PRESS RELEASE

Fraunhofer ISE Develops Cost-effective Industrial Thermal Storage with Filler Materials

Many industrial processes produce waste heat that is often released unused into the environment. With rising energy prices, waste heat recovery and storage are becoming increasingly attractive for companies as a substitute for fossil fuels. In the Fenopthes project, funded by the German Federal Ministry for Economic Affairs and Climate Protection BMWK, the Fraunhofer Institute for Solar Energy Systems ISE worked with industrial partners to develop and optimize low-cost fillers for thermal storage systems. Fillers as additives in storage media in thermal storage systems can replace expensive high-temperature storage media. The new technology was tested in a storage unit for waste heat utilization in an industrial company.

In high-temperature storage systems operating between 250°C and 600°C, thermal oils and molten salts are the typical working fluids. To reduce the amount of these expensive storage fluids in thermal storage systems, filler materials can be used additionally. Other low-cost gaseous working fluids, such as air, can also be utilized, allowing temperatures of up to 1000°C and more. Air has a very low heat capacity. Therefore, when used as a heat transfer fluid, the thermal energy is stored in the filler material. "In Fenopthes project, we investigated the ideal shape, size and properties, e.g., density and thermal conductivity, of the filler material. The objectives were to achieve the maximum possible heat transfer and the most compact packing for the storage unit," explains project manager Julius Weiss from Fraunhofer ISE.
Ceramic packing materials developed by the industrial partner Kraftblock GmbH were investigated in the project. They consist of a low-cost recycled material, phosphate binders and additives. By replacing expensive fluids with filler material having the same or even higher thermal capacity results in a savings potential of around 30 percent.
The filler material was manufactured in different shapes so that the influence of the geometry on the thermal efficiency of the accumulator could be investigated. First, the compatibility of the filler material with different high-temperature media (thermal oils, molten salt) was investigated by means of ageing tests. Subsequently, chemical analyses of the fillers and fluids were carried out, as well as a test on the mechanical stability of the fillers. In parallel, the different filler configurations were characterized initially with water, which behaves physically like molten salt under certain boundary conditions. The project team observed that different filler configurations show different temperature profiles and time histories during cyclic charging and discharging of the storage reservoir. A selected configuration of the packing was additionally analyzed experimentally in a molten salt tank at Fraunhofer ISE.

Contact
Claudia Hanisch M. A. | Communications | Phone +49 761 4588-5448 | claudia.hanisch@ise.fraunhofer.de
Dr. Thomas Fluri | Climate Neutral Industrial Processes and High Temperature Storage | Phone +49 761 4588-5994 | thomas.fluri@ise.fraunhofer.c
Fraunhofer Institute for Solar Energy Systems ISE | Heidenhofstraße 2 | 79110 Freiburg | www.ise.fraunhofer.de

The compatibility of the filler materials and different high-temperature media was investigated by means of ageing tests. The different geometries are used to check the mechanical stability before and after the tests. ©Fraunhofer ISE

Demonstration of High-Temperature Storage in Industrial Plant

A real-life application in an industrial company shows that the storage technology can improve the energy efficiency of industrial processes through the time-independent utilization of recovered heat. At Comet Schleifscheiben GmbH, an air-storage demonstrator system with filler materials was tested. The system stores the waste heat that is generated by firing the ceramic grinding wheels. A heat exchanger integrated in the chimney was used to recover the waste heat. One challenge here was the temperature level of the waste heat, since in this process the exhaust air is normally diluted with ambient air and thus cooled before entering the stack, which makes it difficult to achieve high temperatures. The researchers remark that selecting the best system must be done on a case-by-case basis, as the best storage solution is dependent on the parameters specific to the production process, for example, temperature levels, volume flows, flexibility in heat recovery, predicted number of cycles and available space.

Wide Range of Industrial Applications

The project team sees many possible applications for intermediate storage and utilization of industrial (waste) heat. Processes carried out over a wide temperature range between 150°C and 900°C are suitable. These include applications from the paper, foodstuff or chemical industry also for steam generation.
"Not only heat recovery provides an exciting prospect for industry. Also, power-to-heat is gaining importance as more and more processes are becoming electrified," explains Dr. Thomas Fluri, group manager for Climate-neutral Industrial Processes and High-Temperature Storage. With this concept, heat generation takes place at times when electricity prices are low and then through storage concepts made available for the entire 24-hour day. This allows load shifting from peak times to off-peak times, which not only saves companies money but also reduces the strain on the power grids.
The Fenopthes team sees further need for the scientific supervision of additional large-scale demonstrators. "High temperature thermal energy storage technologies and systems are important topics for the heat transition, and we need more demonstrations showing how this technology can be implemented on a large scale," says Dr. Fluri of Fraunhofer ISE:

On-site at the demonstrator system of the industry partner Comet Schleifscheiben GmbH. The waste heat potential was determined for each chimney and the waste heat recovery was implemented at the one with most potential. ©Fraunhofer ISE