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Discussions of Session VI "Refrigeration"

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During the discussions that followed Prof. KRUSE's report, there were more remarks or comments, than direct questions concerning the papers presented in session VI.

Those comments are all mainly devoted to the working fluids used as substitutes for CFCs and HCFCs in order to respond to environmental problems, ozone depletion and global warming effects.

The first remark concerns the fact that the papers, summarized by Prof. KRUSE are coming from differents parts of the world where the regulations concerning the replacement of refrigerants are different and therefore it is not surprising that various options taken are different according to the country..

1) The first question concerns R 407c as a subtitute for R22. It seems that this mixture is missing from Prof. KRUSE's presentation of the problem and that could give the impression that in Germany mixtures are not popular or favoured.

In his answer , Prof. KRUSE said that he mentionned 407c in the first paper but that in his own slides, he avoided giving a comple list of the 19 mixtures at present on the market. He just used the word "mixtures" which comprises them all.

It is reminded that mixtures have advantages and disadvantages but a fact is that people would prefer to have pure fluids just because they are used to their behavior.

2) The second comment concerns the use of NH3 and hydrocarbons (HC) in the US and in Europe.

It seems that NH3 is more used in Europe than in the States mainly in buildings and that in Europe more used in Scandinavia and Germany than in France, mainly because of differences in regulations concerning ammonia.

Ammonia is used for air conditionning water chillers (300 to 4000 kW cooling capacity; and 6 to 12 °C evaporating temperature). There has been drastic changes in the conception of the circuits with an important decrease of NH3 content: for example, today, a 1MW installation contains only 20kg of NH3 compared to 100 kg earlier.

NH3 is used in Germany mainly because R22 will be outphased at the end of 1999.

As far as HC are concerned, there are a lot of unitary heat pumps (air to air) working with HC installed (± 100 in Germany) and today about 10000 household refrigerators are produced daily in Germany. For these applications HCs are the future, according to Prof. STEIMLE.

3) The discussion continues on the replacement of R22 in the US.

The United States are working agressively on 410b and 407c as "first generation alternatives" and at the same time are looking for “second generation alternatives”. Experiments with 407c in supermarkets are working well.

For low pressure chillers, 123 is used as a substitute for R11 but the US are also looking at 245ca (which showed to be flammable under certain test conditions).

Following these remarks, Prof. KRUSE explains that the situation in Europe is different from that in the US due to the phase out date for HCFCs (1998 in Scandinavia, 1999 in Germany, 2000 elsewhere). That’s why Europe has to decide NOW, and has no time to continue experimentations. R407c and R410a are certainly fluids for the future but for the last one we have no compressors available today.

4) Prof. STEIMLE comes back to the need of bringing together air conditionning people and refrigeration people. He reminds that for air conditionning, 2 temperature levels are needed: one (6-12°C) for dehumidifying and one (16-20°C) for cooling the ceiling.In that case water is an excellent refrigerant and s stage high efficency systems can be designed.

5) The following question is related to the environmental issues about R134a and local effects on the environment.

Prof. KRUSE repeats the figures shown on the slides: R134a has no ozone depletion effect and a low global warming effect; furthemore it is non flammable. R134a should therefore be an excellent fluid for the future not only as a substitute for R12 but also for R22. BUT national decisions are not always taken by enginneers. It has been the case in Germany where the ecologists have started a fight against R134a named “climate killer” for some possible local effects as acid rains and the result is the use of HC in refrigerators.

It is also reminded that the effect of a refrigerant on the environment is not only the direct effect due to leakage but also the indirect effect due to energy consumption, related therefore to the cycle efficiency. These effects are taken into account in the TEWI coefficient. For R134a the efficiency of the systems should be improved.

6) There has been a question about the possible improvment of the efficiency of a cooling process when using a mixture instead (Lorenz) of a pure fluid evaporating at constant temperature.

Prof. KRUSE showed that even by increasing the heat exchange area up to infinity, with the pure fluid one cannot avoid having a temperature difference betwween the fluid to be cooled and the refrigerant. On the contrary when a phase change occurs with a glide, as it is the case with a mixture, by using counterflow heat exchanger it is in principle possible to reduce the temperature difference to zero with, as a consequence, a better exergy efficiency of the process.

7) One of the paper presented by Prof. KRUSE in this session concerned the need to dehumidify air in stores where frozen food are sold.

Prof. STEIMLE’s comment on this issue is that it is better to dehumidify air with a cold surface at 5 °C than with a surface at -30°C. The efficiency of the process beeing of course much better in the first case. So, if by installing an air conditionning system one uses more electricity, one saves energy in the cooling process. The author of the paper agrees with this comment but insists that very often dehumidification is there to make customers happy, in shopping malls for instance.

7) The last question is “Why no comments about absorption systems ?”

Absorption systems have been discussed in another session. It has been shown that absorption cooling was used in Europe but connected with co-generation systems. Direct fired absorption sytems, even with two stages, are less efficient than compression systems. Only when they use waste heat from industry or cogeneration they become interesting to solve CO_2 production problems.