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Topic

Title : Nanofluids based on linear silicone fluids for concentrating solar power

Keywords : Nanofluids; concentrating solar power; rheological properties; thermal properties.

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Abstract:

All solar thermal power plants have two elements in common: a harvesting system that acts as a black body and a high-pressure steam generator that drives an electricity generator. Between both elements, a heat transfer fluid is used whose main mission, depending on the kind of plant, is the storage and transfer of heat. Thus, this kind of industries would benefit immensely from using a fluid with improved heat storage properties, or enhanced thermal conductivity. If, in addition, this fluid is environmentally friendly, using it will be perfectly relevant.

CSP-PTC plants currently use a thermal fluid that is the eutectic mixture of biphenyl and diphenyl oxide as the heat transfer fluid. This fluid presents interesting properties, but doubts have been raised regarding its use in recent times due it not being environmentally friendly since it is highly toxic and irritant. In turn, the scientific community has been working on a new kind of fluid known as linear silicone fluids, which are more environmentally-friendly, inert and non-toxic, while also allowing for a higher maximum operating temperature than the fluid typically used. However, silicone fluids present certain thermal and physical properties, such as density and heat capacity, that are inferior to those of the conventional fluid. Thus, the starting hypothesis is that developing nanofluids based on this new kind of fluid may allow these properties to be enhanced, resulting in their use in CSP-PTC plants, leading to an increase in their global efficiency. Bearing in mind that these fluids are also environmentally-friendly, they would make a double contribution to the green transition required in our society.

The general aim for this thesis is to develop advanced nanofluids based on linear silicone fluids that are very stable and present enhanced thermal properties, making them promising for use in CSP-PTC plants, which would benefit from overall improvements in efficiency. The thesis activities will pay special attention to measuring the physical and chemical stability of the nanofluids prepared and to characterizing their thermal (heat capacity and thermal conductivity) and rheological properties in view of potential use in CSP-PTC plants. Based on those properties, the efficiency of these new nanofluids in CSP-PTC plants will be theoretically and/or numerically evaluated. Following the thesis development and complementary support, such a demonstration could be finally performed at lab scale or in pilot plan.

This PhD thesis will be performed under a cotutelle agreement in Cádiz, Spain (<https://www.uca.es/>) in the group Simulation, Characterization and Evolution of Materials from Faculty of Sciences, Department of Physical Chemistry and Rennes, France, in the Laboratory of Civil Engineering and Mechanical Engineering (<https://lgcgm.fr/>) from Université de Rennes (<https://www.univ-rennes.fr/en>). Collaborations with other labs/companies in Europe could also be planned.

The PhD student will follow the rules of doctoral schools for training courses, seminars participation, expectations, defence, ... Mobilities between Spain and France will be defined between the PhD candidate and the supervisors and formalized in the cotutelle agreement.

Duration: 3,5 years

Expected starting date: June 2023

Brut Salary: 24250 €/year for the two first years, then 36000€ for 1,5 year- Doctoral contract

Candidate Profile

Education & experience

Master in Nanoscience, Physics or Chemistry, Graduate in Chemistry or Physics or related fields

Experience in experimental characterizations

Synthesis of nanomaterials, preparation of samples, thermophysical properties measurements

Good standard of spoken and written English (level B2), knowledge of Spanish and/or French is beneficial

Specific competencies

First experience with nanofluid(s) is beneficial

Experience with working in a science or technology research environment

Curious, rigorous, great taste for experimental activities

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Knowing in solar technologies and nanotechnologies for solar applications and heat exchange

Good inter-personal and communication skills within a multi-national context including diplomacy and confidentiality

Ability to evolve in multidisciplinary team and international context

Think for oneself, being proactive

Other competencies / soft skills

Organized with the ability to prioritize and multi-task and work with deadlines

Reliable with patience and professionalism

Team-orientated work ethic

Flexibility and adaptability

Positive and constructive attitude in an evolving environment

Be mobile between Spain and France

For applying

Please send to both supervisors

- your CV,
- your motivation letter including expected professional project(s) after the PhD and how the PhD can help in its development, and
- 2 support/reference letters from master Teacher(s) or/and Master internship supervisor(s), or relevant people

After selection of applications, successful applicants will be interviewed.