A Study of the Thermophysical Properties and Mathematical Modeling Techniques for Encapsulated Phase Change Materials for Use in Building Envelopes

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With rising energy costs, many owners and designers have searched for ways to cut overall costs of constructing and operating their buildings. A majority of the capital

has led to better building efficiency and a more adaptive system, but, today, there is an added push to move toward a more “active” building. The idea is that the building will react to the surroundings, and if it is correctly harnessed, will drastically lower energy costs. A new technology that has been developed mainly in Europe and Asia over the past fifteen years is the use of phase-change material (PCM) as a building insulation.

While there are many ways to implement PCM insulation, the concept is all the same. As the PCM gains energy and, in turn, heats up, it acts as a normal material that energy conducts through. When the PCM reaches its melting point, it begins to change phase. During its melting process, it stores a high amount of energy while still conducting some energy through to the other side. This creates a thermal mass which slows the passage of heat. Once the amount of energy stored reaches the prescribed latent heat of fusion, the PCM will once again act as a normal material conducting energy. In theory, an “active” building in the summer will be more resistant to conduction through the walls at peak cooling hours than it would normally.

While there have been many attempts to test and model the PCM, most of the work has been conducted in government laboratories. This high scholarly work has produced accurate simulations and tests, but to the average consumer and HVAC engineer, this work is often complicated and inaccessible. Interest in the field of phase change materials in the research world has been growing over recent years, but few companies in the United States produce a PCM insulation. This has created a stagnation

2100, 3200, and 1900 J/kg-°K, respectively. The graph of the heat capacity of the PCM as a function of temperature is shown below in Figure 1.

Figure 1: Heat Capacity (J/gm-