TOPCSP - PhD thesis offer

Turbulent two-phase flows in direct steam generation solar receiver

Starting date: before April 1, 2023

Framework of the TOPCSP project: Ten PhD positions are available in the TOPCSP doctoral network funded by the Horizon-MSCA DN- 2021 call. The Towards Competitive, Reliable, Safe and Sustainable Concentrated Solar Power (CSP) Plants (TOPCSP) project will offer a unique international, intersectoral and interdisciplinary research and innovation framework to 10 promising doctoral candidates and will boost their excellence in the development of innovative technologies and so that they will be capable of solving the challenges that currently face the solar thermal power industry. The overall research objective of the project is to improve the design of the different systems of a CSP plant to increase its cost-competitiveness, reliability, environmental profile, and operational safety.
Core research skills will be acquired by each doctoral candidate through the doctoral-level investigations of the task associated with his/her individual research project. Additional research skills will be delivered in the network-wide workshops, international conferences and training modules. A training in transferable skills, will help the doctoral candidates project their careers towards innovative and hi-tech applications in the non-academic sector. Every doctoral candidate will undertake secondments in academic and non-academic institutions of the consortium institution to develop their intersectoral and interdisciplinary skills.

Specific background of the PhD thesis: One of the concentrated solar technologies currently being developed consists of direct steam generation (DSG) in the solar receiver. This eliminates the need for a HTF, reduces the number of heat exchangers and potentially increases the efficiency of the plant. The steam produced can either drive a turbine to generate electricity or be directly used by an industrial process or a heating network. DSG in the receiver of parabolic trough collectors is proven technology although numerical studies are limited due to the lack of knowledge about the thermo-physical process of two-phase flow boiling in the horizontal and inclined DSG receivers. Current numerical modelling and experimental correlations are limited to specific case studies. At the entrance of the solar field, pressurized water enters the receiver. Under the effect of convective heat exchange between the fluid and the tube wall, water evaporates, and a boiling two-phase flow is created in the receiver. Considering the tube lengths ($\approx 100m$) and the heat fluxes involved ($\approx 40kW/m2$), the vapour volume fraction varies depending on the position in the receiver tube. Reliable prediction of the two-phase flow regime in the receiver is of critical importance for two reasons: (i) predicting the amount of steam produced and, thus, plant production, and (ii) assessing the thermomechanical stresses imposed on the tube materials. CNRS has previous experience modelling these flows using a Euler-Euler approach, showing the ability of the method to reproduce the physics involved in a case of evaporation of a freon in a horizontal coiled tube. In this PhD project this methodology will be applied to a solar receiver.

Objectives and research plan: The candidate, hosted by CNRS, will set up numerical simulations using NEPTUNE_CFD software to model the flow in the DSG plant. The thermal conduction in the walls of the receiver will be considered with Syrthes software. A coupling between the two codes will be implemented to perform massively parallel simulations on European supercomputers. Due to the recent emergence of this type of power plant, experimental operating data, essential for validating numerical tools, are currently unavailable in the literature. The researcher will set up a small-scale experiment, without solar irradiation, to reproduce the physics of boiling flows in a DSG receiver. The experimental data will be compared with the computational results to validate the modelling approach.

Applicant profile: We are looking for candidates with a master degree in fluid mechanics or energetics. Good English speaking/writing/reading skills is required along with a solid knowledge of heat transfer and applied thermodynamics. Given the research program, an appetite for experimental and numerical work is essential. Previous experience in programming would be appreciated but is not required.

Location : PROMES Laboratory – Perpignan, FRANCE.

Salary: The base salary is 3043 €/ month gross. A family bonus is also possible depending on the situation of the person recruited

Eligibility criteria: Recruited researchers can be of any nationality and must comply with the following mobility rule: they must not have resided or carried out their main activity (work, studies, etc.) in France for more than 12 months in the 36 months immediately before their recruitment date. Compulsory national service, short stays such as holidays and time spent by the researcher as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.

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Application deadline: Applications must be performed **before November 1, 2022**

Selection process: Candidates must apply on the online platform of CNRS (CNRS) and join the following informations/documents:

- the application form to be found on EURAXESS portal
- a detailed CV, including the list of the applicant's publications (if any).
- a motivation letter
- a transcripts of bachelor and master's degrees (including the grade range)
- an english language certificate (if available)
- the e-mail address and telephone number of two referees, who can provide a letter of recommendation if needed.