

# Mathematical modelling of nanofluid-based Direct Absorption Solar Collectors - Scientific Report

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**STSM Purpose** The motivation for this scientific mission was to work on mathematical modelling of nanofluid-based Direct Absorption Solar Collectors with Prof. Timothy Myers.

## Report

The ultimate goal of this mission was to help improve the efficiency of Nanofluid based Direct Absorption Solar Collectors (NDASCs), to make solar energy a more attractive alternative energy solution, and to ensure that this renewable energy source meets its full potential. Specifically, the aim was to model the flow of a nanofluid whilst it absorbs solar energy and examine the effect of various parameters on energy transport, using asymptotic and numerical methods.

We began by analysing existing mathematical models that describe the coupled process of solar radiation absorption, fluid flow and heat transfer within NDASCs [1, 2]. We applied a technique for approximating the radial flux integral found in [1], along with other asymptotic and scaling arguments to obtain a mathematical model describing a parabolic trough concentrating NDASC. An existing model for parabolic trough

concentrating NDASCs is solved numerically in [2]. In contrast, our model can be solved analytically and will permit optimisation of design parameters such as: particle loading and particle type; solar absorption characteristics of the fluid; channel dimensions; surface treatments such as blackening; and fluid flow conditions.

Working with Prof. Myers and his Industrial Maths group in the CRM enabled me to acquire and apply the mathematical knowledge and methodologies underpinning the results in Cregan & Myers [1] in a more synchronous environment. This has undoubtedly expedited both my development as a mathematician and the progress of this project. Visiting the CRM has also afforded me the opportunity to share and collaborate with leading world experts in my field; I was able to develop as a researcher by working within a different research group and observing their approaches to various problem solving processes.

This grant for a Short Term Scientific Mission (STSM) was used in conjunction with funding already received from my Government of Ireland Postgraduate Scholarship to boost the collaborative efforts between Prof Tim Myers and I, and between the CRM and MACSI. The specific research outputs from this research visit will be a presentation at the 19th European Conference on Mathematics for Industry at the University of Santiago de Compostela (USC), and a scientific paper.

## References

- [1] V. Cregan, and T.G. Myers, Modelling the efficiency of a nanofluid direct absorption solar collector. *International Journal of Heat and Mass Transfer*, **90**, pp. 505-514, 2015.
- [2] V. Khullar, H. Tyagi, P. Phelan, T. Otanicar, H. Singh, and R. Harjit Taylor, Solar energy harvesting using nanofluids-based concentrating solar collector. *Journal of Nanotechnology in Engineering and Medicine*, **3**(3), pp. 031003, 2012.