Description of the project for the general public

The key role of energy storage systems is to reduce the time or rate mismatch between energy supply and energy demand coming from different sources. Among the energy storage systems, the thermal energy storage (TES) is defined as an important energy conservation technology to store heat and cold for utilization at a later stage. Thermal energy can be stored as sensible heat, latent heat and thermochemical or combination of these materials. A lot of research and development work has been carried out in the first two methods of the thermal energy storage. The thermochemical energy storage (TChES) is one of the least investigated of these methods but is the most promising and attractive technology, because it can provide a high energy storage density. The project is addressed to this storage. The TChES normally uses a chemical compound C (thermochemical material, TCM), placed in reactor, which undergoes a decomposition reaction into two products A and B. The reaction is endothermic with the external heat source used for dissociation of the compound C with the accompanying storing of the thermal energy (charging process). The thermal energy may be stored in the products for a long time with a small heat loss or even transported for long distances together with these products. When the release of the thermal energy is required the reverse (exothermic) reaction is carried out and then the species A and B are again combined into the initial chemical compound C (discharching process).

Recent developments in low/zero carbon buildings promote the development of the low-temperature TChES systems. For the low-temperature applications the salt hydrates have been proposed as the TCMs with dehydration/hydration reaction associated with a release or absorption of the water vapour. Thermochemical storage systems can be divided into open and closed systems. In the open system a water vapour is directly released to the environment while in the closed systems it is a part of the storage system, which is isolated from the atmosphere and undergoes different transformations in a cycle.

One of the most important problems of thermal energy storage, irrespective of the method used, is enhancement of heat transfer to and from the storage. In the case of the TChES the amount of heat stored depends on the mass of the TCM, its endothermic heat of reaction (dehydration reaction) and the extent of TCM conversion. In turn the extent of conversion depends on the heat and mass transfer issues at different scales, i.e., the TCM usually in a form of a porous medium, the storage (chemical reactor) and the whole system. Tools (models & methods) needed for analysis of these problems will be developed in the project. One of the results of the project will be a new complex and detailed micro-macroscopic model of water vapour and heat transfer in the porous bed particles with presence of the hydration/dehydration reaction, and particles interaction with the moist air flowing around them. The air flowing around the particles allows for transport of heat and water vapour to or out of the particles as well as their exchange with the external heat and moisture sources. It also permits to keep the pressure in the bed close to atmospheric pressure noting small equilibrium pressure of water vapour for the hydration/dehydration reaction. The model will be subsequently used to simulate operation of a heat storage (chemical reactor) to improve the efficiency of the thermal energy storing process, to evaluate the charging/discharging times and heat recovery degree. The second important result of the project will be working out a method for the analysis and optimization of different closed-cycle TChES systems from point of their thermal energy storage capacity and charging/discharging rates. This will allow tailoring the specific configuration of the system to the source of the renewable or waste heat available.