

# THE THERMODYNAMIC AND KINETIC STUDY OF $\text{MgSO}_4\text{-H}_2\text{O}$ SYSTEM FOR HEAT STORAGE BY A COMPOSITE

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Renewable energies are regarded as one of solutions for reducing the consumption of fossil fuels and limiting the global warming increases. However, these sources are intermittent most of the time. Energy storage systems can allow to make compatible the supply and the energy demand both spatially and temporally. For example the available solar energy exceeds the domestic demand during summer but during winter the total heating demand exceeds the solar supply. So the main role of energy storage systems is to valorize the excess of solar energy in summer to fulfil the heat demand in the winter. Among the various technologies of heat storage, processes based on a reversible chemical reaction present the most important energy density [1].

A large number of potentially interesting materials has been performed in the last decade. Among all these reactive solid/gas systems, the couple magnesium sulfate/water vapor is presented as the most promising candidate [2]. However, the use of magnesium sulfate powder is difficult in a storage reactor because the particles rapidly form agglomerates during cycle dehydration/hydration, thus limiting gas transfer and causing reversibility issues and low temperature lift. Therefore, system performance is consequently low [3].

Composite materials developed by impregnation of a hygroscopic salt such as magnesium sulfate into a porous matrix appear as an interesting solution for the heat storage technology. This material allows reducing the problem of gas transfer and further to beneficite the heat due to a chemical reaction upon the salt and the heat of adsorption upon the porous material. Composite of zeolite and magnesium sulfate shows the best performances, sufficient power for a low-energy building [4] and good cyclability [5]. However the development of such a system is technologically challenging, the main obstacle is the incomplete understanding of the physico-chemical phenomena involved.

The present work reports the study of dehydration of magnesium sulfate and the mechanism of reaction poorly studied up to now. Dehydration of solid magnesium sulfate in a controlled atmosphere was monitored by thermogravimetry and physico-chemical characterizations have been realized. The results obtained from these experiments show that the water content in the solid phase of magnesium sulfate is a function of a temperature at a constant water vapour pressure. And at a constant temperature, the water content varies with a water vapour pressure. Thus this system is bivariant and some magnesium sulfate hydrates appear as the non-stoichiometric hydrates. This result is new compared to the literature review. In consequence a thermodynamic model has been written and applied to the experimental results. Also, we present a kinetic model allowed to report experimental data and to describe the laws of variation of parameters with the temperature and the partial pressure of water pressure.

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