Report from Selected Technical Sessions

In the vibrant atmosphere of the 14th IEA Heat Pump Conference held in Chicago, a diverse array of experts and enthusiasts gathered to engage in illuminating discussions and presentations that propelled the frontiers of heat pump technology. This section unveils a concise yet comprehensive summary of the captivating insights shared during the conference's presentation sessions. All papers from the conference can be found in the HPT TCP database: www.heatpumpingtechnologies.org/publications

Industrial Heat Pumps and Waste Heat Sessions

by Michael Lauermann

In the keynote session, Takenobu Kaida et al. discussed Japan's current status and future prospects for industrial heat pumps. The technology status was presented from a Japanese perspective, including the availability of air-source and water-source heat pumps that can reach temperatures up to 175°C.

Development perspectives were explored, such as the use of refrigerants with lower global warming potential (GWP) and achieving higher supply temperatures above 120°C. Refrigerant selections were analyzed, and diagrams were used to illustrate the relationship between lift and maximum supply temperature. The session also highlighted the target of reducing greenhouse gas (GHG) emissions by 46% by 2040. However, the actual installation data showed that the current installations are 7.8 times greater than the data used for the government's target.

The industries where these heat pumps have been installed were discussed, with a total capacity of 877 MW and an installed capacity of 186 MW. A barrier analysis was conducted through a questionnaire, with a response rate of 11.5%. The results showed that 38% of respondents have installed heat pumps, and 89% of them are satisfied with their heat pumps. Interestingly, heat pumps were found to have a similar satisfaction level as steam boilers or water heaters. The survey also revealed that 48% of respondents were aware of the technology but had not yet installed it, with the main barriers being large capital investment and space restrictions. Policy options were suggested to address these barriers, including subsidies, reduced subsidy applications, targeting newly built factories, rebalancing taxes and levels, and strengthening demonstration and deployment projects.

The presentation entitled Decarbonizing Steam Generation with High-Temperature Heat Pumps: Refrigerant Selection and Flowsheet Evaluation by Christoph Höges et al. focused on decarbonizing steam generation in industries with high heat demand. A simulation tool was developed to optimize the performance based on process parameters using different flow sheets. Various refrigerants were compared, and compressor efficiencies were evaluated. The results showed that Ammonia had the best performance, but due to the limited availability of components, hydrocarbons and HFOs were being used as refrigerants.

In addition, Tim Hamacher et al. discussed the Industrial High-Temperature Heat Pump for Steam and Hot Water Production. This presentation showcased examples of the ThermBooster heat pump system. One example demonstrated steam production for the gelatin industry, using waste heat from combined heat and power systems. Another example focused on hot water production in the waste recycling industry. The performance of the reciprocating compressor was emphasized.

The presentation given by Elias Vieren et al. session focused on the techno-economic optimization of high-temperature heat pumps using different fluids. The aim was to maximize the COP while considering financial aspects. The model considered electricity and component costs, and the levelized cost of heat (LCOH) was analyzed. The session also explored the use of new binary fluids for heat sink and heat source applications.

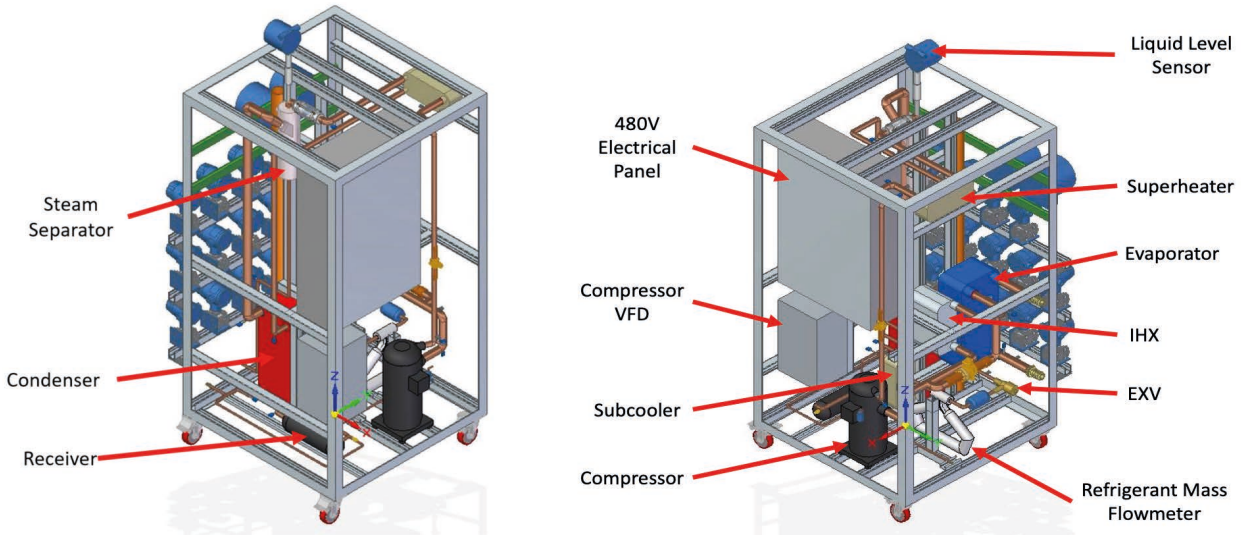
Kashif Nawaz et al. delivered an insightful presentation titled "Performance Analysis of High-Temperature Heat Pumps with Ejectors." The presentation delved into two types of ejectors commonly employed in high-temperature heat pumps: supersonic ejectors and two-phase ejectors. The discussion focused on the gas-dynamic properties and the impact of working fluids on system efficiency, highlighting how the system performs under various conditions.

Arne Høeg's presentation centered around the performance of a cutting-edge ultra-high temperature industrial heat pump that operates on the Stirling cycle. The simulated performance of the heat pump was showcased, and the discussion extended to pilot installations in Norway. Additionally, the ongoing research and development installation at KTH, which focuses on achieving temperatures of 250°C and 280°C on the sink side, was highlighted. Notably, the presentation mentioned the target capital cost of $300 USD per kilowatt (kW) for the next two years.

Christian Huettl et al. delivered a presentation titled "New Perspectives for the Application of Large-Scale Heat Pumps". The presentation highlighted that large heat pumps typically begin at a heating capacity of 5-7 MW, according to Siemens. Real-world testing was conducted with a pilot project in Mannheim, utilizing the Rhein River as the heat source and the district heating network with temperatures reaching up to 99°C as the heat sink. Another example showcased a district heating system in Berlin, where cooling towers were used as a partial heat source. Furthermore, examples from paper mills, chemical plants, waste heat recovery from electrolyzer plants, and exhaust gas condensation from natural gas or hydrogen-fired boilers or gas turbines were presented. Siemens employs synthetic refrigerants for their heat pumps; however, the PFAS ban in Europe poses a challenge. Siemens is actively working on providing alternative choices for customers.

Ammi Amarnath et al. presented on "Industrial High-Temperature Heat Pumps – Ongoing Research in the USA". Their focus is on building a business based on market demand rather than relying solely on incentives. They drew a parallel with the widespread adoption of LED light bulbs, which initially received many incentives but are now considered standard. The presentation (see below) showcased a small prototype system and laboratory tests conducted with three different working fluids. Plans for commercialization include a 50 kW heating capacity prototype, and EPRI is collaborating with small companies, including boiler manufacturers, for the licensing of the prototype. The heat pump employs a newly built standard screw compressor commonly used in the industry with special adaptations.

Prototype System
Dimensions 1m (l) x 1m (w) x 1.8 m (h)



Schematics of prototype presented by Ammi Amarnath et al.