Investigating the Potential of $MgSO_4$ for Domestic Inter-Seasonal Thermochemical Energy Storage

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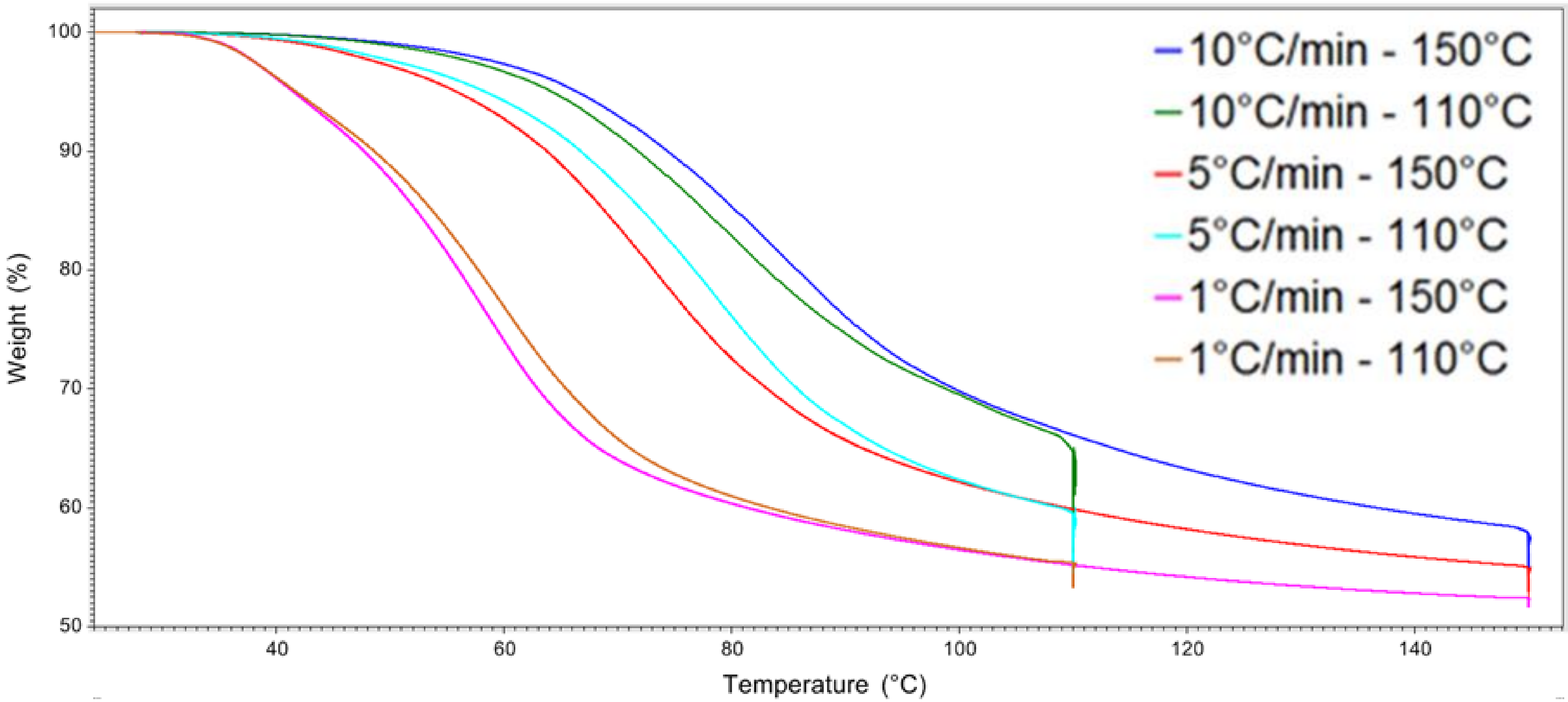
Introduction

Small Scale (~10mg) Dehydration characterisation – Assessment of the theoretical energy density

- Dehydration within DSC & TGA(+RGA).
- SEM(+EDX) & N_2 Vapour Sorption also used.
- Materials hydrated with 1.3kPa pH_2O (achievable winter conditions)
- 1, 5 & 10˚C/min heating rates used
- Several cycles conducted.

Lower Desorption Temperature Tests

- Tested $MgSO_4.7H_2O$. Dehydrated to 110 and 150˚C (using three heating rates).
- Minimum difference in dehydration enthalpy (~100J/g).
- Possibility of using a lower desorption temperature.



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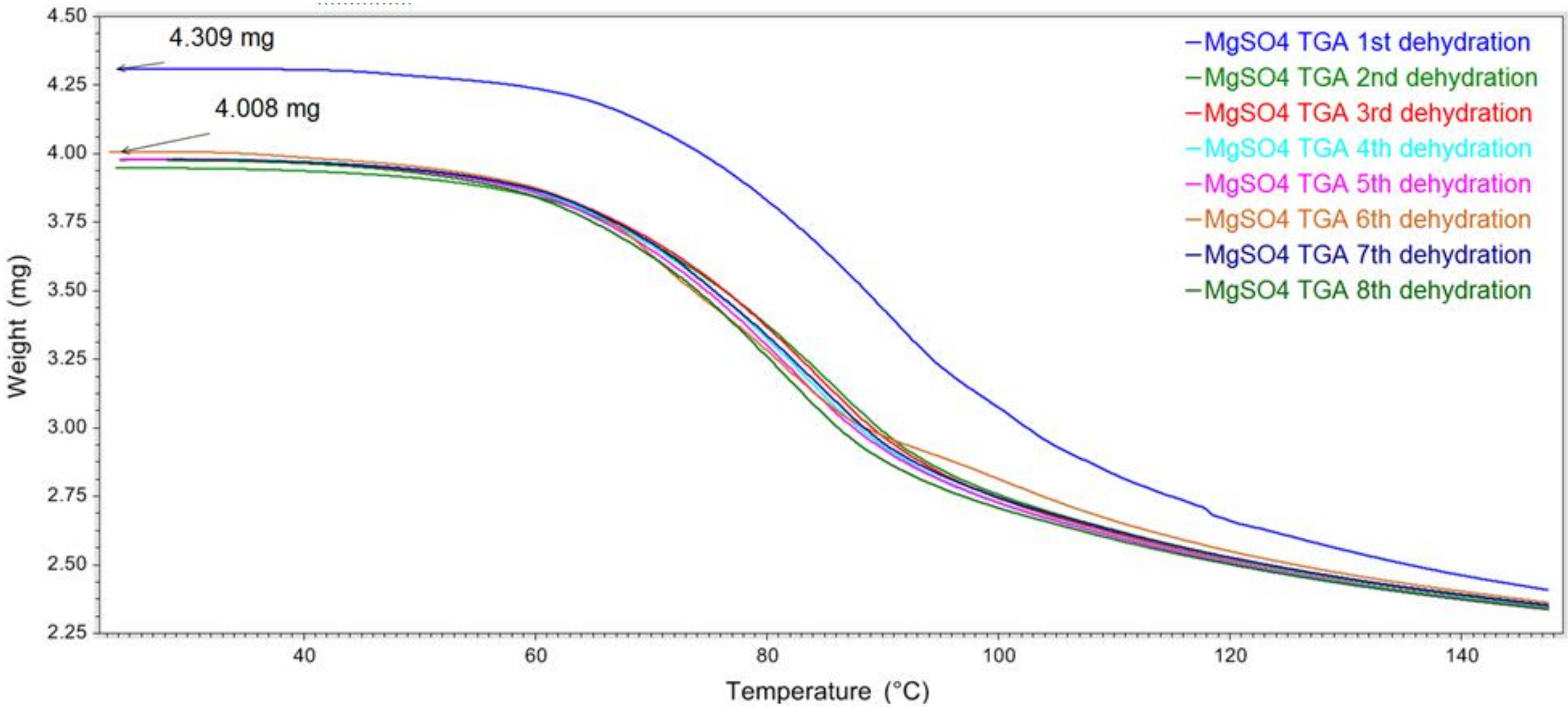
Sample No.	Heating Rate (°C/min)	Dehydration Temperature (°C)	Enthalpy (Normalised) (J/g)	Average Enthalpy (J/g)
1	1	110	1230.6	
2	5	110	1330.1	1284
3	10	110	1291.5	
4	1	150	1429.4	
5	5	150	1382.1	1386
6	10	150	1347.3	

TGA Cycle Stability of $MgSO_4$ (10˚C/min)

- Material rehydrates to hexahydrate
- No sign of degradation



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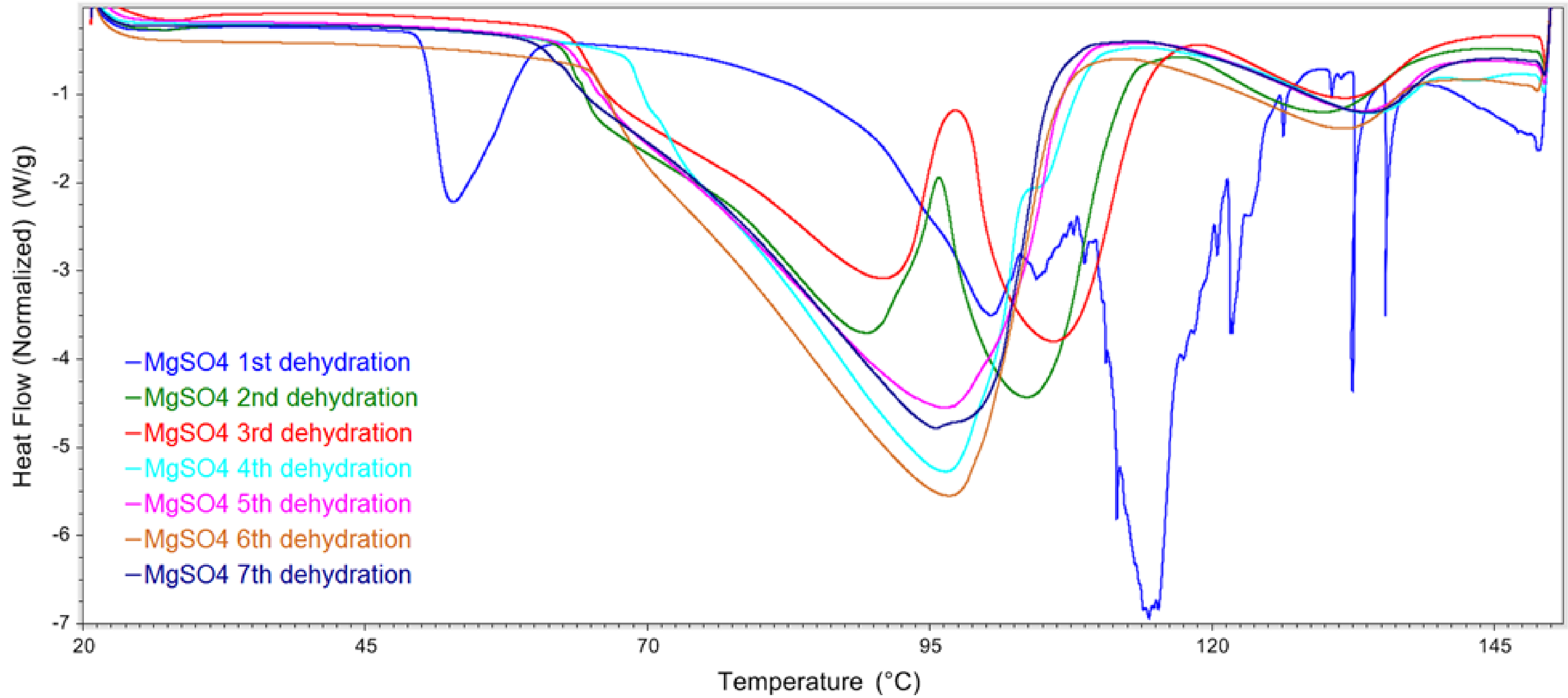
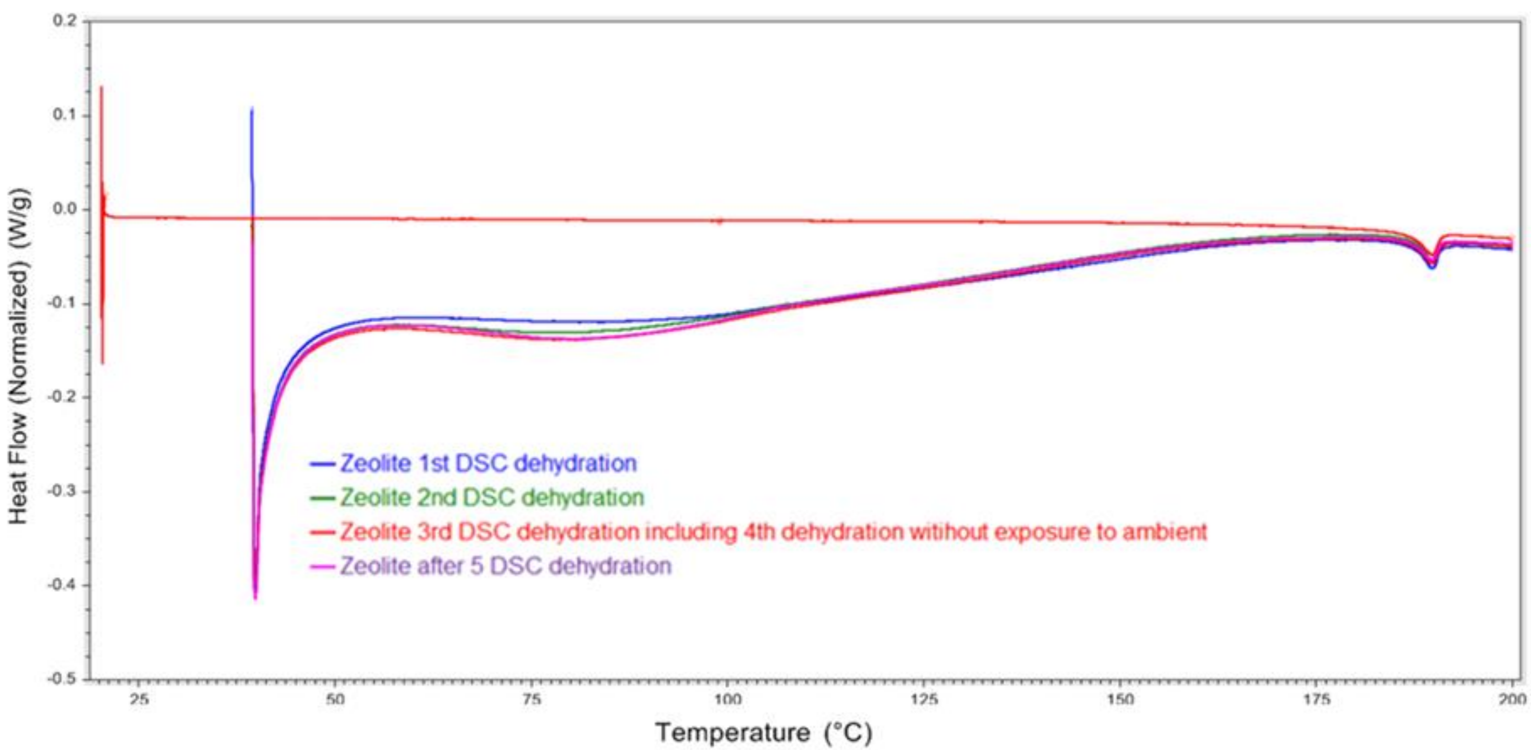
DSC Cycle Stability of $MgSO_4$ (10˚C/min)

- Shift in peak dehydration to lower temperature range.
- Less volatile with increasing cycles.
- Average enthalpy, over 7 cycles =1200J/g .



Cycle Stability of Zeolite

- No sign of degradation
- Majority (~750J/g) of enthalpy below 150˚C
- Unaffected by heating rates



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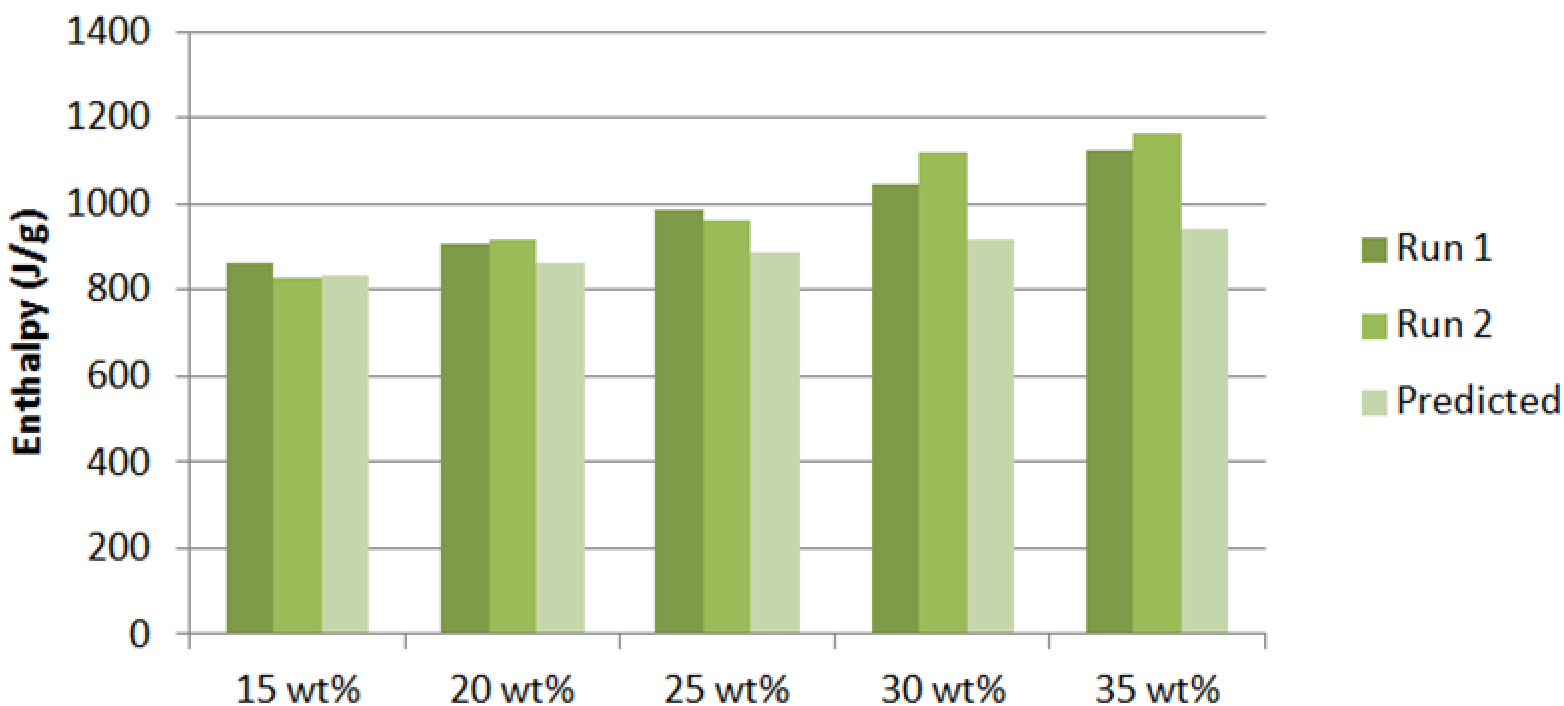
Cycle Stability of Composites

- Composite materials = Zeolite + (wt%)$MgSO_4$
- Pure $MgSO_4$ has poor hydration kinetics
- Promising dehydration enthalpy



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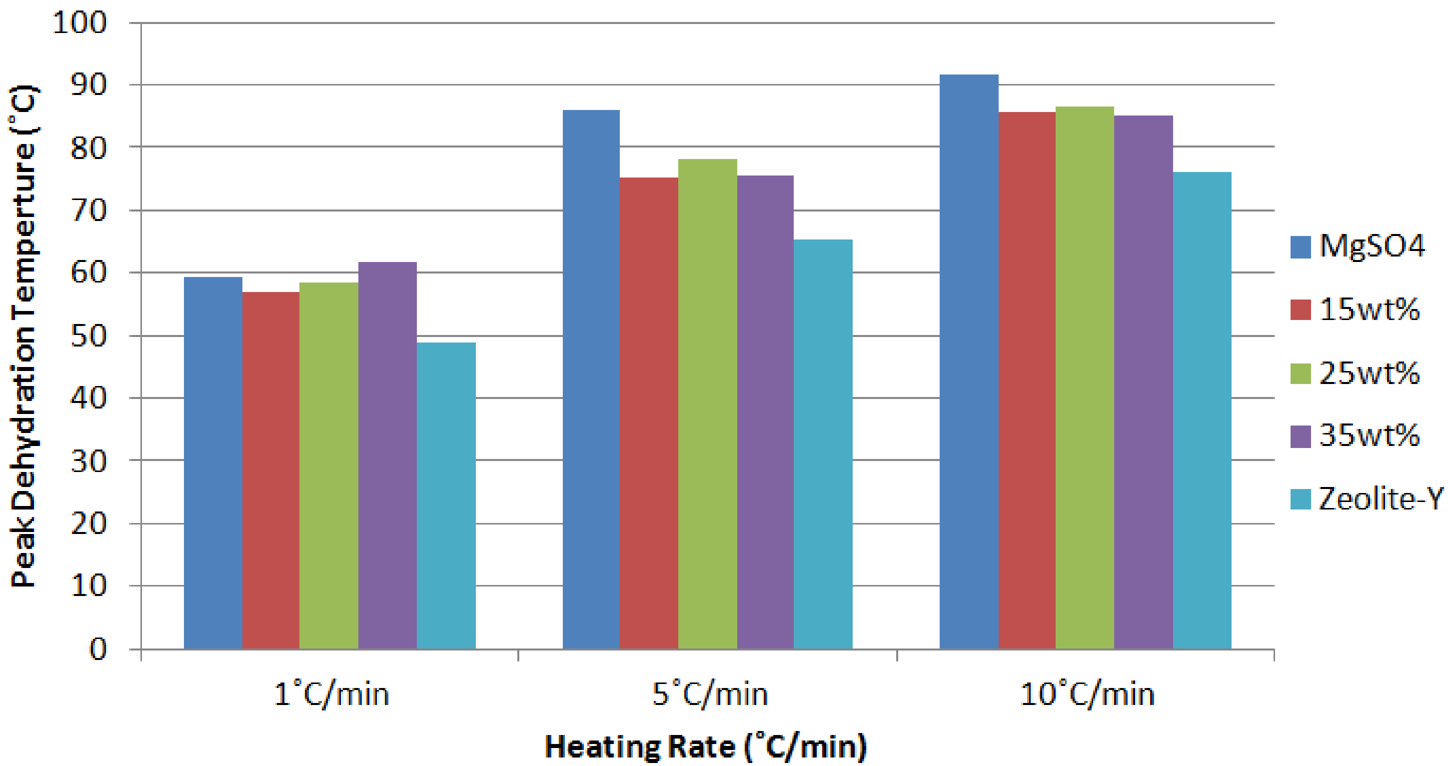
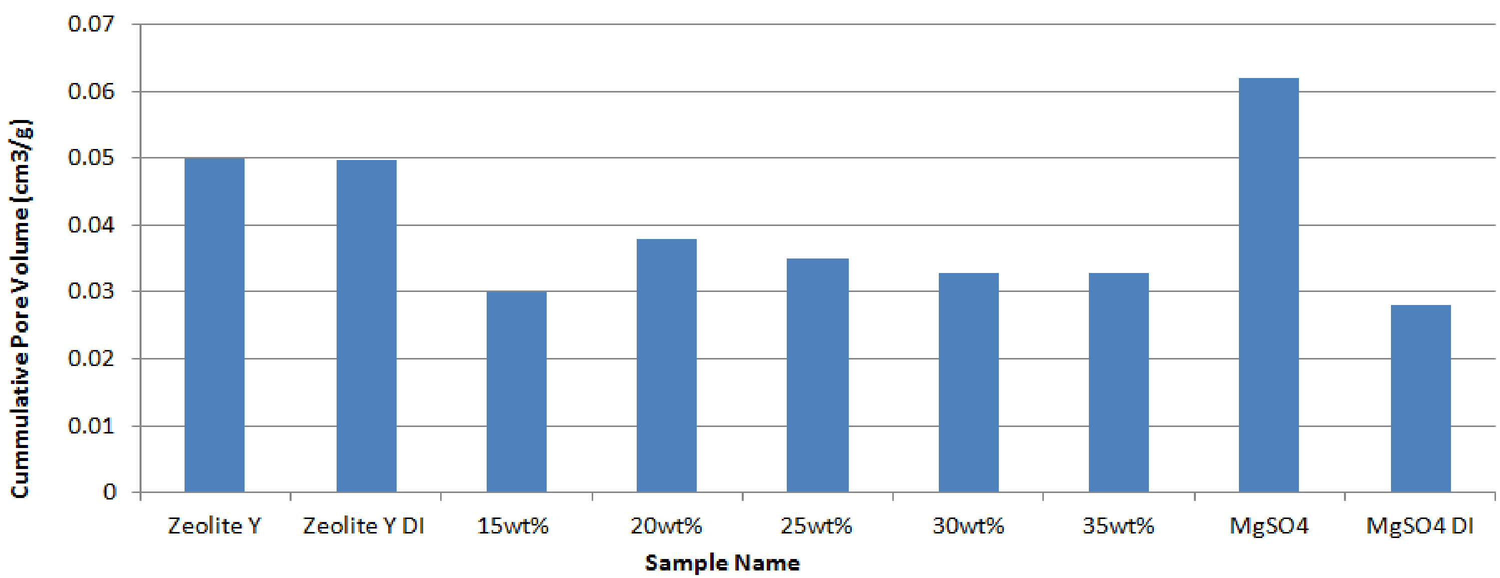
Heating rate effects of Composites

- All composites have similar peak dehydration temp.
- DSC plots of composites show no volatile behaviour.
- Zeolite impregnation appears to neutralize the heating rate affects of the $MgSO_4$
- Promising for practical applications of the composites



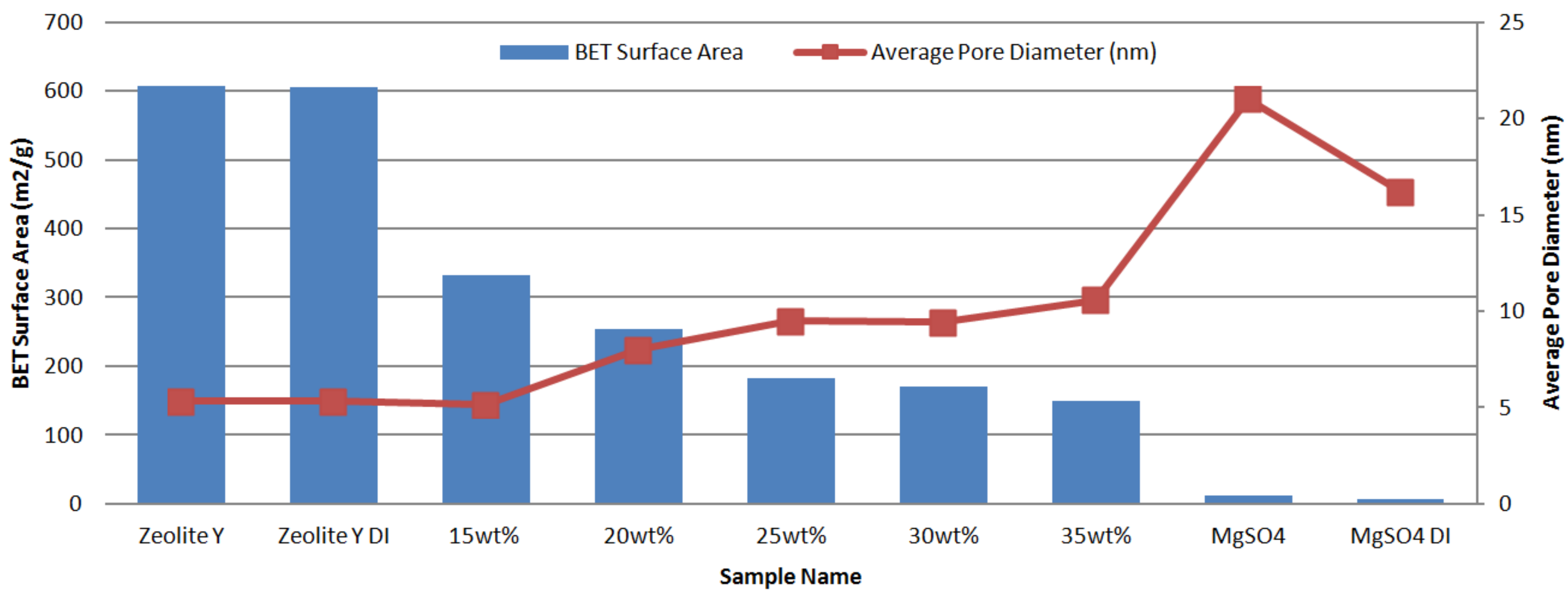
Nitrogen Vapour Sorption Testing

- To assess the changing surface area and porosity of each sample nitrogen vapour sorption testing was conducted.
- Higher surface area and pore volume (Micro or Mesopores) is beneficial.
- Each sample degassed at 170˚C for 3h using N_2 as a purge gas.



Nitrogen Vapour Sorption Testing

- BET surface area decreases with increasing wt%
- Majority of Zeolites pore volume is from 5nm pores (i.e. Mesopores)



Summary

- **$MgSO_4$** – Minimal degradation, characteristics appear to improve with successive cycles.
- **Zeolite** – Unaffected by heating rates, zero visible degradation & high surface area
- **Composite Materials** – Promising enthalpy, decreased heating rate effects.

Thank You

Questions?