Thermal Hot Water Storage

European Association for Storage of Energy

Thermal Energy Storage

1. Technical description

A. Physical principles

One of the most common energy storage systems is the hot water tank based on the sensible heat of water. A heating device produces hot water outside or inside an insulated tank where it is stored for a short period of time (a couple of days maximum). The stored energy depends on the hot water temperature and on the tank volume. The tank insulation determines the thermal losses and limits the storage period.

As presented in the figure, fuel is used to generate hot water. The use of solar energy and heat pumps (HP) are more and more employed to produce hot water with a high efficiency. Other energy sources like electricity, gas, heating oil or wood are applicable.

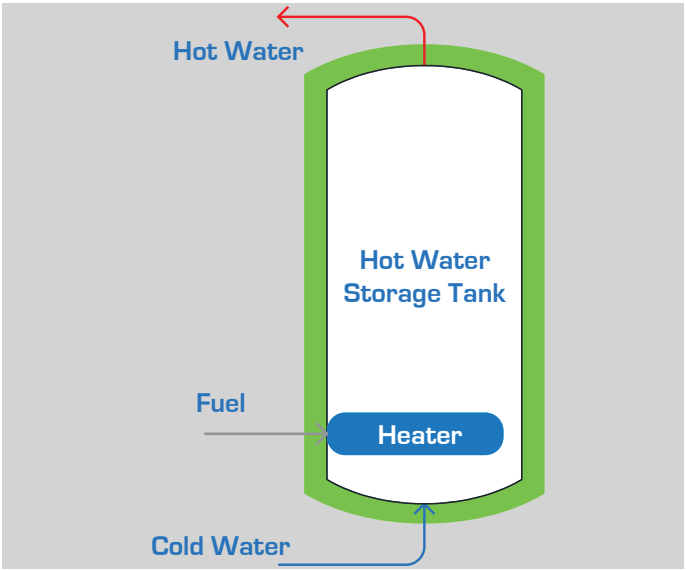
For room heating, hot water between 55 °C and 65 °C is generated. For sanitary hot water heating, the temperature lies usually between 60 °C and 70°C to avoid growing legionella bacteria.

B. Important components

The main component of the thermal storage is the hot water tank. A multitude of designs and capacities exist on the market, mostly dedicated to the residential applications (houses and multi-dwelling buildings) as well as to industrial and commercial systems. The storage volume can vary from 100 dm^3 (1) to 5 m^3.

The second component is the water heater which can be integrated into the tank or outside. The water heater can be dedicated to the hot water production or to multiple tasks (space heating, cogeneration, etc.). When regarding the efficiency of the storage system, one must take into consideration the efficiency of both main components: tank and water heater. This is one of the main reasons that more and more residential applications employ a HP to produce the domestic hot water.

(1) Very small reservoirs of 25 to 70 dm^3 can be used for storing hot water for a short period of time (couple of hours). However, for large scale applications, very large storage containers are in-situ installed with capacity as high as 100 m^3. These applications do not represent the majority and they are out of the scope of this study.



C. Key performance data

	Small Residential	Multi-dwelling Building
Power range	Max 40 kW	Max 400 kW
Energy range	6 kWh - 25 kWh	25 kWh - 320 kWh
Discharge time	>1h	>1h
Cycle life	No limit	No limit
Life duration	15-30 years	20-40 years
Reaction time	some sec	some sec
Efficiency	50 - 85 %	70 - 95 %
Energy (power) density	0.06 kWh/kg	0.08 kWh/kg
CAPEX: energy	40 €/kWh	15 €/kWh

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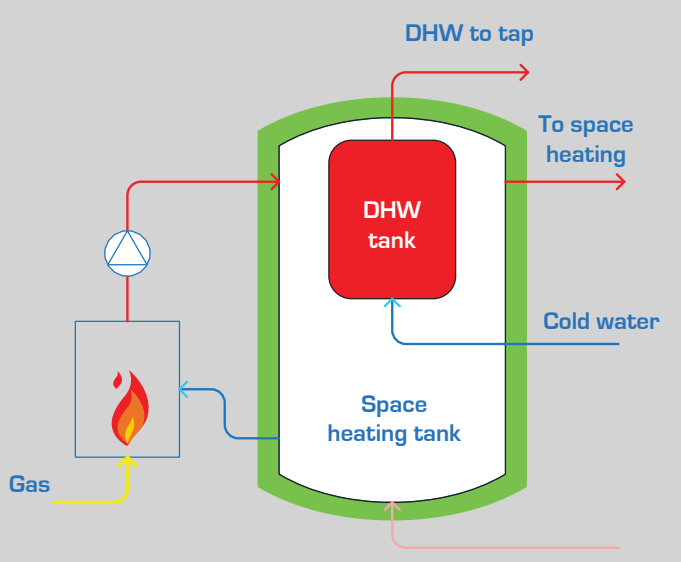
2. State of the art

Hot water energy storage is a mature technology used at large scale in Europe and all over the world. For example, in France one can count for more than 14 million domestic hot water (DHW) tanks running on electricity and about 10 millions on gas. Renewable energy systems like solar thermal and HP are more and more used to produce the DHW in both residential and tertiary applications.

For systems providing space heating and DHW in residential buildings, the tank-in-tank technology was developed. In this case, a large tank stores thermal energy for the heating and a smaller tank, installed inside the first one, contains the DHW. The use of only one boiler makes the system more affordable.

The performance of the storage tank and the thermal losses in time depends highly on the insulation of the tank and on the flow-rate of hot water. When the heated water is used for room heating, the flow-rate depends on the outdoor temperature. When the heated water is used for sanitary water heating, the flow rate depends on the amount of water being tapped per time unit.



3. Future Developments

- A sizing study of the storage (temperature and capacity) is essential to obtain a good performance of the system and to lose less energy.
- Special tanks were developed for renewable energy sources (solar and HP) and they will be continually improved.
- As the capacity of thermal storage is small (even though thermal storages are installed in very high numbers), the overall storage capacity over a region (county or country) could be very large, and can be used with a lot of flexibility to absorb electricity peak production from renewable sources as wind power or photovoltaic.

4. Relevance in Europe

Thermal storage by hot water tanks is a major technology in all European countries.

5. Applications

Heat storage for short time (days) to supply with DHW and space heating the residential and tertiary buildings. Essential component for systems using a renewable energy source (solar energy).

Employed also in industrial and commercial sector for different applications using low temperature heat (<120 °C).

Balancing electricity or gas demand & supply for daily fluctuations.

6. Sources of Information

- EASE Members
- Thermal Energy Storage – Systems and Applications, Wiley, by I. Dincer and M.A. Rosen.
- Solar Engineering of Thermal Processes, 3rd edition, Wiley, by J.A. Duffie and W.A. Beckman.
- Guide of Thermal Storage Technology, IOS Press, by A. Okamura.

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