TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Institute of Energy Systems
and Thermodynamics
Getreidemarkt 9
1060 Vienna, Austria
www.iet.tuwien.ac.at

High-temperature heat storage SandTES

For up to several hundred MWh

In order to reduce energy consumption in industrial production as well as in the energy sector and to increase energy efficiency, the governments of many states have passed relevant laws. The aim is, above all, to intensify the exploitation of waste heat and the development and use of the potential of renewable energies. This leads to a long-term transformation of the entire energy market of these countries. For example, the share of renewables in primary energy consumption in Germany increased from 1.3% in 1990 to 11.7% in 2013. This trend is to grow to close to 100% in the longer term.

In terms of electricity supply, the increasing share of renewables means that conventional power plants have to be operated very flexibly and often at their respective minimum load. The latter will have to decrease even further in the future. At the same time, the total energy supply becomes more and more volatile with the increase of renewables. Under these conditions, the renewable energy resources that are used to provide electricity must be integrated into the existing electrical grid. Compared with conventional power plants, renewable energy resources are of very different scale and availability. This leads to major challenges in their integration into the energy grid.

At the same time, if the provision of electricity from renewables increases, the economic profitability of thermal power plants is reduced. In order to meet all the technical requirements for a stable grid and a stable energy supply in the future, it makes sense to store excess electrical energy, but also heat.

Objective

In order to be able to store excess energy, be it in the form of electricity or heat, from power plants or industrial processes in an efficient, scalable and cost-effective manner, a high temperature level must be aimed at. For this, a new storage technology had to be developed.

Regarding the storage material, the desired technology should work as close as possible to the ambient pressure in order to minimize the wall thickness of the required components. Another requirement was that the storage material used should be abundant in nature. In addition

SandTES pilot plant at TU Wien

to the economic aspects, this was to ensure simple technical handling and safety for humans and the environment. In order to use the storage as universally as possible, it should allow for a quick change between charging and discharging cycles and be very flexible in terms of the medium used for heat transfer.

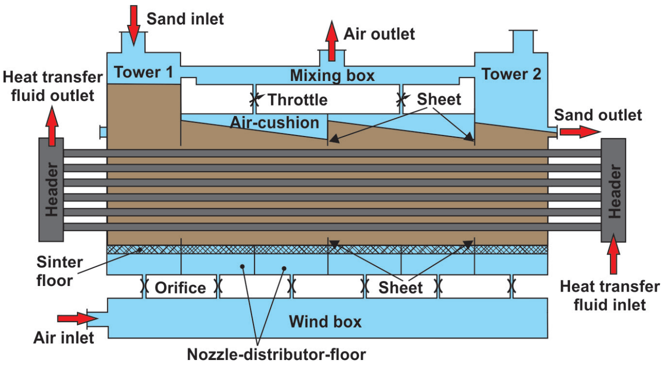
Solution

In order to minimize the technical risk always associated with the development of a new technology, an approach based on already proven technical solutions was chosen. The fluidized bed technology was combined with the principle of a counterflow heat exchanger. The latter provides the maximum average temperature difference for the heat transfer between the heat transfer medium and the bed material of the fluidized bed, which also serves as a storage material. This reduces the heating surface required for the heat exchange and therefore also the costs.

The transport of the viscous storage material suspension through the heat exchanger takes place without moving components. By means of a fluidized bed, a pressure difference between the inlet and outlet of the storage material from the heat exchanger is applied, which corresponds to the difference of the respective storage material heights. In order to keep the overall height of the heat exchanger constant, a new process, the so-called air cushion principle, was developed.

Results

The SandTES heat exchanger developed at TU Wien uses sand, corundum or ash as a storage material – hence the name "Sand Thermal Energy Storage", SandTES for short. With a correct choice of grain size (usually 50 to 100 µm), the fluidized bed may be operated just above the minimum fluidization velocity. The auxiliary energies necessary for the operation of the heat exchanger, such as e.g. for the fan, may therefore be minimized.



Scheme of the SandTES heat exchanger

The SandTES technology was realized in a semi-industrial pilot plant at the laboratory location of the institute. The pilot plant was able to prove the functionality of the SandTES storage.

In a large number of test runs, among others, the dynamic behavior of the entire plant under different load conditions was examined. It was of great interest e.g., how much time would be required to reverse the flow direction of the storage material in the heat exchanger. This provides information about how dynamically the entire plant may be operated.

The flow direction of the storage material in the heat exchanger may be reversed within 120 seconds. Thus, SandTES may be used for applications requiring a rapid change between charging and discharging processes or vice versa.

Through its high flexibility in terms of storage performance, storage capacity and temperature level during heat charging and discharging, SandTES may be precisely adapted to the respective process requirements.

Your Benefits

- only one heat exchanger required for charging and discharging the thermal energy
- use for temperatures up to approx. 800°C – depending on the storage material used
- easily scalable, full integration into processes in thermal power plants and industrial production
- protected by patents
- high reversibility and short reaction time between charging and discharging of thermal energy
- cost-effective and environmentally friendly storage materials
- heat output decoupled from storage capacity
- suitable for the highest heat and storage capacities
- high energy density
- storage capacities up to several hundred MWh

Notes

Contact

Prof. Dr. Markus Haider
TU Wien – Institute of Energy Systems and Thermodynamics
www.iet.tuwien.ac.at
+43 1 58801 302301
markus.haider@tuwien.ac.at