ENERGETICS

Ammin/DENERG - Experimental analysis of processes of chemical looping to produce solar-chemicals

Funded By	Dipartimento DENERG Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	Chemical Looping Solar-chemicals
Objectives	The primary goal of the PhD is the design by modeling of an optimized integrated solar receiver-reactor and its validation, integrating advanced CFD-based simulation, hardware engineering, and prototype development. The work will focus on the following objectives: • Integrated solar reactor-receiver modeling Formulate transient models (2D-3D) coupling mass, momentum, energy conservation and reaction kinetics in realistic solar reactor-receiver geometries. The use of tools such as COMSOL Multiphysics will allow to combine different physical models in the same modeling suite. • Prototype development: translate modeling insights into prototype designs with manufacturable components. Test small-to-intermediate scale prototypes under realistic conditions to assess performance and degradation. • Optimization of experimental setup for prototype testing: a novel testing setup capable of simulating high-temperature solar concentration for testing prototype-scale reactors is under development within the H2SHFIT project (test-bench availability planned by the end of 2025). The experimental setup will be calibrated and optimized to perform the cyclic testing of prototype reactors. • Prototype testing for model validation: the prototypes will be tested in the solar concentrator simulator setup to validate the model developed and to collect data on reactors and oxygen carrier cyclability. Beyond State-of-the-Art contributions: • Complete integrated solar reactor-receiver transient model including kinetics of oxidation and reduction of oxygen carrier materials. • Solar reactor-receiver prototyping, with an integrated loop between design, simulation and experimental testing.

	• Validation of a high-temperature solar simulation experimental facility for prototype reactor testing

Skills and competencies for the development of the activity	The PhD candidate will develop and apply the following interdisciplinary skills: • Computational Fluid Dynamics modelling skills: o Use of finite element simulation software (e.g., COMSOL Multiphysics). o Ability to implement multiphysics models involving fluid flow, heat exchange mechanism (including irradiation) and reaction kinetics. • Reactor Engineering skills: o Knowledge of solar reactors design o Understanding of thermal management in high-temperature reactors o Ability to design small-scale reactor up to the executive drawing • Experimental Skills: o Ability to operate an advector o Ability to interpret electrochemical and gas-phase measurements (e.g., current-voltage curves, CO2 concentration profiles). • Scientific Communication: o Experience in presenting complex results in multidisciplinary teams and writing scientific publications.