MANUFACTURE OF LIGHTWEIGHT AGGREGATE GRANULES CONTAINING PHASE CHANGE MATERIALS

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INTRODUCTION

Phase Change Materials (PCMs) can reduce the energy requirements of a building by reducing peak demand for either summer cooling or winter heating. PCMs also have the potential of reducing the amount of energy lost and increasing thermal comfort in buildings, by buffering temperature fluctuations. This research explores more efficient ways to host PCMs and further develop new methods of encapsulating PCMs and incorporating them into the built environment.

OBJECTIVES

1. Investigate how to impregnate PCMs into lightweight aggregates (LWA).
2. Identify suitable methods and conditions for optimal absorption of these PCMs into LWA.

MATERIALS

Rubitherm RT18HC, RT22HC & RT25HC were the PCMs selected, with Aerated Concrete used as the LWA.

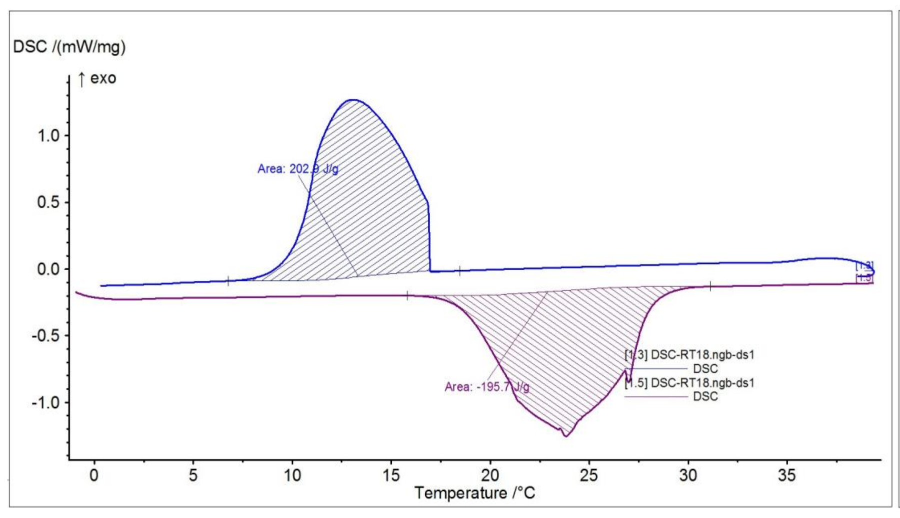


Figure 1 – Rubitherm RT18HC has a melting temperature of 18°C.

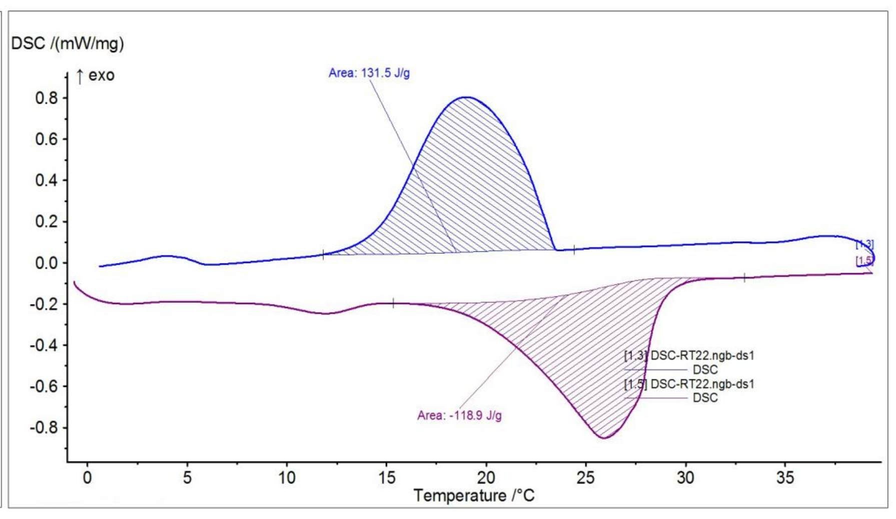


Figure 2 - Rubitherm RT22HC has a melting temperature of 22°C.

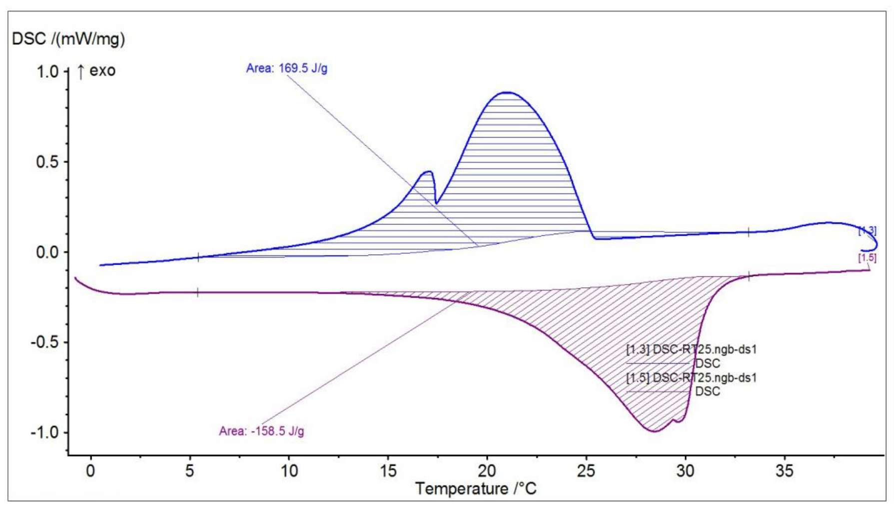


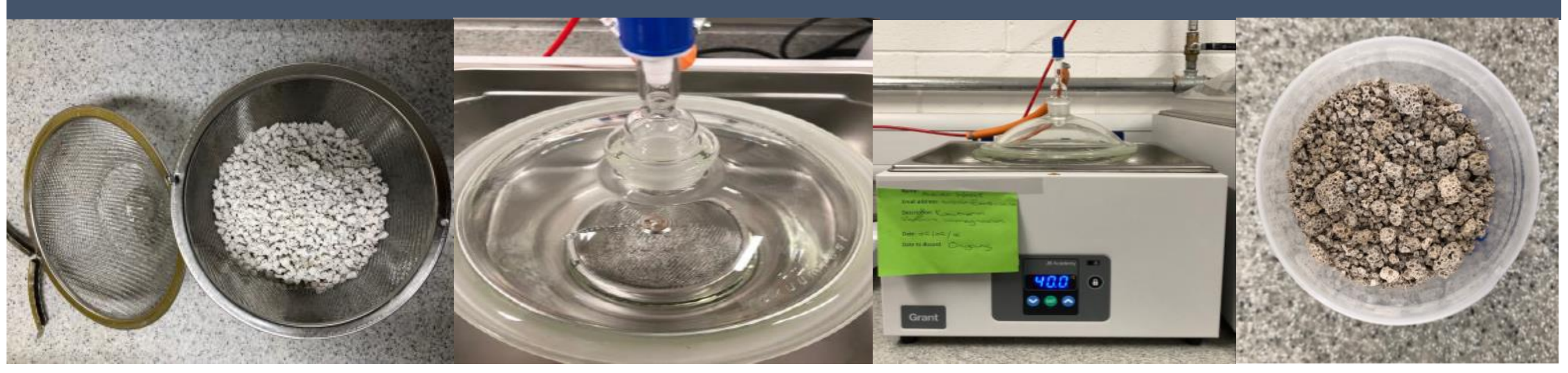
Figure 3 - Rubitherm RT22HC has a melting temperature of 25°C.

Table 1. LWA:PCM mass ratio

LWA :PCM Mass Ratio	LWA (g)	PCM (g)
0.3	50	15
0.5	50	25
0.7	50	35
1.0	50	50
1.3	50	65
1.5	50	75

Table 1 – The mass ratio of PCM:LWA used in the immersion and vacuum impregnation tests.

EXPERIMENTAL PROCEDURE



Vacuum Impregnation – Removes the air from the pores of the aggregate using a vacuum and absorbs the PCM by force.

Immersion – Absorbs the PCM by capillary action.

Three PCMs with melting temperatures of 18°C, 22°C, 25°C were absorbed into the LWA using the 2 methods, at different PCM:LWA ratios.

Initial tests had an absorption time of 1 hour and an absorption temperature of 40°C

RESULTS

Comparison of Vacuum Impregnation & Immersion

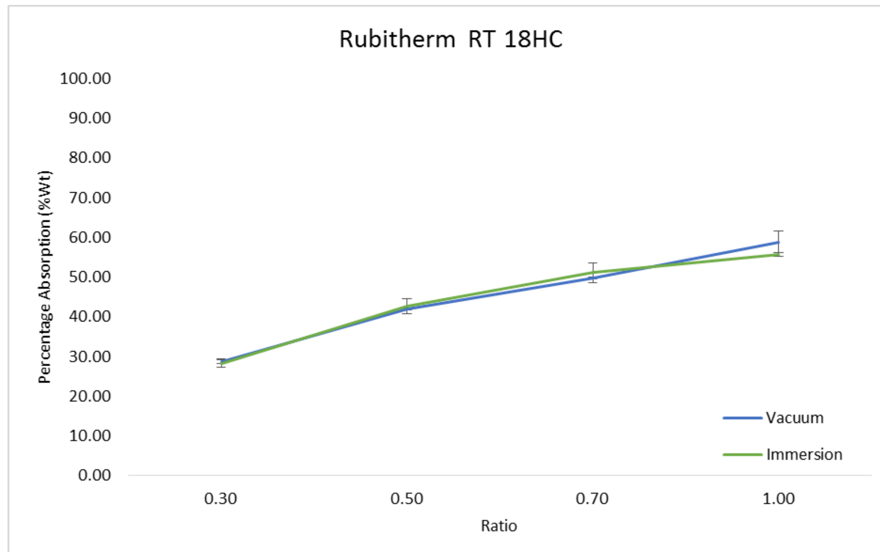


Figure 4 – Compression of Immersion and Vacuum impregnation for Rubitherm RT18HC.

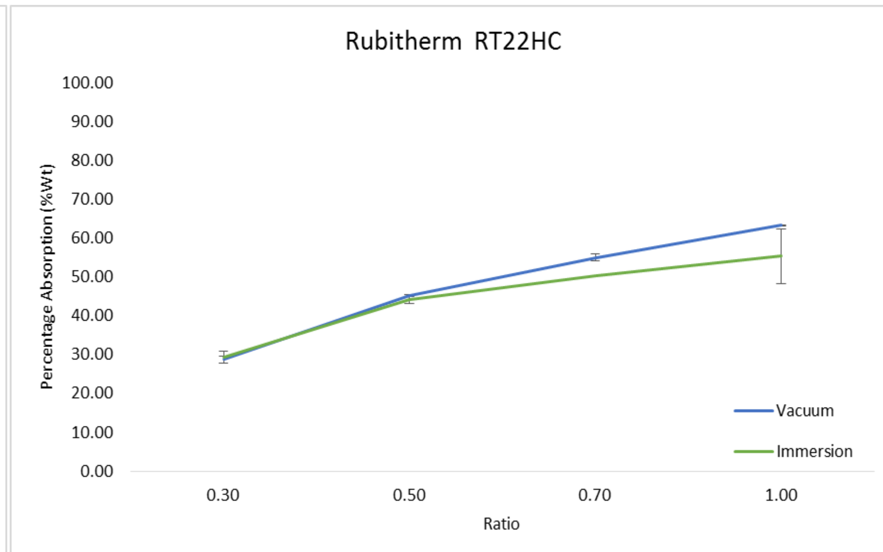


Figure 5 - Compression of Immersion and Vacuum impregnation for Rubitherm RT22HC.

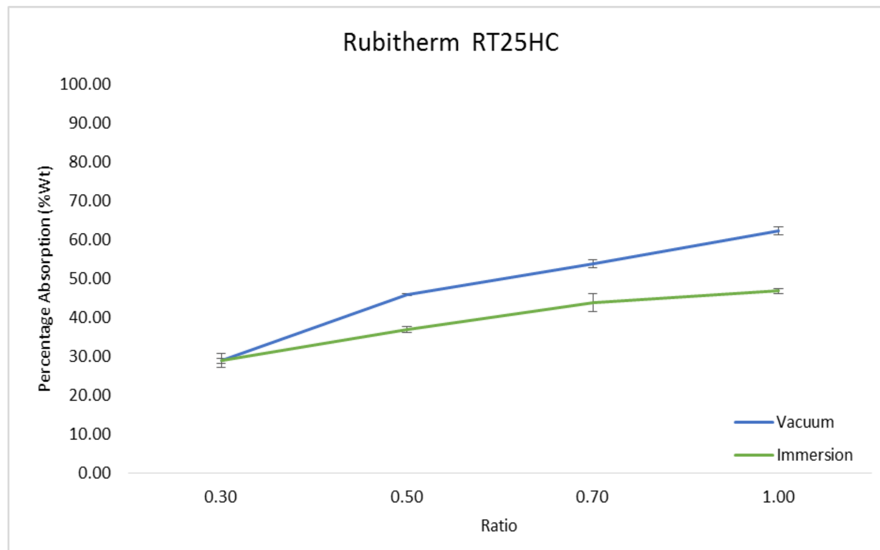


Figure 6 - Compression of Immersion and Vacuum impregnation for Rubitherm RT25HC.

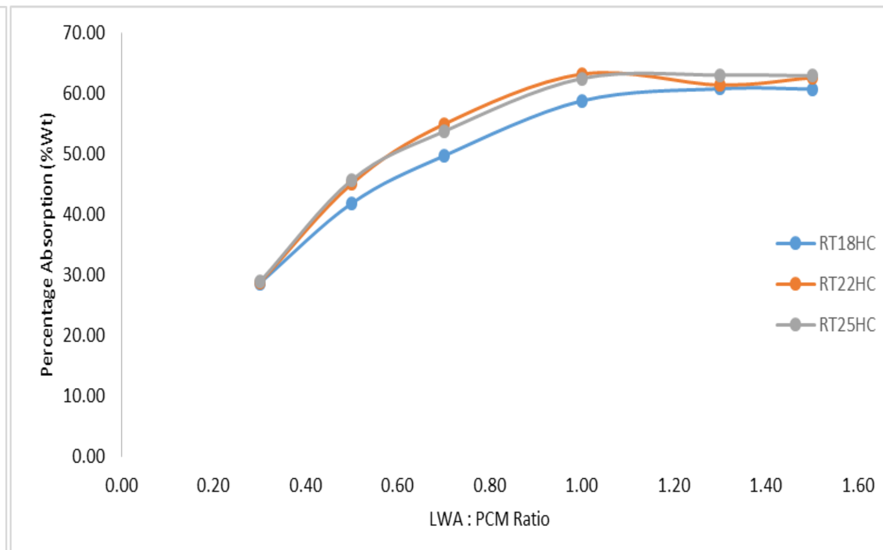


Figure 7 - Comparison of Vacuum impregnation for the 3 PCMs, to find the optimum impregnation ratio.

Adjustment of Variables

Viscosity, time and temperature were adjusted to see what effect it would have on the amount of PCM absorbed in to the LWA.

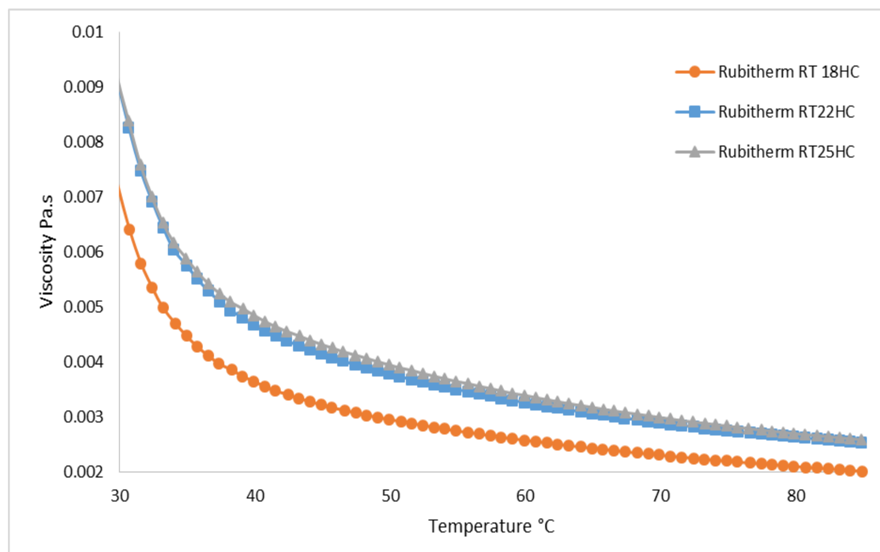


Figure 8 - Viscosity test using a rheometer. Analysing how increasing the temperature would affect the viscosity of the three PCMs

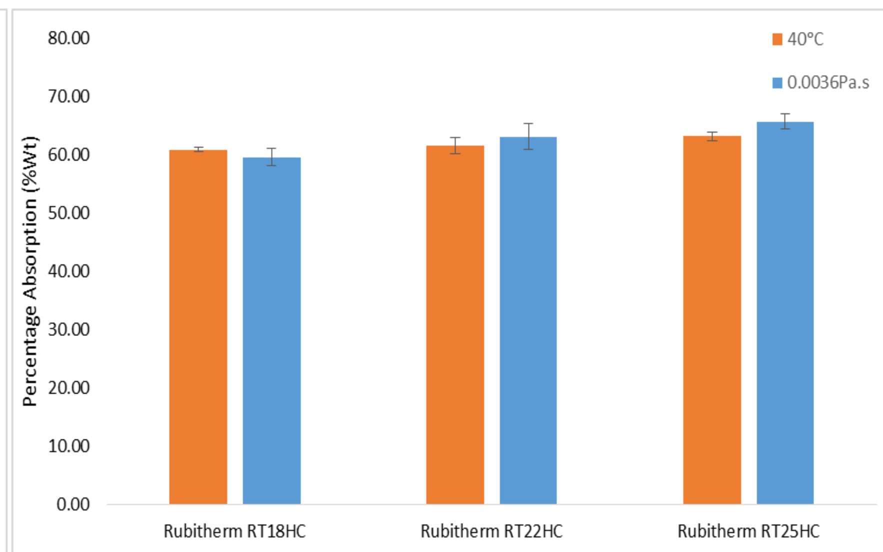


Figure 9 - Comparison of absorption at constant viscosity and constant temperature.

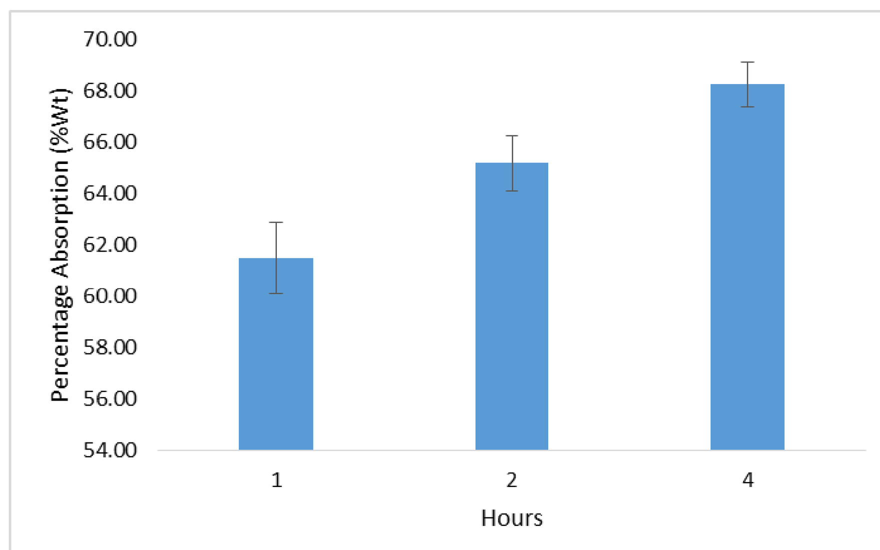


Figure 10 - Effect of time on the amount of Rubitherm RT22HC into aerated concrete using vacuum impregnation.

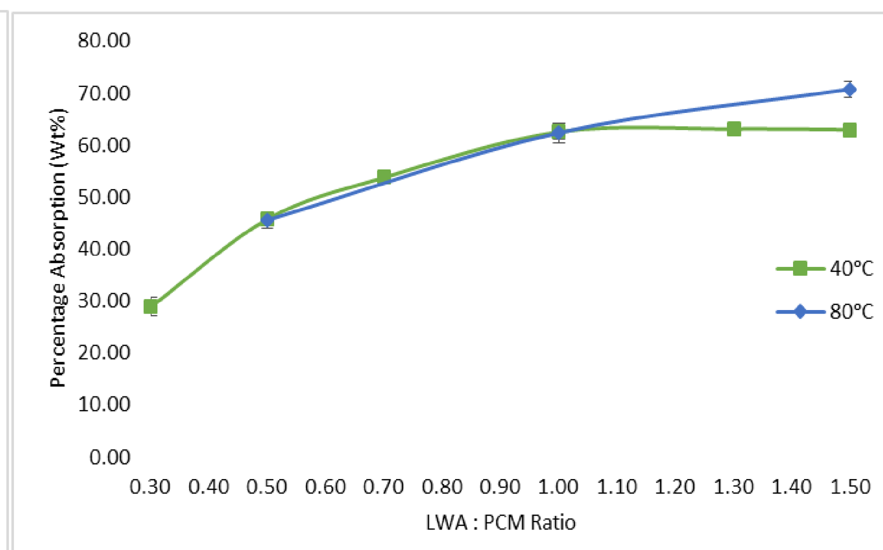


Figure 11 - Comparison of absorption of Rubitherm R25HC at 40°C and 80°C.

CONCLUSIONS

The following conclusions can be drawn from the results obtained thus far:

1. Vacuum impregnation is a more effective method of absorbing the PCM into the LWA than immersion.
2. The optimum impregnation ratio using a aerated concrete LWA and a temperature of 40°C is 1.3.
3. The viscosity of the PCM influences the amount of PCM absorbed, although at lower temperature the effect is less significant.
4. The time allowed for absorption influences the amount of PCM absorbed.

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