ecological systems in Romania and abroad with Romanian work and intelligence.

- The R-744 transcritic new hypermarket in Galati is based on the requirements and internal design and achieved complete refrigeration plant at the proper operating conditions. Installation was made entirely of our Romanian mounting division, being subjected to a regime of installation particularly manufacturing, testing and certification considering the very high pressures. The system allows heat recovery and its use for the preparation of hot water for space heating and sanitary purposes of the hypermarket. To optimize operation in the climatic zone, technical solutions for CO₂ sub cooling and parallel compression were adopted.

In 2016 was built by Frigotehnica the first Romanian R -744 pumped system in Tulcea (Bakery).
THEORETICAL STUDY CASE

• The refrigeration system theoretically analyzed, worked with R404A refrigerant at an evaporating temperature between -23 °C and 7.2 °C and condensing temperature between 10 °C and 60 °C.

• The refrigeration (classical one stage vapor compression) system was a modulated system with two compressors and used the pulse width modulation technology. In this way the energy consumption was minimized through continuous modulation of the refrigeration capacity.

• The cooling capacity was 100 kW, condensing temperature 25°C and evaporating temperature -10°C.

• Was calculated the TEWI factor (Total Equivalent Warming Impact relations are explained in the Standard EN 378-1).
### COMPARISONS

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>R404A</th>
<th>R744</th>
<th>R717</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qₒ (kW)</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>GWP</td>
<td>3260</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TEWI [tonnes of CO₂]</td>
<td>1.125.4</td>
<td>908.4</td>
<td>886.1</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• After a global analysis of the Romanian Refrigeration situation, it could be said that our country remains a traditional ammonia user. Making an analyzes on the Romanian market during the last four years it can be concluded that the most important field where ammonia applications were used, was the food industry.

• Demonstrating a strong commitment to protect the environment through the use of natural refrigerants and most advanced refrigeration solutions, Romania decided to use green technology for CO₂ cascade, pumped and trans critic new commercial applications.

• In the theoretical study case:
  ❖ The main disadvantages of R744 are high condensing temperatures and pressures in comparison with refrigerant R404A and R717.
  ❖ From the environmental perspective (factor TEWI ) R717 and R744 have the advantage of a lower global warming potential (GWP) than R-404A.
  ❖ For the point of view of energetically efficiency and yearly consumption , the R717 is the best alternative and has a higher EER than R744 and R404A.
CERTIFICATION OF COMPANIES AND PERSONNEL INVOLVED IN THE FIELD OF REFRIGERATION AND AIR-CONDITIONING ACCORDING TO THE EU–REGULATION (CE) 517/2014
PFACR and AGFR
GOOD COOPERATION WITH:

• Representatives from the trade, including representatives from different sectors and relevant authorities such as the Ministry of Environment, Ministry of Education, MEC, R&D Inst., Universities, Standardization organizations etc.
COOPERATION WITH UNIVERSITIES

- Refrigeration;
- Thermodynamics;
- Heat and mass transfer;
- Heat Exchangers;
- Experimental models and experiments, stipulated before;
- Eco-refrigerants and UE legislation about that;
- Eco-refrigeration and UE legislation about that;
- Environmental legislation regarding the field of Refrigeration and Thermodynamics so.
Laboratories

The research team of the PFACR - AGFR and UTCB develops its work in national and international research projects.
SUCCESS !

• Thank you for your attention!
  • gratiela.tarlea@gmail.com
  • office@agfro.ro
  • www.agfro.ro