Heat Storage in Phase Change Materials

Kasper Torbensen

DTU Chemistry, Technical University of Denmark

In climate debates there are great focus on finding new renewable energy sources and further development on the existing technologies. This focus strives from the desire to get independent of fossil fuels. A not as well known factor, but a key element in renewable energy, is energy storage, which gives the ability to save energy, for when it is needed. How can we get wind power when the weather is calm or how do we get hot water or electricity from solar panels when it is cloudy or night? We can't! Oil and coal can be stored and used when needed, but this cannot be done with wind, wave or solar energy. The reliability of these forms of energy, and thereby the independence of fossil fuels, can only be a reality when energy storage devices can balance the time difference in energy production and energy consumption.

An interesting technology in energy storage is *latent heat storage* which can store heat energy due to a phase shift. This allows energy to be stored as sensible heat until the phase shift temperature is reached, and after this point additional latent heat. In this way the energy storage becomes much more efficient. Some types of materials which can be used as latent heat storage materials includes salt hydrates and combinations of salt hydrates called eutectics.
Most of these substances are measured and developed by an experimental approach which is both time consuming and very expensive. An alternative to this approach is using a thermodynamic model, which can, if the model is accurate enough, be used to predict relevant thermodynamic properties, including relevant information as melting temperature and heat of fusion.

This project is about the eutectic salt hydrate consisting of $Mg(NO_3)_2 \cdot 6H_2O$ and $MgCl_2 \cdot 6H_2O$. This eutectic system has a melting temperature at around 59 degrees Celcius and is therefore suitable as a heat storage material in application which have an operational temperature at this point. This is because the material melts at this temperature and the energy required to make the phase change is released at this temperature. It makes this eutectic applicable in heating water in households, where the hot water is around this temperature. This great operational temperature has made this eutectic salt hydrate very interesting in connection with private solar panels, but actually very few published experiments has been made of the system. This project was about testing the eutectic salt hydrate to verify the old and contradictory data which has been published. More over some parameters in the model called the Extended UNIQUAC model, was improved. This model is of many considered as the best model to describe electrolytes and is therefore the obvious choice for this type of project. The results obtained by the improved parameters was significantly better.