Research Centre for Gas Innovation

Lead institution: University of São Paulo **Work Address of the position:** Escola Politécnica – University of São Paulo – Cidade Universitária Av. Professor Mello Moraes, 2231 Butantã – 05508-030 City: São Paulo State: São Paulo Country: Brazil	
Supervisor name: José R. Simões Moreira	**Supervisor department: Mechanical Engineering**
Co-supervisor name: Bruno Souza Carmo	**Co-supervisor department: Mechanical Engineering**
APPLY AT: **Recipient**: **http://www.rcgi.poli.usp.br/opportunities/** **Ref: 17PDR035** **http://www.rcgi.poli.usp.br/opportunities/application-form-rcgi/**	**Type: POS DOCTORATE** **40 hours weekly** **Duration: 2 years**

Project title

Numerical modelling and optimisation of a reactor for solar thermal methane reforming

Research theme area

Numerical modelling, numerical simulation, design, optimisation, solar thermal steam methane reforming, hydrogen production

Abstract

Hydrogen can be used either in fuel cells, which generates electricity and water vapour, or in an internal combustion engine, which generates mechanical power and water vapour. Transport powered by hydrogen does not produce any direct CO2 emissions. The environmental impact of using hydrogen as transportation fuel depends on the source of the energy used to produce the hydrogen. In this sense, the ideal scenario is to have hydrogen produced entirely from renewable sources. However, the technologies available for that have shown very small efficiency.
Consequently, most of the hydrogen produced today is sourced from fossil fuels, with the principal method employed being the catalytic reforming of methane, CH_4, the principal component of natural gas and other gaseous fuels.

The reforming reaction is highly endothermic, and is, thus, favoured by high temperatures; industrial reforming processes are carried out between 800 °C and 1000 °C. The required energy is usually supplied by combustion of additional natural gas and process waste gas from the downstream hydrogen purification step. The share of natural gas consumed as fuel varies from 3% to 20% of the total plant’s natural gas consumption. The reaction gas product mixture is known as synthesis gas (syngas): a gas mixture that contains varying amounts of CO and H_2 whose exothermic conversion into fuel and other products has long been commercially employed, for example, via the Fischer-Tropsch technology.

Research Centre for Gas Innovation

Methane reforming technologies are not carbon neutral unless bio-methane or other bio- derived resources are used, but this is not competitive in terms of cost nowadays. However, although methane from natural gas reform is not carbon neutral, there is the advantage of concentrating the CO_2 production in a large industrial facility, where efficiency optimisation can be more easily carried out, carbon capture and storage techniques may be possibly employed and wide spread of green house gases and pollutants in highly populated areas (i.e., cities) can be avoided. In addition, reforming carbon based fuels into hydrogen using renewable energy, such as solar concentrated power, can reduce CO_2 emissions of at least 25% when compared to using them directly as fuels and also bring economical savings. In doing so, solar energy is embodied thermochemically in the product hydrogen, being thus able to be stored at ambient conditions, transported from the point of production to where it is required, and used outside daylight hours. Such a transitional technology is considered by many to be an essential stepping stone from current practice to a truly renewable-based hydrogen economy.

Description

This Post doctorate position is expected to be developed in collaboration with researchers from the Engineering Programme, mainly the project 16, of USP's Research Centre for Gas Innovation – RCGI (summary of the program and projects is found in the RCGI website at www.usp.br/rcgi).

Numerical modelling and simulation of a receiver-reactor of solar thermal steam methane reformer in order to provide a tool for design and optimisation. We will work at lab and pilot scale, using parabolic dish as solar concentrator. The design should maximise the hydrogen yield.

Requirements to fill the position

In this project, we intend to employ numerical modelling and simulation to design and optimise a receiver-reactor of solar thermal steam methane reformer in order to provide a tool for design and optimisation in terms of maximisation of hydrogen yield. We will work at lab and pilot scale, using parabolic dish as solar concentrator. The focus will be on direct, volumetric absorbers with a structured stationary matrix with the catalysts necessary for the reactions. The model should be able to represent the heat transfer, flow dynamics and chemical reactions that occur inside the reactor. The model and designs can be validated using the experimental facility developed in a companion PhD project developed within project 16 of the RCGI.

Information about the FELLOWSHIP

The selected candidate will receive a FAPESP Post-Doctoral fellowship in the amount of R$ R$ 7.174,80 monthly payed in Reais and a research contingency fund, equivalent to 15% of the annual value of the fellowship which should be spent on items directly related to the research activity, as well as displacement funding, if necessary and applicable. More information about the fellowship is at: **fapesp.br/en/postdoc**.