IEA HEAT PUMP PROGRAMME

Fuel-Driven Sorption Heat Pumps

In many countries, especially where space heating is dominated by fossil fuel boilers, fuel-driven sorption heat pumps can substantially help to decrease primary energy consumption and CO_2 emissions, especially in the boiler replacement market.

Short background

The heat pump market today is dominated by electrically-driven compression technology. After a period of being relatively overlooked in the mid-20th century, thermally-driven sorption heat pumps started to gain more attention, e.g. for solar or, more generally, thermal cooling. More recently, fuel-driven sorption heat pumps have been recognised as a complementary technology to electrically-driven units with a significant potential for reducing electrical energy demand and balancing the overall energy demand in future energy mixes by using different energy sources and existing infrastructures. **Especially in the retrofit market, due to their characteristics, gas-driven sorption heat pumps might be the next generation of fossil fuel heating devices to replace condensing boilers.** Growing market opportunities lead to market entry of a number of products from different manufacturers. This generates a need for technology-specific performance evaluation procedures to support current positive market development.

Potential energy savings with the technology

Fossil fuel, especially natural gas, dominates many large European heating markets. As a number of studies show, the average age of the installed boilers stock is quite high, whith associated inefficient operation when compared with the state-of-the-art. **Fuel-driven sorption heat pumps reach gas utilisation efficiencies of 1.2 to 1.5, values which are 30 to 50 % higher than the most advanced condensing boilers and about twice the efficiency of the installed boiler stock**. As fuel-driven sorption heat pumps are mainly aiming at the fossil fuel boiler replacement market, more widespread use of this technology would have a substantial impact in terms of reducing energy consumption, and would facilitate the introduction of renewable energy sources in the fossil fuel heating market.

Potential CO_2 savings with the technology

Fuel-driven sorption heat pumps operate with much higher efficiencies than conventional or condensing fossil fuel boilers, leading to lower CO_2 emissions. Further CO_2 savings are expected in the future with the greening of the gas grid, through extension of biogas feed-in regulations and development of power-to-gas technologies in future smart grid solutions. This would be an important means of balancing the fluctuating electricity production from renewable energy sources, such as solar energy or wind power. Further development of sustainable biofuels would also contribute to wider acceptance of the technology.

Policies required to speed up market uptake

Further development of the technology can improve its efficiency and reduce costs, which would have a positive effect on market development. Relevant R&D topics should therefore be addressed in the international and national funding schemes. As the technology is already available on the market, sustainable growth can be ensured only through implementation of appropriate quality assurance schemes, including quality labels – similar to EHPA quality label for electrically-driven compression heat pumps. Finally, the technology must be included in the energy labelling schemes to provide transparent comparison with other technologies on the market. Raising the awareness of policy-makers and other important stakeholders is another important task that must be accomplished in order to achieve the overall goal of efficient and environmentally friendly solutions for the heating market.

Ongoing research and market development

Following international efforts to increase energy efficiency and usage of renewable energy sources, fuel-driven sorption heat pumps were seen by many as a technology with a substantial potential for upgrading the fossil-fuel boiler market for heating and domestic hot water production to a new level in terms of primary energy consumption, emission savings and use of renewable energy sources. Consequently, a number of well-established and new companies, particularly in Europe, introduced products or are in the final stages before a market launch. Their focus is on heating capacities under 50 kW, i.e. aimed at single-family or small multi-family residential buildings and small commercial applications. To support these activities, a European testing and rating standard for gas-driven heat pumps was recently reviewed with strong participation from the industry.

IEA HPP Annex 43 was initiated in order to increase the market share of fuel-driven heat pumps in a number of countries. Current information on the annex can be found at **http://www.heatpumpcentre.org**.

The joint R&D effort will focus on:

- System classification and development of performance evaluation methods
- Knowledge and technology transfer regarding materials, components and system issues between research institutes and the industry
- Development of standardised testing and measurement / monitoring procedures, with the aim of extending existing standards, developing new standards and quality insurance procedures, and conducting field trials
- Investigating market potentials for different applications and market segments, and developing a technology road map
- Preparation of information material and recommendations for policy-makers, and dissemination of project results through workshops for different target groups

EXAMPLES of successful installations



Fig. 1: Robur ammonia/-water gas-driven sorption heat pump, roof installation
Fig. 2: Two-stage gas-driven absorption heat pump at the Lindner company.
Fig. 3: Buderus ammonia/-water gas-driven air-source sorption heat pump

EXAMPLES of successful research in adsorption technology

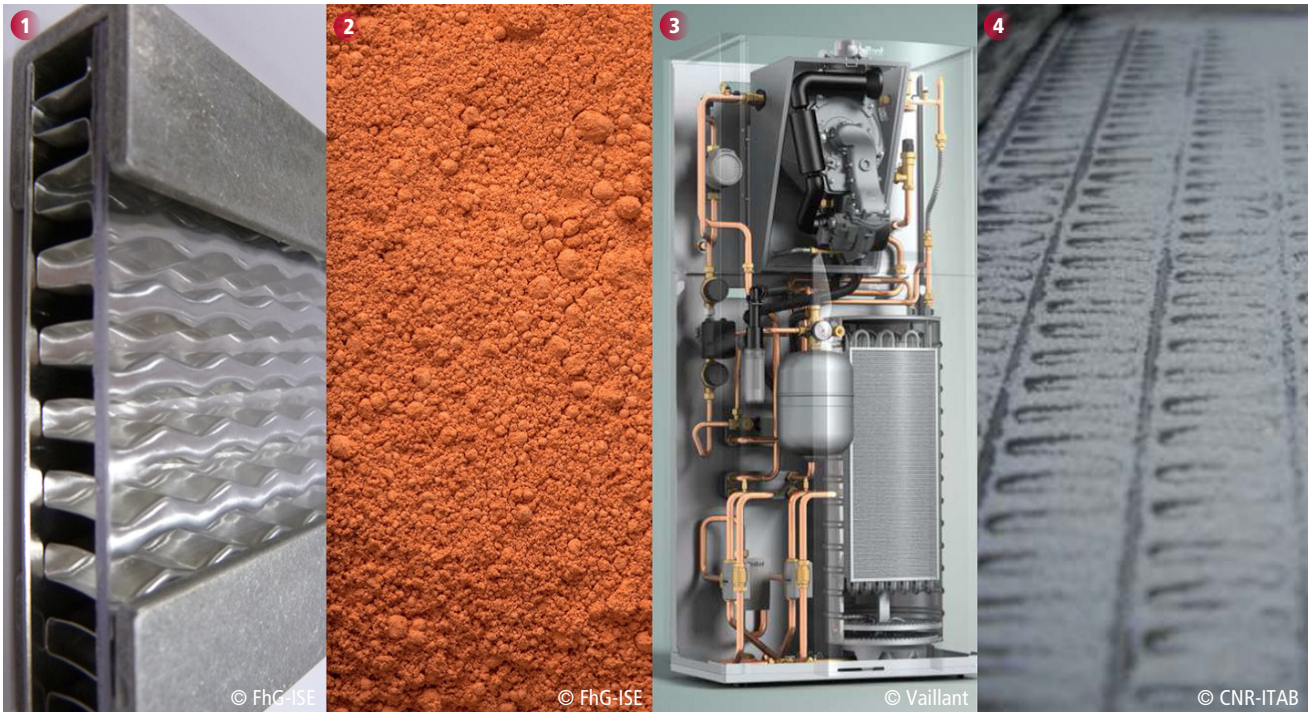


Fig. 1: Heat exchanger model for evaluation of coating procedures
Fig. 2: MOF (Metal Organic Framework) material for adsorption processes
Fig. 3: Refrigeration circuit of Vaillant zeoTHERM gas adsorption heat pump
Fig. 4: Granular adsorber grains (SAPO34) integrated into an aluminium flat-tube heat exchanger

EXAMPLES of successful research in absorption technology

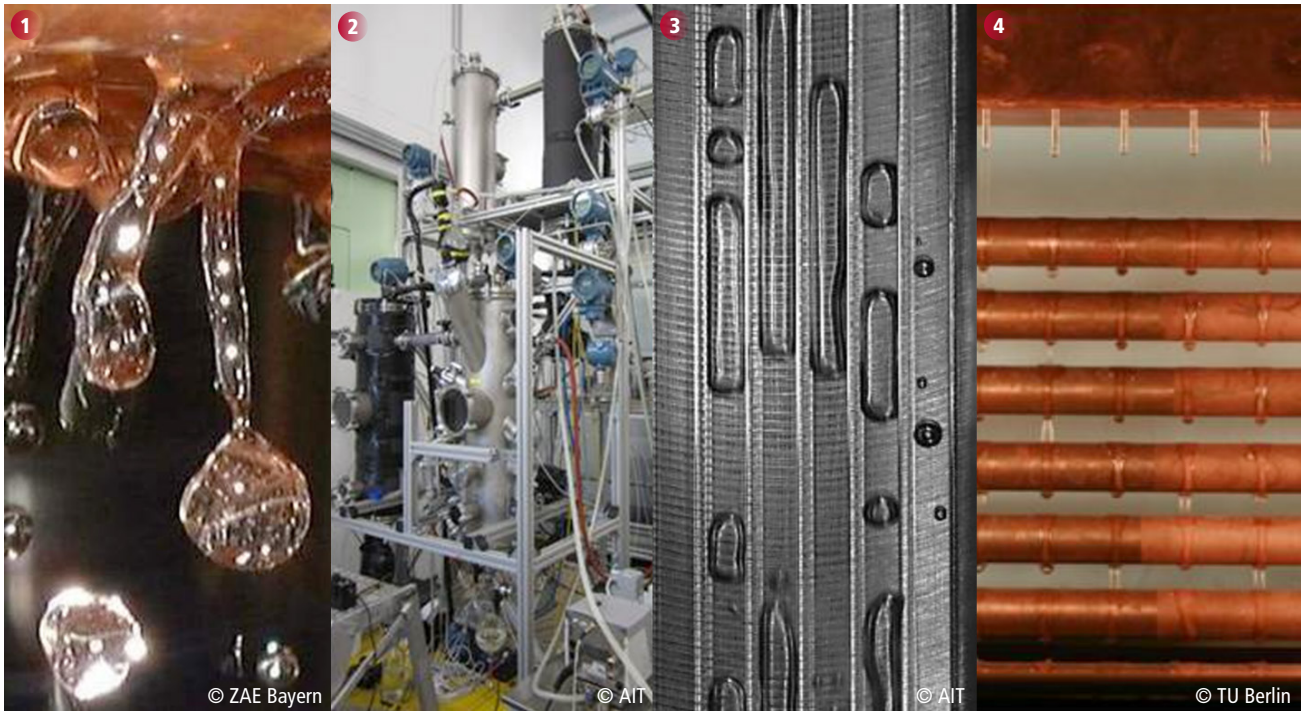
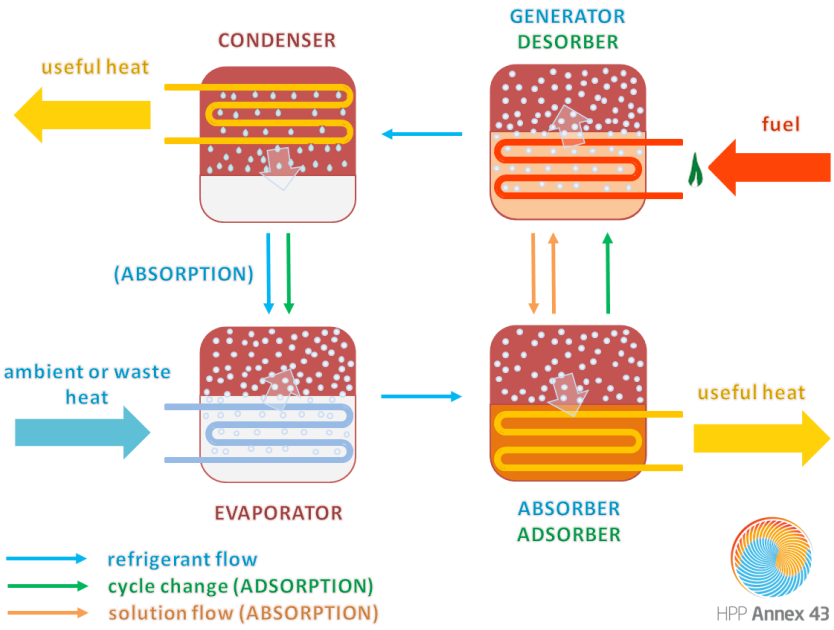


Fig. 1: Droplets of water/-LiBr solution in an absorber heat and mass exchanger
Fig. 2: Experimental setup for research into absorption heat exchangers
Fig. 3: Slug flow pattern in a plate absorber heat exchanger
Fig. 4: Falling film of a solution in a shell-and-tube heat exchanger

OPERATING PRINCIPLE of fuel-driven sorption heat pumps



SORPTION CYCLE: Refrigerant is generated from the solution in the GENERATOR *(Absorption)* or released from the sorption material in the DESORBER *(Adsorption)* by supplying high temperature heat. It condenses in the CONDENSER releasing useful heat at temperatures needed for heating and domestic hot water preparation. The condensate is evaporated at low pressure in the EVAPORATOR by adding ambient or waste heat at ambient temperatures. Refrigerant vapour is absorbed by the solution in the ABSORBER *(Absorption)*, or adsorbed on the surface of the sorption material in the ADSORBER *(Adsorption)*. In both cases, useful heat is released. In case of Absorption, the solution of different concentrations flows between the GENERATOR and the ABSORBER to complete the cycle. In Adsorption units, the function of DESORBER-CONDENSER components changes to ADSORBER-EVAPORATOR, thus providing a quasi-continuous operation of the heat pump. Heat pumps with one or more DESORBER-ADSORBER units exist.

What is the IEA Heat Pump Programme?

The Programme is a non-profit organisation funded by its member countries. It is the foremost worldwide source of independent information and expertise on environmental and energy conservation benefits of heat pumping technologies.

What is the aim of the Heat Pump Programme?

The aim is to achieve widespread deployment of appropriate practical and reliable heat pumping technology systems that can save energy resources while helping to protect the environment.

Why is that important?

The world's energy and climate problems are well known. The buildings sector is responsible for a very considerable proportion of greenhouse gas emissions. Heat pumps are a key technology in the solution to break this trend.

What needs to be done?

By disseminating knowledge of heat pumps worldwide, we contribute to the battle against global warming. In order to increase the pace of development and deployment of heat pumps for buildings and industries, we need to increase R&D efforts for heat pumps, and we need to implement long-term policies for further deployment of heat pumps.

Contact us

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