THERMOCHEMICAL ENERGY STORAGE FOR SEASONAL BALANCE OF SURPLUS ELECTRICITY AND HEAT DEMAND IN DOMESTIC BUILDINGS

Summary

Thermochemical storage systems are predestined to store thermal energy for a long time since the storage principle itself is free of losses and allows for very high energy densities. Therefore we developed a new approach where electricity, p. e. from private PV-panels in the summer, is used to charge a thermochemical reaction system. The reaction product then can be stored in an inexpensive tank at room temperature. If there is heat demand during the winter part of the material can be supplied from the tanks and reacts with liquid water, back to the starting substance. In order to investigate the technological feasibility of this innovative power to heat concept an experimental test bench has been set into operation.

Key-words: thermochemical energy storage, seasonal storage for domestic buildings, power to heat, balance between source and demand,

1. Introduction

Whereas the production of renewable electricity has gained considerable progress in the last decades, the share of thermal energy supplied by renewable technologies still remains small. In contrast 70% of the final energy demand in domestic households of central and northern European countries is needed for space heating. Unfavourably this heat demand prevalently occurs during winter whereas periods of surplus electricity from renewables are more frequent in the summer. Therefore, efficient long term storage solutions to balance the seasonal discrepancy between excess electricity and the heat demand in buildings, gain increasing interest [Sternberg et al.].

2. Innovative seasonal thermochemical storage concept for domestic buildings

The principal of thermochemical energy storage offers minimal losses and high energy densities. Calcium hydroxide (hydrated lime) is among the cheapest of the thermochemical storage materials and therefore suitable for a seasonal storage system. Additionally the material is environmentally friendly and already in large scale available. The reaction with water vapour or liquid water is chemically reversible and has already been investigated at our institute for several years. [Schaube et al., Schmidt et al.].

Basic idea of the presented concept is to charge the calcium hydroxide electrically at times of surplus electricity available either from your own PV-panels or the grid. Fig. 1 shows the energy flows during electrical charging. Approximately 50% of the energy is contained in the sensible and latent heat of the freed water vapour. This part of the energy can be used directly for the daily hot water supply. The remaining 50% of the energy is stored in the chemical potential of the calcium oxide. The charged material can be stored in inexpensive containers at room temperature. If there is thermal energy needed during winter time parts of the material can be extracted from the container and react with liquid water back to the starting substance. Once there is electricity available again the material can be regenerated.

3. Test infrastructure

In order to demonstrate and investigate this novel concept experimentally a new test infrastructure was developed and set into operation. Fig. 2 shows the process flow sheet of the test bench. As a basic principal the material is stored in two ordinary containers at room temperature. Only with this decoupling of the storage container and the reactor the necessary large storage capacity can be realized cost effectively. For each case, the charging and discharging process, one reactor has been developed. The movement of the material under reaction conditions and sufficient heat and mass transport is currently one of the major technological challenges in the reactor design which can now be investigated.

This contribution presents an innovative concept for seasonal storage of electricity to cover the heat demand of households. Based on first experimental results the feasibility of the technology will be discussed as well as conclusion for future cost effective reactor designs will be derived.

4. Figures

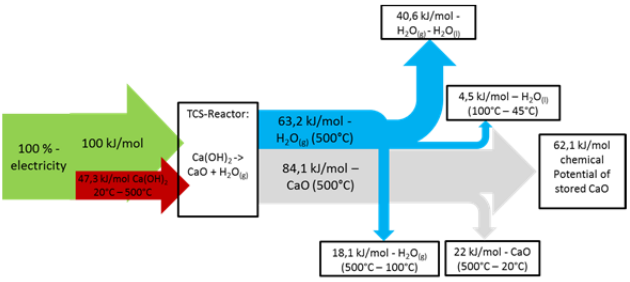

Fig. 1 Energy flow diagramm during dehydration of calcium hydroxide (charging of the storage material through electrical heating)

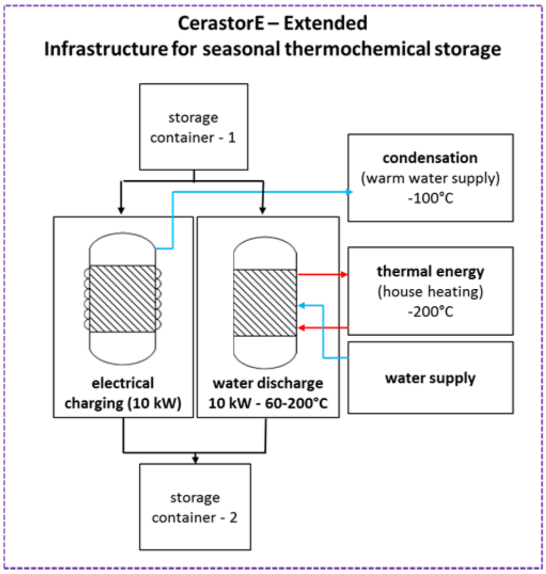

Fig. 2 Infrastructure for seasonal thermochemical energy storage for domestic heating

5. References

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