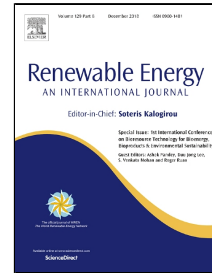


# Accepted Manuscript

An Improved, Generalized Effective Thermal Conductivity Method for Rapid Design of High Temperature Shell-and-Tube Latent Heat Thermal Energy Storage Systems



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1        **An Improved, Generalized Effective Thermal Conductivity Method**  
2        **for Rapid Design of High Temperature Shell-and-Tube Latent Heat**  
3        **Thermal Energy Storage Systems**

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11        **Abstract**

12        To avoid full — expensive — computational fluid dynamic (CFD) simulations, latent  
13        heat thermal energy storage (LHTES) systems are often modelled by incorporating  
14        natural convection Nusselt correlations. This enables fast, coarse optimizations for  
15        phase change materials (PCMs) selection and geometrical design. While this approach  
16        is very convenient and often works well, it is frequently invoked in an ad-hoc manner  
17        — outside of known limits. To broaden the limits of applicability for this approach, this  
18        study develops natural convection Nusselt correlations for high temperature shell-and-  
19        tube LHTES systems, which are under development for concentrated solar power (CSP)  
20        plants. In these systems there is a large gap between PCM melting point and heat  
21        transfer fluid, up to 280 °C, which drives melting process. To date, many correlations  
22        that have been developed (for low temperature PCMs) in the literature are only suitable  
23        for a specific geometry and/or PCM. Therefore, this study also expands on the literature  
24        by providing correlations that are appropriate for a wide range of realistic geometric  
25        parameters and high temperature PCMs. These new natural convection Nusselt  
26        correlations were obtained by comparing the heat transfer rates in conduction only and  
27        combined conduction/convection CFD models for several PCMs and geometries in the

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