

European Heat Pump NEWS



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editorial

Natural Refrigerants – answer to the F-gas regulation?

The European Parliament will soon vote about the compromise of the trilogue between Commission, Parliament and Council with a substantial impact on our industry: The F-Gas Regulation will be revised. Amongst others things, the use of F-gases in special applications will soon be prohibited. Refrigerants such as R134a, R407C, R410A and especially R404A will gradually be phased out and prohibited. The question is: Which refrigerants will be best to satisfy forthcoming regulations, to enhance our products in technological terms and make them more competitive compared to conventional heating systems. Many companies in our industry have accepted the challenge and are finding new ways to use natural refrigerants. However, are these solutions for all applications?

Widespread use of natural refrigerants

Natural refrigerants are already used in many industries. One example is supermarket refrigeration with CO₂ – a virtually ideal refrigerant from an ecological and safety perspective. It is neither toxic nor flammable, has no ozone depletion potential and is chemically inactive. However, CO₂ has efficiency disadvantages in the case of low temperature applications and therefore is not the optimum solution for low temperature systems.

Ammoniac is used in large-scale industrial plants, but it cannot be applied in residential homes due to possible odors. HCs have been successfully used in refrigerators for years. In Australia more than one million vehicles are currently in operation with propane air conditioning. Without a doubt, it is suitable for use in heat pumps as well. With 3,3 it has an extremely low GWP and meets most of the environmental requirements of the new F-Gas Regulation.

The advantages of using R290 in heat pumps are obvious: Flow temperatures of up to 70°C are possible without an

additional electric heater. Even at very low ambient temperatures as low as -20°C water temperatures above 60°C can be reached. R290 will be available for a long time, which provides producers and their clients with planning reliability. The experience of several heat pump producers indicates that it is suitable for serial production and after-sales service. However, all of the prerequisites for serial use of propane in heat pumps have yet to be fulfilled.



Joachim Maul - AIT

Additional efforts and incentives required

A lot of components for HCs are available today; overall availability, however, is not yet a reality. Certainly R290 is suitable for heat pumps in outdoor areas. By reason of different standards within the EU and its classification, in several countries it cannot be used indoors without safety precautions such as a gas alarm and ventilation systems. Thus if we want heat pumps with R290 to prevail on the market, then consumers must be provided with financial incentives.

The current conclusion is that HCs are suitable for heat pumps in outdoor areas. However, due to the lack of suitable natural refrigerants, responsible use of HFCs will continue to be urgently needed for indoor applications in the foreseeable future. With regard to the phase out scenario, acceptable solutions have to be identified very soon.

Our products and technology are remarkable for their functionality – already environmentally friendly and low in CO₂ emissions. We can reinforce this aspect by indicating our use of natural refrigerants wherever possible. Nevertheless, today there is still no comprehensive solution available that is based on natural refrigerants. Nevertheless, the heat pump industry will have in the near future the legal certainty and I'm sure, we will cope that challenge at the best.

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Views on natural refrigerants

What would be the impact of the F-Gas regulations on natural refrigerants and related technologies? Mr. Kontomaris, expert from DuPont and Mr. Timm, expert from Glen Dimplex answer the questions of Ms. Eirini Litina, EHPA.



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INNOVATIVES HEIZEN UND KÜHLEN



1. Heat pumps have been identified as best in class technology for heating and cooling. Which impact does proper refrigerant choice have on the efficiency of a heat pump unit?

Mr. Kontomaris, DuPont: „Heat pumps for direct space heating and cooling have historically used HCFC-22, and HFC-based R-407C and R-410A as working fluids. With the phase-out of HCFC-22 in the European Union (EU), R-407C and R-410A were selected as they offered the best balance of capacity and efficiency for heat pump equipment. R-410A is the predominant refrigerant choice for new equipment today. With the advent of the EU F-Gas regulations for HFCs and the growing concern regarding the total carbon footprint of air conditioning, refrigeration and heat pump systems, the GWP of HFC-based refrigerants is coming under greater scrutiny. DuPont is developing a portfolio of working fluids based on Hydro-Fluoro-Olefins (HFOs) to deliver the optimal balance of environmental sustainability, including significantly reduced global warming impact relative to incumbent fluids, safety, and performance, including energy efficiency. These new refrigerants are being developed under the DuPont™ Opteon® brand name. Both non-flammable and mildly flammable (class 2L) fluids are being developed as possible alternatives to R-410A in heat pumps. Opteon® XP20 is a non-flammable fluid with a GWP of about 950 and Opteon® XL20 is a mildly flammable fluid with a GWP lower than 150. Both fluids approach the capacity and energy efficiency of HCFC-22. A third option, Opteon® XL41, is mildly flammable, has a GWP of about 460, and effectively matches the performance of R-410A.

Heat pumps for heating at higher temperatures (e.g. water heating at temperatures higher than 55 °C for domestic or commercial use, hydronic space heating, district heating or industrial heating) have been attracting a rapidly growing interest in Europe and other parts of the world in recent years. Heat pumps can reduce overall energy use, environmental impact and heating costs relative to fossil fuel or electrical

resistance heating in these higher temperature applications thanks to their high energy efficiency. HFC-134a has been used for heating at temperatures up to about 70 °C. DuPont is developing working fluids with reduced GWP to enable heat pump platforms for heating at higher temperatures and with higher energy efficiencies than feasible today. DR-65 is a nonflammable developmental fluid with a GWP lower than 950 designed for high temperature lift applications; it could enable heat pump heating with attractive efficiencies and heating capacities (e.g. substantially exceeding HFC-134a) even when the only available heat source is cold ambient air. DR-14, another promising lower GWP candidate, is also non-flammable and has a GWP of about 375; it is designed for heating at temperatures up to about 100 °C.

Heat pumps for heating at temperatures higher than 100 °C have typically used HFC-245fa as the working fluid. DR-2 is a nonflammable fluid with a GWP lower than 10 that could enable heat pumps for heating with high efficiency at temperatures up to about 160 °C. This temperature range opens a new area for heat pumps in the huge field of industrial heating by lifting lower temperature waste heat back to usable levels, thereby delivering an effective and sustainable technology to save fossil fuel on large scale. DR-2 offers both very low GWP and non-flammability, thus breaking an early stereotype about fluids based on HFOs. Moreover, it shows a remarkable thermal stability at least up to 250 °C (the highest temperature tested to date) despite its unsaturated chemical nature. DR-2 is currently under lab and field testing for various targeted applications.“

Mr. Timm, Glen Dimplex: „Generally the application gives the boundary working conditions for the heat pumps in terms of heat source and heat sink temperatures. Preliminary the right refrigerant choice enables in general the application at the given working temperatures. The refrigerant properties such as vapor pressure curve, specific volume etc. define the working conditions for the components in the system like



compressors and heat exchangers and as such they define significantly what levels of efficiency can be obtained with each component. To put it in a nut shell: the proper refrigerant makes the application and enables / limits efficiency of the heat pump.“

2. The current draft of the F-gas regulation foresees a phase-down of the availability of fluorinated refrigerants down to 21 to 16% (based on the average of 2009–2012). This raises two questions from the heat pump industry:

2.1 Will there be enough alternatives for refrigeration and AC applications that allow today's F-gases to be used for heat pumps in the future?

Mr. Kontomaris, DuPont: „DuPont is developing a broad portfolio of lower GWP, HFO-based working fluids for a variety of refrigeration, air conditioning and heat pumps applications. Some of these candidates are close matches in properties and performance to the current HFCs, enabling a cost-effective transition in new and existing equipment. Some candidates will require more substantial equipment redesign to achieve the lower GWP and desired performance. It is the opinion of DuPont that this full portfolio of options will be required for the EU to meet the proposed phase-down schedule. We are expecting that market forces will drive the market to lower GWP options, and that each market application will gravitate to the option that delivers the optimal balance of total cost of ownership, performance, environmental sustainability, and safety. We believe that this holds true for heat pumps as it does for other applications that use F-gases. Today's F-gases will be used as long as they offer the optimal balance of properties as compared to the next best available option.“

Mr. Timm, Glen Dimplex: „There is broad range of application in the HVAC and HP-industry starting and few 100 Watt s up to Megawatts. Each application has its own – over time – optimized processes and applied working substances – and as a matter of act its limits. The majority of applications are using a vapor-compressions-cycle, others such as absorption have smaller shares (also caused caused by limited choice of working fluids!). Commercialized refrigerants can be divided into groups, the main are: A.) A limited number derivates of short-chain Hydro-Flouro-Carbons (today also Olefins) and

their mixtures; B.) Refrigerants that can be found in a natural environment like CO₂, Ammonia or Hydrocarbons; C.) Others only in niches.

If the limitation will be increased more significantly or possibly completely ban substances under A.) it will get harder or impossible to find the right choices as described under 1.) without major impact on other properties such as safety, costs or performance or efficiency.“

2.2 If the first assumption is wrong and competition renders current F-gases as too expensive for heat pumps: will there be drop-in replacements available for existing refrigerants such as R-410A or alternatively, will there be new refrigerants that can be used with a limited need for the redesign of the refrigeration cycle?

Mr. Kontomaris, Dupont : „For direct space heating and cooling applications, XL41 effectively matches the performance of R-410A. Moreover, it leads to compressor discharge temperatures within the limits of currently available equipment even for air conditioning in regions with high ambient temperatures. Finally, XL41 is compatible with widely used POE type lubricants. Until work to assess the flammability risk of 2L fluids, develop safe use guidelines, revise safety standards and update building and safety codes is completed, the non-flammable Opteon® XP2o could be used with some degree of optimization of legacy equipment designs for a cost-effective transition. For higher temperature heat pump applications, replacement of HFC-134a with DR-14 could increase the maximum feasible heating temperature with largely existing equipment.“

Mr. Timm, Glan Dimplex: „The experiences of past transitions in the field of refrigerants have proven that if there are real alternatives for banned refrigerants, the chemical industry was able to provide solutions for drop-ins as well. Practically these processes of exchanging fluids or modifying cycles worked out in many case, but with at least some disadvantages in some characteristics. In practical terms it may have limited influence on the operation of the product, when it comes to optimized areas like COPs for quality labels or grants, the influence may not be neglected.“

3. To what extent do you think components such as compressors and heat exchangers will be available for the new refrigerants?

Mr. Kontomaris, DuPont: „I know of no issues that would prevent the use of largely existing equipment with the new refrigerants mentioned above for direct space heating and cooling. For higher temperature heating applications DR-14 and DR-2 generate pressures easily confined within the limits of currently available equipment. However, the realization of heat pumps capable of delivering heating at temperatures higher than about 125 °C does present equipment design challenges (e.g. high compressor discharge temperatures, lubricant stability, functionality and durability of plastic and elastomeric materials of equipment construction). Initial interactions with world-class equipment manufacturers make me optimistic that these challenges can be addressed especially given the strong motivation to replace fossil fuel heating.“

Mr. Timm, Glen Dimplex: „In general the components follow the fluids; it is a question again if there are the right fluids commercially available. If yes, component manufacturers will be able provide solution as they did in the past. With respect to heat pumps, efficiency and optimization is a very critical issue. Current refrigerants and current components have been optimized over time to a unique level in the heating industry. It is doubtful if we can achieve the same level in with new substances or at what time.“

4. How fast and in what quantities will any of the discussed alternatives be available to industry?

Mr. Kontomaris, DuPont: „Clear demand signals, such as firm regulations and customer specifications, create the demand certainty required for DuPont to make the necessary investment in capacities to meet market demand. We are currently monitoring the impact of the F-gas regulations to assess how and when market demand will materialize for our low GWP Opteon® refrigerants. We will work closely with our customers to ensure that the required products are available in sufficient volumes to meet market demand.“

Mr. Timm, Glen Dimplex: „Regarding the final products (heat pumps, air conditioning or refrigeration systems) it is a chain of commercialization from the refrigerants over the components to the final product including third party approvals. We as manufacturers of heat have to insure several aspects into the market; the right fit of the application, competitive technology and costs, availability in service cases, ease of use, reliability to the customer etc. Each of the players in the chain faces this challenge and it mainly a question of time before alternatives are fully settled. It is a question of several years to fully tackle this challenge. Do we still remember how long it took to implement hydrocarbons in smallest appliances or how long before R410A developed its role in the industry?“

5. Talking about refrigerant alternatives: what is your position on their applicability? What about the practicability of use, efficiency and safety? How do you see building codes

Mr. Kontomaris, DuPont: „We hold firm to the position that any working fluid should be selected for a given application by considering the optimal balance of properties – total cost of ownership, safety, performance, environmental sustainability – required for that application. We believe that both fluorinated and non-fluorinated working fluids have their place in the market and need to be considered on a case-by-case basis. Revisions to standards and building codes to allow safe use of the new class of mildly flammable refrigerants are underway.“

Mr. Timm, Glen Dimplex: „Referring to what was mentioned before there are several aspects in evaluating whether a substance is suitable or not. Besides general thermodynamically fit (which may end in pure theoretical applicability), ideally all stakeholders should be convinced about the advantages. Safety (no matter if pressure or flammability or toxicity) is a major issue for acceptance or applicability, ease of use for service or installation is another, environmental focusing on the fluid or its handling as well and finally social acceptance in all terms. Regulations dealing with refrigerants or its applications should be aligned to avoid obstacles or divers assessments.“

6. What is your personal expectation on the future of heat pumps?

Mr. Kontomaris, DuPont: „I anticipate that the use of heat pumps will greatly expand especially for heating at higher temperatures to reduce heating costs and environmental impacts relative to heating with fossil fuels. The comprehensive pipeline of fluids DuPont is developing promises to enable applications ranging from water heating for residential and light commercial use (including the replacement of aging boilers in Europe), to district heating and industrial heating up to temperatures exceeding 155 °C (e.g. steam generation)! The fluids are capable! The challenge now is equipment and market development. I greatly appreciate the efforts by EHPA to effectively communicate the great opportunities before us to end users, the general public and public officials with regulatory responsibilities.“

Mr. Timm, Glen Dimplex: „We live in a world where environmental care and sustainability are evident to all of us. To limit the negative impact of climate changes we try to ban harmful substances or create a transition of energy. Heat pumps are amongst the greenest heating systems and can provide a major role in the energy transition and climate change (use of primary energy, storage in smart grids etc.); industrial processes of the manufacturers are providing the right environment to avoid emissions of refrigerants. If we keep this mind and rely on our common senses we cannot effort to risk the use of heat pump technology.“



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Is your project innovative, energy efficient and relevant to the heat pump world?

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The range of candidate who can apply is broad: Cities, Regions, National associations, Projects Managers etc. If you have a heat pump project, you might be a successful applicant!

When to apply?

15.03.14: deadline for applications
15.04.14: winner will be announced
19.05.14: Award Ceremony in Berlin

Any Question?

Ask Vincenzo Belletti
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The Jury 2014



Thomas Nowak
EHPA Secretary General



Karl Ochsner
EHPA President



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Architectural Council of
Europe

Project Update: Green Heat Pump progress in the development of the evaporator unit

Thomas Fleckle
AIT Energy



Introduction

Being an efficient alternative to conventional methods for heating (e.g. gas boilers), in particular with respect to the low carbon economy, the air-water

heat pumps are the fastest growing application for heating of buildings (in particular with respect to the retrofitting). This is the main motivation for the large heat pump community, to join their efforts in improving the performance of the air-water heat pumps.

One outstanding feature of the Green Heat Pump is the usage of a brazed microchannel heat exchanger as evaporator. Its advantages, limitations and possible solutions investigated in the EU FP7 Green Heat Pump project will be presented in this article.

State of the art

Evaporators in general

In a heat pump, the evaporators' task is to extract heat from the outside so that the heat pump cycle can rise its temperature to a usable level. Therefore, in the evaporator liquid refrigerant is evaporated at low pressure. In our case, the refrigerant is in thermal contact with the outside air.

The efficiency of the heat pump is determined by the pressure difference between the low pressure side and the high pressure side which has to be overcome by the compressor.

So, for an efficient system, the evaporator should work at the highest possible pressure, and given that the pressure is determined by the boiling temperature of the refrigerant, this is equivalent to the highest possible boiling temperature. The heat transfer from the outside air to the refrigerant always requires a temperature difference, and this depends on the surface conditions (e.g. frost). For maximum efficiency, this temperature difference should be as small as possible. One possibility to lower this difference is to use large heat exchanger areas, the other possibility is to enhance the heat transfer coefficient. A large heat exchanger always means higher cost and higher space requirements, so the main effort for research and development is to augment the heat transfer properties of the evaporator.

Air side

As the water content is getting extracted from the humid air on the air side of the cold evaporator, either through condensation or desublimation, the frost or ice is being formed. This results in an air side pressure drop increase, a decrease of air flow rate, and consequently lowering of the heat transfer. Related to that, the most widely used solutions in evaporators are non-coated fins and hot-gas or reverse cycle defrosting. Nevertheless, there are different approaches (depending on the required temperature difference, air humidity and velocity) which can be used to avoid or minimize these unwanted effects.



Image 1: The small-scale wind tunnel at AIT, used for the investigation of ice formation and defrosting.

An improvement can be sought in the design and geometrical characteristics of the evaporator that will provide the most pronounced delay, if not a complete elimination of the frosting process. In that respect, different fin densities and aspect ratios will yield different flow conditions and thus different onset and growth of frost. Naturally, the treatment of the evaporator surface will have a decisive influence on the frosting performance. Either through various coatings, specific materials and/or surface structures, the frosting behaviour of the existing evaporators can be influenced. Finally, the problem with frost and ice can also be dealt with through improved energy efficient defrosting cycles.

Refrigerant side

The refrigerant inside the evaporator is boiling, thus it has a very high heat transfer coefficient compared to the one on the air side. But the heat transfer coefficient decreases dramatically in the moment the tube gets dry and no more boiling takes place. Therefore, in an evaporator having several parallel passes, it is important to distribute the refrigerant at the entrance so that in all passes the mass flow of refrigerant is adapted to the heat transferred in the pass.

When leaving the expansion valve of a heat pump, the refrigerant is two-phase. So, at the entrance of the evaporator, this mixture of liquid and vapour has to be distributed equally to all parallel passes. This usually is done by nozzle distributors or by Venturi distributors. In both, the flow is restricted and then expanded again, so the liquid phase forms a spray of small droplets entrained in the vapour phase. This spray is then distributed to the entrance of each pass.

Brazed Aluminium Microchannel Heat Exchangers

An alternative to traditionally used fin and tube heat exchangers are brazed aluminium microchannel heat exchangers. These heat exchangers, instead of round copper tubes use flat multi-port extruded aluminium tubes. In many applications this heat exchanger type is used today, for example in automotive coolers and air-conditioners and also in HVAC condensers. But for HVAC or heat pump evaporators it is not used due to problems with refrigerant distribution

and with defrosting. For the Green Heat Pump project, a brazed aluminium microchannel heat exchanger will be used as evaporator because it has the potential to integrate in a system with very low refrigerant charge and has good heat transfer properties. This, however, requires further research activities which are described in the following sections.

Current activities for evaporator design in Green Heat Pump

Air side

In this project the problem of ice formation and defrosting is being tackled using state-of-the-art fin-and-tube HEX with measures which are only of limited usefulness for brazed HEX based on MPE tubes. An immanent scientific objective here is the investigation of icing processes and measures to reduce ice formation on the HEX fins. This is done by studying surface (coating) and fin modifications at flow conditions typically found in brazed aluminium HEX.

A small-scale wind tunnel at AIT is used to analyse samples with respect to their heat transfer, pressure drop and anti-icing and defrosting capabilities. The wind tunnel, shown in Image 1, has a modular set-up to allow an easy change of the sample and is operated in the climatic chambers at AIT. Originally developed to investigate condensation effects on heat exchangers, this wind tunnel was redesigned to allow investigations of icings processes and measure up to the demands of the Green Heat Pump project.

In a first step surfaces with different fin structures and coatings were analysed by single plate experiments in the wind tunnel. The changing of pressure drop and heat transfer due to icing was investigated at temperatures around -1 °C. Based on the results of these first experiments the fins with the best anti-icing respectively defrosting behaviour will be selected and used for small HEX packages. The next step then is to investigate the influence of icing on the heat transfer characteristics in heat exchangers with different surfaces including one coated sample. Again, this is done using the small-scale wind tunnel at AIT.

Parallel to the experimental investigations, AIT performed a numerical analysis of fins frosting using OpenFOAM. From

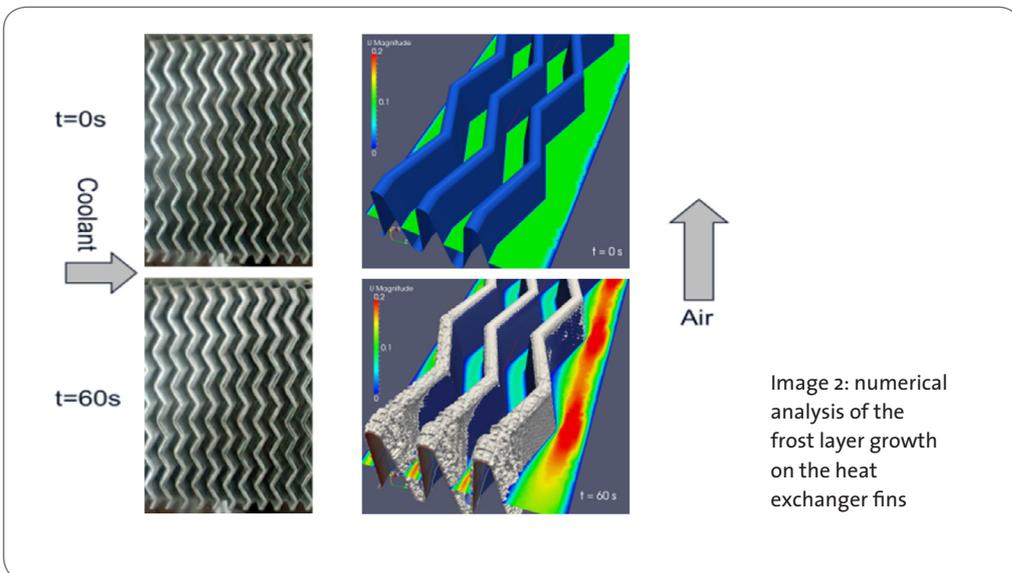


Image 2: numerical analysis of the frost layer growth on the heat exchanger fins



Image 3: Investigated prototypes of a nozzle (left) and a fractal (right) fluid distributor for model development and validation

the comparison between the experiments and numerical predictions, given in Fig. 2, it can be seen that both approaches are indicating that the most intense frosting is taking place at the most exposed fin surfaces. Furthermore, dictated by the flow characteristics of the coolant and the air, the spatial distribution for the frosting intensity can be observed: from left to right (due to the coolant flow), and from bottom to top (due to the air flow). Finally, in both approaches it is possible to determine the frosting time which will lead to the impairment of fins efficiency due to the frost blocking. The presented result is showing how the analysis of the heat pump performance with respect to frost creation can be used to identify weak points of the construction design, and also to indicate the possibilities for their improvements.

Refrigerant side

The main challenge on the refrigerant side of the microchannel evaporator lies in the equal distribution of the two phase refrigerant. Due to the small channels, a higher amount of parallel passes is required in order to avoid an unacceptably high pressure drop. Traditional nozzle or Venturi distributors require manual manufacturing and connection to the evaporator, so for a high amount of passes (up to 64) they present a high cost. Therefore, a novel fluid distribution concept is investigated in this project. The two-phase refrigerant is distributed by a set of subsequent bifurcations. A prototype of the distributor is manufactured in transparent PMMA (Image 3). This distributor is investigated at Fraunhofer ISE in a test bench to evaluate the distribution quality by means of mass and energy balancing. The test bench is able to provide a defined mass flow of propane at given temperature, pressure and phase distribution. So, different working conditions of the heat pump can be simulated and tested.

Additionally, laser-optical techniques to analyse the two-phase flow in the channels and the bifurcations are available at Fraunhofer ISE. In parallel, the bifurcations are investigated by CFD-Simulation using OpenFOAM.

Future work

The outcome of the work presented in the previous paragraphs indicates the guidelines for the improved design of air-water heat pump evaporators. Furthermore, the tendency in the overall improvement of the efficiency of these heat pumps is to focus on the adaptive control of the optimal heat release on one hand, and on the other hand to work on the favourable defrosting conditions in connection to the ventilator performance.

In that view, the presented work contributes significantly to the reaching of the main objectives of the Green Heat Pump project – development of highly efficient air-water heat pumps for heating system in urban areas. In addition to that, the air-water heat pumps also show icing on the fan blades when defrosted, and the water droplets from the defrosted evaporator freeze on the sub-cooled surfaces of the blades. Therefore, as a further aim in this project, the investigation of the icing effects on the fan blades and of measures to reduce ice formation will be performed. Fan blade tips made of different materials will be tested in the wind tunnel by AIT to investigate the effect of icing.



The Green Heat Pump Project is supported by the European Commission within the EU FP7 framework programme.



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The German „Energiewende“ and the EU policy framework: what does it mean for heat pumps?

The 7th edition of EHPA's annual Forum is back with an insightful programme and great opportunities to network and to expand your knowledge on the heat pump universe. This year's Forum will be the perfect occasion to discuss the latest regulatory issues affecting the technology. Just a few days before the European Parliament elections the programme will cover the most relevant EU policy items affecting the heat pump markets, such as:

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- The European electricity grid – excess electricity and heat pumps
- nearly Zero Energy Buildings
- Social benefits from the use of heat pumps

Next to that, there will be presentations on the European Heat Pump Market, as well as on the latest technology developments.

Taking place in Berlin, Germany one of the most important heat pump markets, the EHPA Forum will welcome representatives of manufacturers, universities, industry experts and decision makers at European and national level.

Be part of it and do not miss the chance to find out how heat pumps can contribute to the “Energiewende”!

For more information, registration and fees, please visit our website at <http://forum.ehpa.org> or contact us at forum@ehpa.org

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Meet EHPA's new members!



Panasonic

With more than 30 years of experience, selling to more than 120 countries around the world, Panasonic is one of the leaders in the heating and cooling sector. With a diverse network of production and R&D facilities, Panasonic delivers innovative products incorporating cutting-edge technologies. Panasonic's range of innovative solutions in heating and air conditioning cover both residential and commercial applications.

With demand for energy efficient heating solutions increasing, Panasonic developed its Aquarea air source heat pump range – an innovative low-energy heat pump.

The range is designed to provide extremely energy efficient heating and hot water, even when outdoor temperatures are as low as -20°C.

Offering capacities from 3kW through to 16kW, the Aquarea range is suitable for both new build and refurbishment projects. Extremely adaptable, and with various models produced for varying situations or requirements, the Aquarea range is available in Mono-bloc or Bi-bloc units, in Panasonic's High Connectivity (HC), High Temperature (HT) and Total Capacity (T-CAP) heat pump models.

Certification of Heat Pumps by SZU



The Engineering Test Institute, Public Enterprise (herein after referred to as „SZU“) having its head office in Brno, offers a complete range of services including support for introducing heat pump products in the Czech and European market. SZU is also active outside Czech Republic by obtaining for its clients all the necessary documents to launch their products in EFTA states (European Free Trade Association) and to export goods to countries such as Russia, Turkey, China, India, Korea, Brazil, and Saudi Arabia.

Moreover, SZU performs tests on heat pumps under the following schemes:

- Air/Water capacity up to 40 kW (heating),
- 25kW (cooling), temperature (-30 °C up to 45 °C)
- Brine/Water capacity up to 60 kW
- Water/Water capacity up to 80 kW
- Direct Exchange Ground Coupled/Water

SZU is also an accredited testing laboratory for tests such as π SN EN 14511, π SN EN 255, π SN EN 16147, π SN EN 14825, π SN EN 15879, π SN EN 378 and π SN EN 12102.

SZU, being the EC Notified Body 1015, has been accredited for assessment of conformity to 15 EC directives. Besides conformity assessment, SZU offers to its clients specialised services of the testing laboratory and of the certification body for certification of products, management systems and persons (including the EHPA quality label). SZU also functions as an inspection body and calibration laboratory.

SZU cooperates with many notified bodies in the EU countries and it has bilateral agreements on mutual cooperation with a number of test institutes abroad.

Will be arriving soon...

Two organisations have submitted their applications. We hope to see them join us from February on. Members who haven't voted: it still time!



The Heat Pump Association of Ireland

HPA is the industry representative body of manufacturers and importers of heat pumps in the Republic of Ireland.

Members are committed to quality and the promotion of a high standard of professionalism and service in the Irish Heat Pump Industry.

KTH, Department of Energy Technology, Division of Applied Thermodynamics and Refrigeration



KTH, or the Royal Institute of Technology, is the largest technical university in Sweden. The Division of Applied Thermodynamics and Refrigeration, a group of about 35 persons, is part of the Department of Energy Technology, in total having about 100 researchers and Ph.D. students.

The Division has a long history, starting about one hundred years ago with the development of household refrigerators. In fact, the birth of the department was closely related to the birth and growth of the Electrolux company.

During the last 35 years, heat pump research has been an important part of our work. It has often been stated that the development of the heat pump industry, and the high percentage of buildings having heat pumps, in Sweden is partly the result of the research performed at the Division. Since several years the Division is responsible for the national research program Effsys+, financed by the Swedish Energy Agency and aiming at increasing the efficiency of heat pumping systems for all applications. The Division is also participating in a number of EU, IEA and IIR projects (e.g. Ground-Med, GreenHP, NxtHPG, Exp-Heat, GeoPower, E-Store, Henix) related to heat pumping technology. Our work in these projects range from development of new heat exchanger geometries and heat transfer calculation methods to system modeling and development of heat pump systems for smart grid applications.

We have developed extensive models of heat pump systems by which we are able to do comparative, descriptive, and predictive analysis of different systems with different characteristics and components or different control strategies. The system modeling can evaluate the annual performance of

the system and it includes the detailed characteristics of heat pump components, different heat sources (e.g. borehole heat exchanger, exhaust air, etc.), and different types of buildings and heating distribution systems.

Recently, we analyzed more than 80000 faults which have been reported to heat pump manufacturers and an insurance company. Based on this analysis, the most common and the costliest faults which occurred in the heat pump systems were determined. The results are used in order to develop a Smart Fault Detection and Diagnosis (SFDD) mechanism for heat pump system. The SFDD can be used to detect the faults in installation and operation phases and also to help the technicians for fault diagnosis, similar to what is used in car industry.

Since many years we have been interested in the application of natural refrigerants. In our lab we have trans-critical CO₂, small DX ammonia, and HC systems. However, we are also evaluating the performance of systems with new HFCs, often referred to as HFO.

Geothermal heat pumps, and energy storage in borehole fields is another focus area at the Division. By using fiber optic temperature measurements we have been able to develop Distributed Thermal Response Tests which allows evaluation of the ground surrounding the borehole at different depths.

Our work is mainly focused on vapor compression systems, but we have some projects on other technologies, as ejector- and magnetic cooling processes.



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The development of heat pump compressors under the influence of emerging new refrigerants

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Under the influence of new European regulations, new refrigerants are emerging also in heat pumps, raising questions of what new compressor designs are necessary to utilize these new refrigerants. Image 1 gives a good overview of the presently used refrigerants and new refrigerant alternatives. The x axis shows the Global Warming Potential (GWP) value while the y axis shows indicators like pressure, cooling or heating capacity. In addition, typical applications of these refrigerants are given. On the far right we see the most commonly used refrigerant R410A with 2088 GWP and what we call intermediate refrigerants like R407F and R407A, all in the range between 1500 and 2000 GWP. All of these refrigerants are A1 class refrigerants, which means they are not flammable.

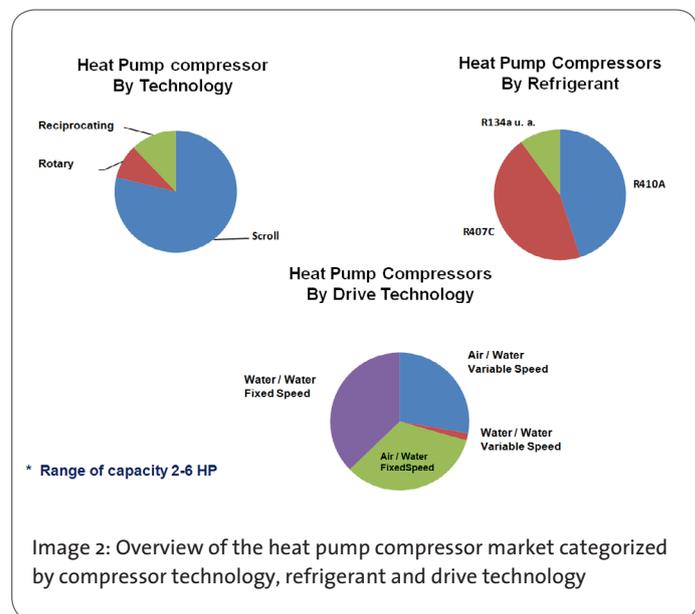
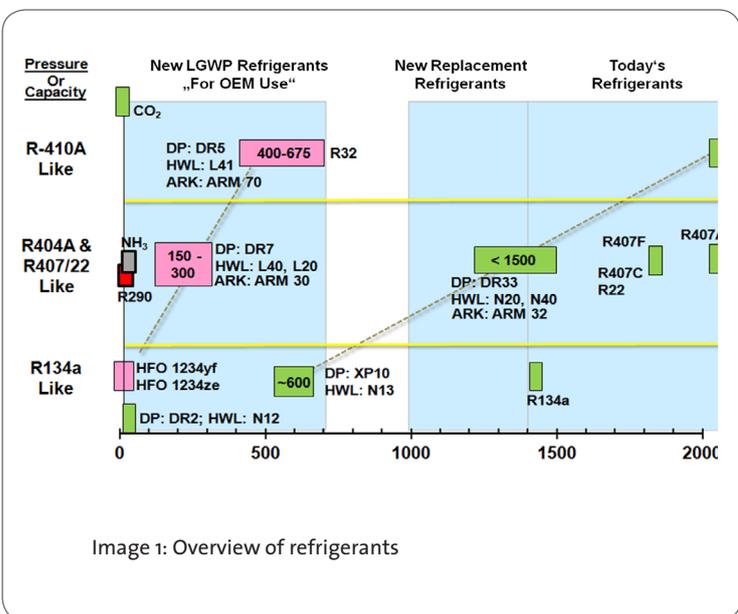
As we go down in GWP, we enter a region where refrigerants are flammable, either A2L or of A3 category. CO₂ with a GWP of 1 is an exception in the group of the most interesting candidates in this region as CO₂ is non-flammable (of course) while R32 with 675 GWP is flammable like many of the low pressure refrigerant mixtures based on the HFO molecules R1234yf and R1234ze. The refrigerant manufacturers try to develop blends on the basis of these two HFO alternatives in order to simulate the thermodynamic behavior of traditional refrigerants such as R404A. In this article we will mainly concentrate on the alternatives R32, R290, R1234yf, R1234ze as well as on L41 which is a blend of an HFO and other components.

When talking about future compressor technologies it is necessary to set the proper benchmark and image 2 gives a market overview of heat pump compressors categorized by compressor technology, refrigerant and drive technology.

The vast majority of heat pump compressors today are of scroll design, although there are some reciprocating compressors and rotary compressors. However, scroll compressors set the standard for heat pump compressors. Regarding refrigerants, the market is almost equally divided between R410A and R407C, with a relatively small fraction of R134a. R410A has gained so much influence within the past years that it has become a benchmark for an outlook into the future.

Considering motor technology, a large portion of fixed speed motors are still used, but variable speed is also gaining high share and has a substantial growth rate for air to water heat pumps. For water to water heat pumps, fixed speed technology is still the predominating technology. Given the market potential for new heat pump installations we will consider variable speed motors as the dominating technology for this article.

Image 3 gives an overview of the main design features of compressors dedicated to heat pump applications. They have a vertical design with either a standard induction motor or with a brushless permanent magnet motor in the lower part of the compressor. The scroll elements have certain





components embedded such as additional bypass valves or check valves in order to generate good performance at high pressure ratios as well as good performance at lower pressure ratios. This is instrumental for a good seasonal COP (Coefficient of Performance). When variable speed motors are used, it is necessary to provide a positive displacement oil pump which provides oil from the sump of the compressor to the scroll elements and to the bearings. An additional shell penetration is often needed to provide the vapor injected gas into the scroll elements. These features are designed to provide high average or rating point efficiencies or COPs for the compressors, which is a very important point to meet the operating map requirements for heat pumps. These operating envelopes for heat pumps are specifically demanding if they are used for air to water heat pumps.

Image 4 shows the typical operating map with a limitation set by the compressor from scroll stability limit, the motor limit and also from the condensation temperature which is given by the ability of the pressure enclosure to withstand pressure. Three demand lines are shown. The first corresponds to a typical demand line for underfloor heating (yellow) and the second for radiator heating (red). The third line (green) shows the demand for domestic hot water at a constant condensing temperature of about 65°C. In the upper left corner we see that the temperature limit has been exceeded and that the compressor can only operate in this region with vapor injection and particularly with wet vapor injection.

From a recent field test we had the opportunity to see how these compressors behave in reality and image 5 shows the result of the R410A compressor with variable speed used for a house in Germany with radiator heating. The upper part of the right picture shows the operating times over approximately half a year and the size of the bubbles indicates the time spent in those operating points. It is apparent that most of the time the compressor operates at relatively moderate condensation and evaporating temperatures and that hardly any time is spent in the very demanding region at the upper left side. We can also see that the high speeds of the compressor are very rarely operated as the compressor operates most of the time at relatively low speeds around 1800 to 2000 RPM. This is true for almost half of the compressor's lifetime.

The conclusion of this is that the ambition of the compressor designer should be to maximize compressor efficiency in that area where the compressor operates most of the time while technically the most demanding operating points are hardly ever being used by the compressor. This knowledge can be condensed into some main aspects of the compressor design which have to be clarified before a new compressor design is being approached:

- Firstly we need to define the optimizing target for compressor COP. Is it a nominal point or is it a seasonal average? Or do we want to have a compromise of both?
- Secondly we need to define which nominal heating capacity should be achieved. Is it for a heat pump with additional

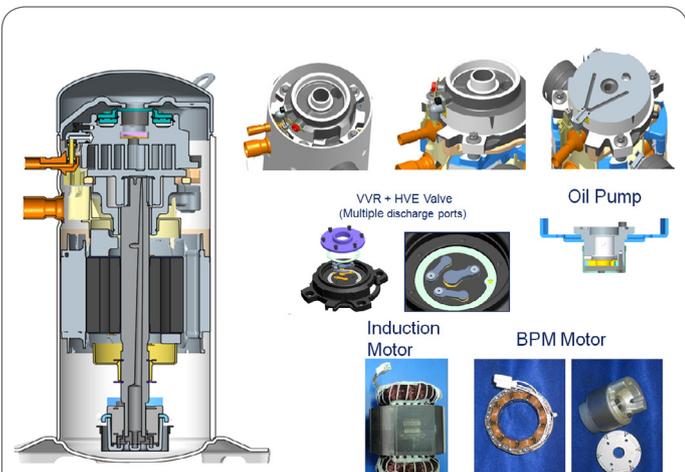


Image 3: Main design features of compressors dedicated to heat pump applications

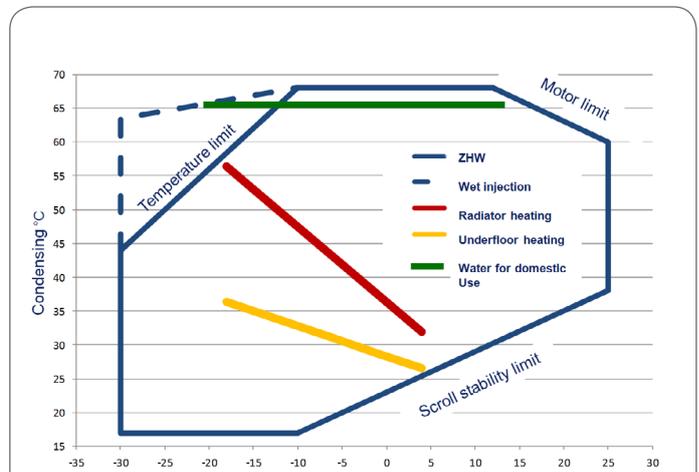


Image 4: Operating limits of a compressor dedicated to heat pump applications

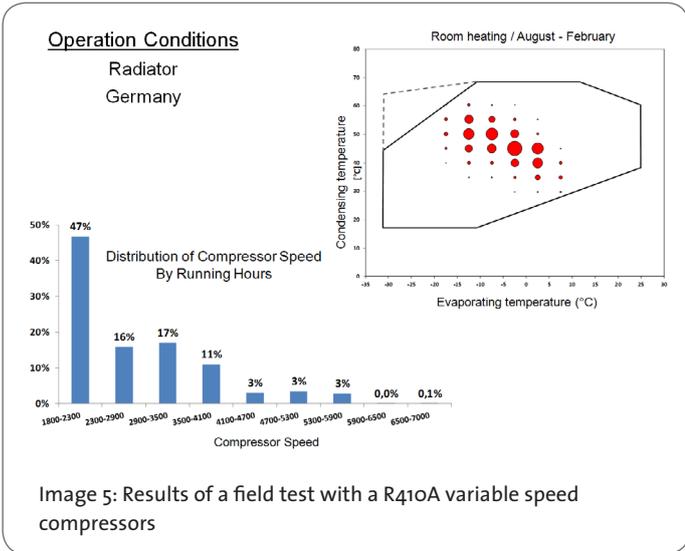


Image 5: Results of a field test with a R410A variable speed compressors

Refrigerant	GWP	Pressure @ 5°C (bar)	Pressure @ 68°C (bar)	Refrigerant Volumetric Capacity	Compressor Discharge Temp. (°C) (*)	Safety Group
R410A	2088	9	45	100%	110	A1
R407C	1774	5	30	64%	102	A1
R744 t/c *	1	40	120	290%	135	A1
R290	3	5	25	60%	85	A3
R1270	2	7	30	73%	96	A3
R32	675	9	47	113%	146	A2L
R1234yf	4	4	20	39%	71	A2L
R1234ze	6	3	15	31%	77	A2L
L41-2	500	7	39	86%	127	A2L

*Gas Cooler: 40°C

Reference refrigerant: R410A
(*) at -10° /50°/ 0° / 5K

Legend:
 Negative (Red)
 Acceptable (Yellow)
 Positive (Green)

Image 6: Refrigerant alternatives

electrical heating or without? This defines very strongly what should be the maximum nominal heating capacity.

- Thirdly, given the fact that with variable speed we have another parameter available, the speed range and the corresponding scroll design have to be matched. Concerning speed, it is important to understand that high speed is not always a problem. Low speeds are equally challenging! Likewise, on the scroll side it is always a challenge to design rather large or rather small scrolls. As for the operating conditions, it is important to decide whether the compressor is made for a heat pump for underfloor heating or for radiator heating. Or if domestic hot water supply has to be generated as well.

Image 6 gives an overview of the number of candidates with regards to several criteria. As a benchmark R410A and R407C are listed and then there are the most likely candidates listed from Propane or R290 down to L41 which is an HFO blend. Criteria shown are GWP, pressures, specific volumetric capacity, and of course the safety class. There was a relatively

arbitrary categorization of the numbers into red, yellow and green color coding. Red being negative vs. what we have today, yellow being in a relatively acceptable range and green being positive. Without going through a detailed discussion it is apparent that none of the refrigerant candidates have an all green or green and yellow line. Each of those candidates have some red fields that indicate that there is some challenging work to be done. In other words it is not possible to select one optimum candidate refrigerant purely from such a comparison. It is apparent that a compromise has to be made in order to balance all of these various aspects.

Image 7 shows how the refrigerant properties influence the compressor design. It is clear that refrigerants have many properties and that many compressor design features can be influenced by them.

The question then arises how a differently chosen refrigerant with its properties influences a new compressor design and how this design varies from a R410A optimized design which

Refrigerant Properties	Compressor
Pressure	Body design Strength - built-in parts Internal tightness
Pressure ratio	Scroll design
Chemical properties	Material compatibility
Refrigerant volumetric capacity	Dimension scroll elements Motor selection Size
Isentropic exponent	Scroll design Application limits Measure for discharge gas cooling
Thermodynamic properties (density, cp, ...)	Compressor COP Gas Flow / Pressure losses Internal heat transfer
Convective properties (viscosity, conductivity)	Compressor COP Motor cooling
Oil compatibility	Oil selection Bearing design

Image 7: Influence of refrigerant properties on compressor design

Design Features	Design Changes vs. R410A				
	R744 (CO2)	R290 (Propane)	R32	R1234yf R1234ze	L41
Body design	Red	Green	Green	Green	Green
Scroll design	Red	Red	Yellow	Red	Yellow
Oil Selection	Red	Green	Green	Yellow	??
Strength Built-in parts	Red	Green	Green	Green	Green
Motor Selection	Red	Yellow	Green	Red	Yellow
Material compatibility	Red	Green	Green	Green	Green
Application Limits	Red	Green	Red	???	???
Measure for gas cooling	Red	Green	Red	Green	Red
Bearing Design	Red	Green	Green	Green	Green
Internal Tightness	Red	Green	Green	Green	Green
Gas Flow / Pressure Losses	Red	Green	Green	Green	Green

Legend:
 Substantial Change (Red)
 Change in testing (Yellow)
 Small Change (Green)

Image 8: Compressor design changes caused by refrigerant changes

	Refrigerant			
	R744 (CO2)	R290 (Propane)	R32	HFO/R32 Blends
Status	ISO 68 VG POE In production	ISO 32VG POE in production (reciprocating) ISO 68VG POE in qualification (Scroll)	ISO 32VG POE in production	POE variation in Testing
Problem	Lubrication at Mixed Friction	Lubrication at mixed friction High refrigerant solubility Viscosity reduction	Miscibility Gap High refrigerant solubility Viscosity reduction	Limited Experience
Alternative Oil	Alternative POEs & Additive in testing	n/a	Improvements in testing	In testing

Image 9: New refrigerants require specific oils

COP Potential vs R410A at:

	7/35°C		-10/50 °C	
	R290	-7%	4%	9%
R32	-1%	1%	-2%	3%
R1234yf		3%		1%
R1234ze		5%		5%
L41	-5%	1%	-2%	3%

Tested
Calculated

Image 10: COP changes of the listed refrigerants vs. R410A

is what we have today. This is shown in image 8. Here we are taking the design features from the previous image and show to what extent these individual design features have to change if an R410A base compressor has to be adapted to a new refrigerant. Obviously CO₂ with all red boxes is the most challenging design for new refrigerants in that respect and therefore a highly unlikely choice. On the other hand looking at propane, R32 with HFO blends and L41 there are also some red boxes which indicate that a substantial modification is required but there is certainly also a lot of green ones which means there is really no change to be done and also some of the yellow boxes indicate that only minor changes need to be done. The question marks also indicate that there are still some open topics on how to do an optimum design for the individual refrigerants.

Another aspect is the choice of the oil which is shown in image 9. While these oils are available for the refrigerants listed, there is still some work to be done to satisfy the requirement for a safe and reliable operation. Nevertheless while this work has to be done, the message is that oil is

available but work still has to be done to get as good an oil behavior as with existing products on the market. Of course an important aspect is the topic of compressor performance or COP.

Image 10 shows the COP changes of the listed refrigerants vs. R410A for two representative operating points. The available data for these refrigerants still leaves some uncertainties. The table shows some tested data in blue and calculated data in yellow. It is important to point out that these tested data are coming from non-optimized compressors. In other words these are drop-in results in the majority of cases, while the yellow numbers are derived from the thermodynamic properties of the refrigerants in combination with certain assumptions on compressor behavior. The overall message is that these changes can be done with a relatively minor impact upon COP. Moving to smaller GWP refrigerants does not necessarily mean that the performance or the efficiency of these compressors will have to suffer and there is still some room to improve the tested data by optimizing the compressors for this specific refrigerant chosen.

SWEP aims for Ecodesign targets with brazed plate heat exchangers

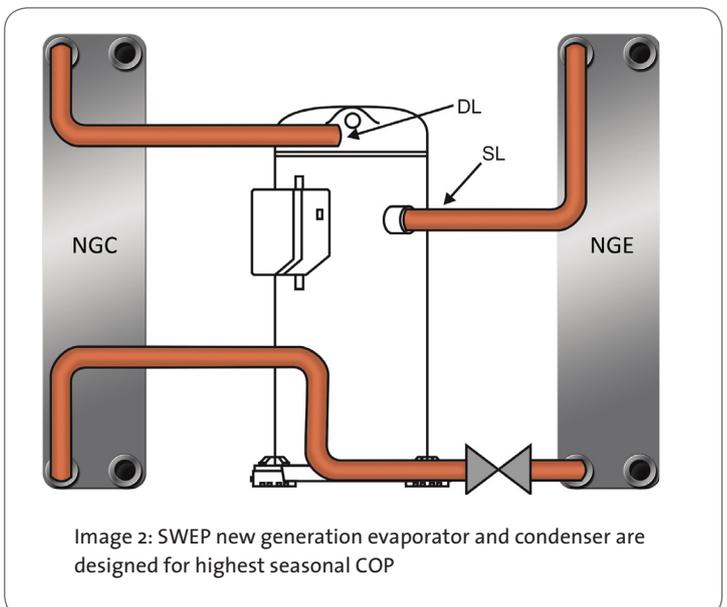
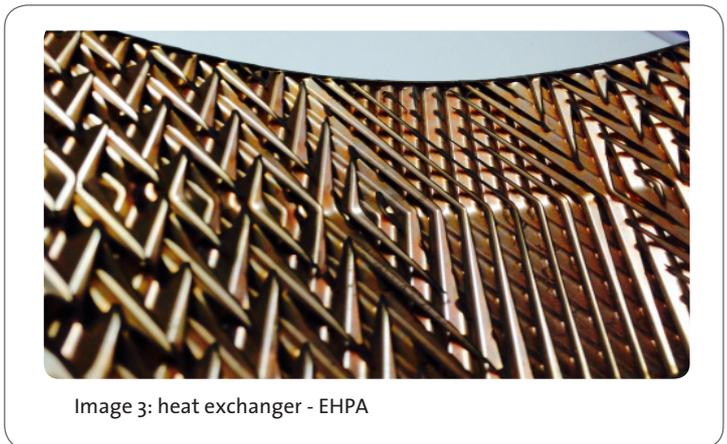
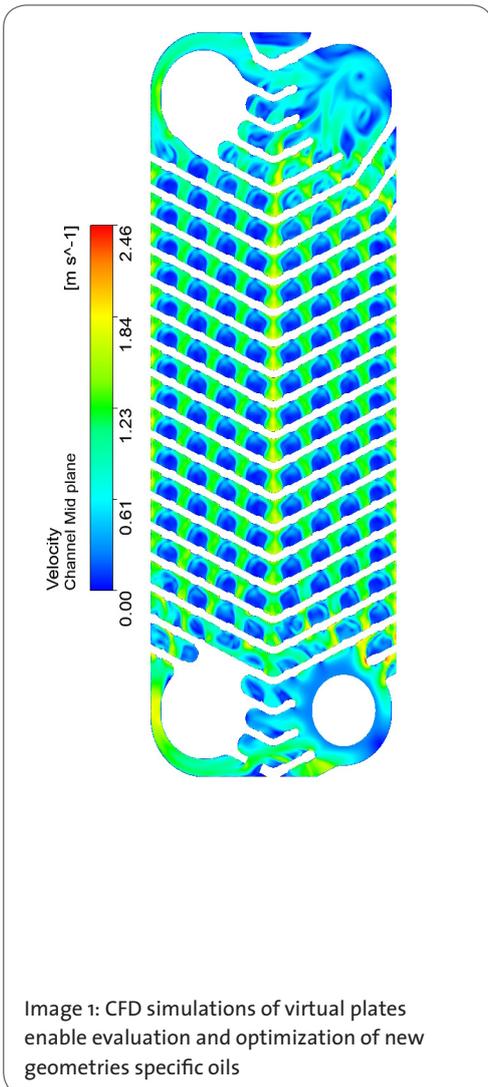


The Ecodesign directive aims at setting mandatory requirements for energy efficiency. When Ecodesign Lots 1 and 2, concerning heating systems and water heaters, are implemented in September 2015, they will increase transparency and facilitate performance comparisons between heat pumps and other heat source alternatives. This will lead to opportunities to diversify heat pump technology for a wider range of market niches, and increase demand for heat pump components developed for seasonal efficiency.

SWEP's development of brazed plate heat exchangers (BPHEs) is based on a combination of application knowledge and design innovation. Computational fluid dynamics (CFD) simulation and braze point modelling are used to evaluate and improve new plate geometries on heat transfer performance, flow distribution and freeze behavior.

A new generation of dedicated ground source condensers (NGC) and evaporators (NGE) will be launched in 2014, designed to optimize seasonal COP and achieve the highest energy class (A+++). Asymmetric plate design and enhanced refrigerant distribution improves performance while minimizing the pressure drop and refrigerant charge. SWEP's aim is to optimize energy efficiency and material utilization for the highest sustainability.

SWEP has been producing BPHEs since 1983. The first products designed for heat pumps were launched in 2005, and the company now offers the market's most comprehensive product portfolio for heat pumps.



Spanish Tax on Fluorinated Greenhouse gases



Last October 31st, the Spanish law 16/2013 came into force which established certain measures in environmental taxation and adapted other tax and financial measures. It also introduced the article 5 regarding a tax on Fluorinated Greenhouse gases.

In summary the most relevant aspects of this tax are:

Type of tax: Indirect tax that levy, one single time, the consumption of fluorinated greenhouse gases based on their Global Warming Potential (GWP).

Taxable event: The tax will be applied to the first sale or delivery of fluorinated greenhouse gases having a GWP higher than 150, after its manufacture, importation or intra-community acquisition.

Exemptions: Are exempted from taxation all fluorinated greenhouse gases intended to load for the first time new equipment or installations as well as gases imported or acquired inside new equipment.

Tax rate: The tax rate is the result of applying a coefficient of 0.020 to the GWP corresponding to each fluorinated gas, with a maximum of 100 Euros per kg, as per the tariff reflected in the text of the law.

Transition period: For years 2014 and 2015, the fee to be applied will be calculated by multiplying the tax rates established for each fluorinated gas, by the coefficients 0.33 and 0.66 respectively.

The table below shows, as an example, the actual tax rate of three different HFCs during the transition period and afterwards.

Regenerated and recycled gases: The tax rate is applicable to recycled and regenerated gases will be the result of multiplying the full tax rate corresponding to each gas by a coefficient of 0.85.

Repercussion: The taxpayer will transfer the amount of the tax on to the purchaser reflecting on the invoice this concept separately from the rest of the items.

Deductions and refunds: The actual text allows for some deductions and refunds under the conditions determined by a further regulation that will develop and clarify the law. One case is, for instance, when it is proved that the delivery of the fluorinated greenhouse gas was delivered to a waste manager, recognized by the Administration, for the purpose of its destruction, recycling or regeneration.

Date of application of tax: January 1st, 2014.

All the above points refer to the main aspects of the law as approved by the government but the initial text, known by AFEC on July, included other aspects, such as application of the tax to all non hermetically sealed equipment, new or not, and did not consider any transition period.

Immediately after knowing of the existence of the draft AFEC, prepared several position papers and sent them to the Spanish Tax office, the Spanish Climate Change Office and the Ministry of Industry, expressing our concern and position.

Our argumentation was based basically on the following aspects:

A. From the economic point of view the application of the tax on HFCs, would lead to a disproportionate increase in the price of gas with a significant impact on the prices of air conditioning equipment as outlined in the following table, calculated with conservative criteria, which was part of the information prepared by the Association. (See table 2)

B. For climate reasons the air conditioning plays a prominent role in Spain both economical and socially and the application of the tax would worsen the already difficult situation of the sector as it can be easily understood when comparing 2012 sales figures with those of year 2007.

C. As a result of the new tax, small installers could be forced to join the black economy and get the supplies of fluorinated gas from the black market due to the lack of enough working capital necessary to cope with the price increase of the gas.

Fluorinated greenhouse gas	Global Warming Potential	Tax (€/kg) 2014	Tax (€/kg) 2015	Tax (€/kg) 2016 and on
HFC-32	550	3.63	7.26	11
HFC-134	1.100	7.26	14.52	22
HFC-134a	1.300	8.58	17.16	26

Table 1

Some other aspects like for instance the relatively small tax levy coming from these units were also part of the discussions maintained, jointly with other associations, with the Tax Office civil servants and with the responsible people from the Climate Change Office. Finally a new text was adopted for the legislation.

At the time of drafting this article the above mentioned Regulation was addressed to clarify certain aspects of the law in the phase of the final approval by the government but as far as we know the wording is so complicated that it will not solve certain questions that will arise when the tax will be applied.

About AFEC. AFEC, which stands for Air Conditioning Equipment Manufacturer's Association is a not for profit organization founded in 1977 formed by 65 manufacturing companies active in the air conditioning field.

The purpose of the Association is to represent, manage and defend the professional interests of the manufacturers of air conditioning equipment.

	Average capacity (kW)	Average refrigerant load (kg)	Refrigerant cost (Euros)	Impact on cost of equipment (%)	Total tax on final price (% including VAT)
Package units	< 12 kW	3,50	138,25	12	36,08
Package units	> 12 kW	7,00	276,50	7	29,70
VRF Systems	30 kW	15,40	608,30	6	27,99

Table 2

	Sales 2007 (MM Euros)	Sales 2012 (MM Euros)	2012 vs 2007
Package units < 12 kW	194.000.000	70.000.000	36,08 %
Package units >12 kW	64.500.000	34.000.000	52,71 %
VRF Systems	201.000.000	83.500.000	41,54 %
TOTAL market	459.500.000	187.500.000	40,80 %

Table 3



Heat pumps: best-in-class technology for heating & cooling event

An event in conjunction with the Conference on Product Policy – International Trends in Ecodesign & Energy Labelling.

The European Heat Pump Association (EHPA) warmly invites you to its event „Heat pumps: best-in-class technology for heating and cooling.

This event will focus on the impact of the Ecodesign Directive on heat pumps in light of its recent adoption (09/2013). The event will be organised in conjunction with the Conference on Product Policy – International Trends in Ecodesign & Energy Labelling (20-21/02/2014)

Speakers – different heat pump stakeholders and EU officials – will cover topics such as the manufacturer perspective for different market segments, the quality label and the impact of the EU legislation on consumers' purchasing decisions.

Practical info:

Venue:

Jenk room, Charlemagne Building
Rue de la Loi, 170 - Brussels

Date: 19.02.2014

Time: 16:30 - 18:00

To register: eirini.litina@ehpa.org

The future is now

Heat Pumps with propane – experience at ait-deutschland



Joachim Maul - AIT

The changes are coming – sooner or later fluorinated refrigerants will be regulated by new guidelines and then disappear from the market as a final consequence. The future F-Gas Regulation of the European Parliament will presumably limit the use of F-Gases to a not inconsiderable extent within a certain transition period and even prohibit such use in some applications.

This step was anticipated and thus ait-deutschland began several years ago with the development of heat pumps that operate with natural refrigerants. The new generation of propane (R290) operated heat pumps were successfully launched on the market. Initial experience has shown that consumers have accepted the models using natural refrigerants. In addition to environment friendly heating, this also is due to several “classic” features such as less noise, a good COP and high temperatures how they can be attained in particular with propane.

It is known that R290 falls into Classification A3. Thus due to existing international standards we only use this refrigerant in heat pumps for outdoor areas. Three capacities are available with 5, 7 and 9 KW at A2/W35. Each of them comes in a compact mono-block design with water piped into the indoor area.

In the preliminary stages of our development we verified all options in terms of natural refrigerants. We ultimately decided to use R290 as, from our point of view, it offers the most advantages:

- With the extremely low GWP of 3.3 it anticipates the expected requirements of the new F-Gas Regulation.
- Excellent limitations of use: Flow temperatures of up to 70°C are possible without an additional electric heater; therefore R290 is well-suited for use in renovation projects.
- Water temperatures above 60 °C can be reached even at very low ambient temperatures of as low as -20 °C.

- R290 will be available for a long time, thus offering manufacturers and their clients planning reliability.
- It is suitable for serial production without considerable additional effort and is uncomplicated when it comes to after-sales service.

One of the challenges in models operated with propane is to construct them in such a way to make sure that the refrigerant is unable to ignite or come into contact with hot surfaces or penetrate the interior of the equipment. This was made possible through simple design arrangements such as additional sealants, and was certified in extensive tests by the German safety standards authority TÜV. Furthermore, we use a special oil in order to provide for optimum lubrication.

However, the specific technical precautions required for using R290 are acceptable. These include propane sensors at the filling stations in our production and test facilities. Additional testing scenarios were setup due to pressure resistance, stability and especially the tightness of the electrical box.

Our initial experience has demonstrated that R290 is suitable for series production of heat pumps. In addition, it is easy to handle when it comes to service. The costs are within the scope of those for HFC-operated head pumps. Training of production staff, service technicians and customers is necessary, as in the case of every other refrigerant. Moreover, less components are required in order to reach comparable temperatures than in the case of compressors with EVI technology.

The results show, the first steps have been taken – the future of the heat pump with natural refrigerants at ait-deutschland has begun.



Image 1: LWD Wärmepump Alpha Innotec



Image 2: AIT model

EHPA warmly welcomes new members in the secretariat team!

Pascal Westring is the new EHPA team member responsible for the statistics. As a graduate Economist he is delighted to bring his experience in market research and number crunching to the EHPA team. He is particularly interested in data reporting methods that turn complex databases into simple and accessible visual aids and enjoy presenting such information in innovative ways. He is looking forward to a good collaboration with EHPA members in order to maintain or even raise quality of our reports and insights on the European heat pump market.

Pascal Westring | pascal.westring@ehpa.org



Vincenzo Belletti is our new project assistant. Vincenzo graduated in International Relations at the University of Napoli Federico II. Shortly after graduating he moved to Brussels to work at the European Parliament and EUROCITIES, where he developed a strong interest in EU environmental and energy policies. His main tasks will be to assist in EHPA's communication and projects such as the Heat Pump City of the Year.

Vincenzo Belletti | vincenzo.belletti@ehpa.org



next meetings

EHPA Events

EHPA Manufacturer Com. Meeting
21.01.2014 | Brussels, BE

EHPA Board & Sco Meeting
21.01.2014 | Brussels, BE

Delta-EE & EHPA HP Round Table
06.02.2014 | Paris, FR

EHPA Technical WG Meeting
17.02.2014 | Brussels, BE

EHPA Quality Label Committee Meeting
18.02.2014 | Brussels, BE

Best-in-class technology
19.02.2014 | Brussels, BE

EHPA Manufacturer Com. Meeting
26.03.2014 | Brussels, BE

EHPA Thermally Driven HP WG
15.04.2014 | Paris, FR

EHPA EduCom. Meeting
24.04.2014 | Stockholm, SE

EHPA General Assembly
19.05.2014 | Berlin, DE

7th EHPA Heat Pump Forum
20.05.2014 | Berlin, DE

EHPA Manufacturer Com. Meeting
27.05.2014 | Brussels, BE

EHPA Technical WG meeting
03.06.2014 | Stockholm, SE

EHPA Quality Label
Committee Meeting
04.06.2014 | Stockholm, SE

Project Meetings

GreenHP Consortium Meeting
23-24.04.2014 | Germany

Other Events

Cold Climate event
23-24.01.2014 | Gorinchen, DE

World Sustainable Energy Day
26-29.02.2014 | Wien, AT

Mostra Convegno
18-21.03.2014 | Milan, IT

11th IEA Heat Pump Conference
12-16.05.2014 | Montreal, CA