Phase Change Materials Studies (Experimental and numerical)

Solid-Liquid Phase Change Materials (PCM) are used to store efficiently energy while taking advantage of the latent heat of the change of state. The material is selected on the basis of several criteria, the most important of which are the melting temperature and the latent heat.

Thermophysical characterization is then conducted using improved calorimetric methods.

These studies go hand-in-hand with the study of the phase change kinetics (melting - crystallization) for larger volumes of materials, with a view to approaching real operating conditions. Once the choice of material is validated, experiments are conducted on an industrial scale.

Additional fundamental studies are also conducted to better grasp the combined thermal and hydrodynamic phenomena encountered with PCMs.

PCM Thermophysical characterization laboratory

The study of the energy and thermal behavior of systems with PCMs requires detailed knowledge of the phase-transition process. An accurate determination of the thermophysical characteristics is therefore needed. As commonly-used methods such as calorimetry are not always sufficiently accurate, we are working on the characterization of PCMs using identification methods (inverse methods or genetic algorithms (GA)) that provide more consistent results than those obtained with the physics of phase changes.

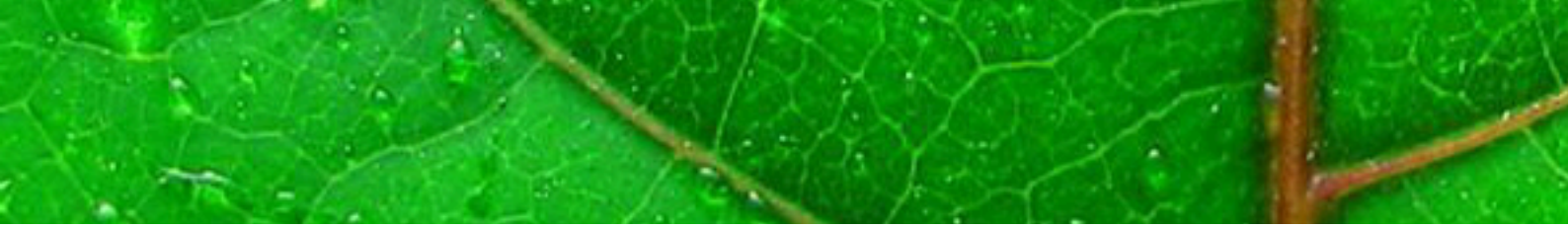
We base our work on experiments involving increasingly large and complex samples. These studies enable us to develop an experimental protocol that is part of a procedure for technically evaluating PCM-bearing components. As some gas hydrates may be good candidates for thermal storage, characterization work associated with high pressure micro-calorimetry has been initiated on these substances.

For several years, LaTEP has undertaken studies in the field of “cold” storage using latent heat. This particularly involves the use of PCMs encapsulated in spheres (called nodules) 77 mm in diameter; with 2,500 nodules per m^3 they can fill a tank. However, the best PCM that we have identified so far has one disadvantage: it is a supercooled liquid (it crystallizes below the melting point). This is a drawback in storage operations and in the performance of cooling machines.

The study represents an innovative scientific topic: the application of probabilistic functions pertaining to supercooling to randomly distributed spheres, functions governing the flow of the cold liquid passing between the spheres, thermal exchanges, etc.

One of the major issues of solar thermodynamic technology or Concentrated Solar Power (CSP) resides in its intermittence, as is the case for most renewable energies. The challenge is to disconnect the production of electricity from the availability of that energy source, using heat storage. The aim of our work is to develop a thermal storage solution suited to CSP power stations that produce DSG (Direct Steam Generation). More specifically, the study concerns latent heat storage with solid-liquid PCMs.

The objective is to select the most suitable PCM for the application and to implement it within a particular solar loop device. Experimental works are conducted in combination with numerical works.



Several other studies have been carried out to better grasp the phenomena at the boundary of supercooling and to consider the use of PCMs for other domestic applications.