Workshop for Heat Pumps for Low GWP Refrigerants During The 14th IIR-Gustav Lorentzen Conference on Natural Refrigerants - GL2020

Location: Virtual Meeting

Time: 20:00 – 23:00 (Japan Time) on 7th Decmber 2020

Organizer: Yunho Hwang (IIR Commission B1 President, IEA HPT's ANNEX54 Operatingt Agent)

Agenda

1. "Introduction of *IEA HPT's Annex 54 for Heat Pumps for Low GWP Refrigerants*" by Dr. Yunho Hwang (US)
2. "NEDO's efforts in research and development of natural refrigerant utilization technology" by Mr. Masamichi Abe (Japan)
3. "Application of natural refrigerant R290 as the replacement of current refrigerants" by Dr. Thore Oltersdorf (Germany)
4. "Systematic application of the decision-making process for the fluid selection of natural refrigerants in heat pumps" by Mr. Christian Vering (Germany)
5. "Condensation and flow boiling heat transfer of hydrocarbons in minichannels" by Dr. Stefano Bortolin (Italy)
6. "Natural refrigerants for residential air-conditioning systems: component research review and novel system design" by Dr. Tao Cao (US)

Abstracts

1. "Introduction of *IEA HPT's Annex 54 for Heat Pumps for Low GWP Refrigerants*" by Dr. Yunho Hwang (US)

In 2019, IEA Heat Pump Technology started *Annex54: Heat Pumps for Low GWP Refrigerants* for promoting the application of low-GWP refrigerants including natural refrigerants to accelerate the phase down of high-GWP HFCs and developing design guidelines of optimized components and systems for low-GWP refrigerants. Annex54 successfully started in 2019 with four member countries with four new member countries joined in 2020 and successfully complied 2019 Country report. Annex54 planned to organize two workshops and two expert meetings annually to achive its goal. Current workshop focuses on natural refrigerants.

2. "NEDO's efforts in research and development of natural refrigerant utilization technology" by Mr. Masamichi Abe (Japan)

In the 2016 Kigali Amendment to the Montreal Protocol, specific rates and schedules for reducing hydrofluorocarbon production and consumption were presented. It is therefore becoming urgent to develop both alternative refrigerants with lower greenhouse effects and refrigeration and air conditioning equipment using such alternative refrigerants.
The New Energy and Industrial Technology Development Organization (NEDO) has been actively engaged in research and development of low GWP alternative technologies.
This presentation will focus on development of technology for low-GWP equipment systems by natural refrigerants and assessment of the safety of natural refrigerants in NEDO Projects.

3. "Application of natural refrigerant R290 as the replacement of current refrigerants" by Dr. Thore Oltersdorf (Germany)

This contribution condenses findings on worldwide activities in the last 10-15 years for the experimental comparison on A3 and A2L refrigerants in comparative tests with each other and with the refrigerants to be replaced. Similar to AREP II we will present the current state on a "soft optimization" measure to compare a R32 (high pressure) system (compact outdoor unit) to a R290 (mid pressure) system with adequate/needed adjustments therefor.

4. "Systematic application of the decision-making process for the fluid selection of natural refrigerants in heat pumps" by Mr. Christian Vering (Germany)

The selection process of optimal natural working fluids is challenging because of a large number of both various applications and different boundary conditions. In addition, different stakeholder imply various weightings of each boundary conditions. A guided procedure that takes stakeholder into account is therefore promising to support the selection of a reasonable working fluid for future applications. Applying the prescriptive decision theory in combination with the PROMETHEE method, we demonstrate a guided decision process to determine natural working fluids regarding predefined weighted boundary conditions. This procedure is summarized in a tool with graphical user interface, which is freely available and open source. Utilizing this tool, we are able to estimate reduced numbers of possible natural working fluids for heat pump systems in residential buildings from different stakeholder perspectives. As a result, hydrocarbons and their mixtures represent a good choice of working fluids.

5. “Condensation and flow boiling heat transfer of hydrocarbons in minichannels” by Dr. Stefano Bortolin (Italy)

Hydrocarbons present very low values of GWP together with favorable thermodynamic and transport properties that make them attractive for use in heat pump systems. Due to their flammability, the realization of low-charge heat transfer devices (e.g. minichannels heat exchangers) is important for a wider use of these natural refrigerants. Heat transfer coefficients are measured during condensation and flow boiling of propane (R290) and propylene (R1270) inside a 0.96 mm internal diameter minichannel. The effects of mass velocity, vapor quality and heat flux are discussed. The database is compared against some predicting correlations available in the literature. Measured heat transfer coefficients are also compared against data taken with HFC/HFO non-azeotropic mixtures.

6. “Natural refrigerants for residential air-conditioning systems: component research review and novel system design” by Dr. Tao Cao (US)

Natural refrigerants have been considered for residential air-conditioning systems for a long time. The ever-rising environmental concerns have prompted the resurgence of natural refrigerants, such as R290, H_2O, and CO_2 in residential air conditioning systems. We will review the latest research advancements on components to accommodate natural refrigerants. Our focus will be primarily on heat exchangers and compressors, which are the majority of research interests. Then, a novel system design using R290 is proposed and investigated. The system integrates the advancements of component designs to address the balance between the efficiency and flammabilities of hydrocarbons. In the end, we will suggest future R&D directions of component designs and ways to integrate them for natural refrigerants in residential air conditioning systems.