PhD Position Offer (2019 - 2022)

COTUTELLE CORIA (France) & SINTEF-NTNU (Norway)

Thesis subject
An experimental study of turbulent gaseous oxyfuel flames diluted with CO_2 by Spontaneous Raman Scattering

Keywords
Combustion, Spontaneous Raman Scattering, CO_2, CCS

French Doctoral School: PSIME (ED 591 – ComUE Normandie Université)

French Research Unit: CORIA (Complexe de Recherche Interprofessionnel en Aérothermochimie) – UMR 6614 CNRS, Normandie Université, INSA Rouen Normandie, Université Rouen Normandie.

Norwegian Research Unit: SINTEF Energi and Norwegian University of Science and Technology (NTNU)

Skill Profile
The candidate must have a Master's degree or an Engineer diploma with skills in fluid mechanics, combustion and thermal transfers.
A profile with a strong interest in experimental research activities and optical diagnostics for reacting flows will be appreciated.

Presentation of the PhD project
In the aim of the reduction of CO_2 emissions in atmosphere, innovative combustion systems have to be developed in order to enhance their efficiency or to apply carbon capture and sequestration (CCS). One solution for the latter is to associate oxyfuel combustion and flue gas recirculation to enhance CO_2 concentration in combustion products. This is a promising technology for large scale combustion systems for power production and manufacturing industry (glass, steel,…). However, the modifications induced on the flame features are important and are not yet fully understood. This requires more academic fundamental knowledge of these specific combustion regimes.
The CORIA laboratory (Rouen, France) has been carrying out experimental studies on the subject within collaborations with Air Liquide R&D division for several years and more recently with SINTEF (Trondheim, Norway). Development of advanced laser diagnostics for combustion is also one of the main research activities of CORIA. It has been shown recently that Spontaneous Raman Scattering (SRS) is a convenient laser diagnostic to measure instantaneously and simultaneously temperature and main species concentrations in laminar and turbulent flames of gaseous or liquid fuels and with different oxidising mixtures.

A measurements campaign performed by CORIA in 2018 at SINTEF has demonstrated the large potential of SRS for experimental characterisation of turbulent oxyfuel flames diluted by carbon dioxide. The present project is the continuation of this collaboration as a PhD thesis in

cotutelle between CORIA (UMR 6614 CNRS, Normandie Université, INSA Rouen Normandie, Université Rouen Normandie), SINTEF Energi and NTNU (Norwegian University of Science and Technology) to pursue the development of SRS technique and its application to different experimental configurations of CO_2 diluted oxyfuel combustion.

The objectives are to perform instantaneous and simultaneous measurements of temperature and main species concentrations in turbulent flames on one hand in a multi-fluid oxyfuel combustion chamber at atmospheric pressure in CORIA and on the other hand in the high pressure (10 bars) pilot facility in SINTEF. This will require the development of new optical configurations to collect SRS signal despite of the limitations of optical accesses in the combustion chambers. Post-processing of experimental SRS spectra is based on automatic spectral fitting with theoretical spectra convoluted with apparatus functions determined from SRS radiation collected in-situ. During the PhD period, the procedure of SRS spectra processing will be adapted depending on the gaseous fuel composition (methane, hydrogen,…) and the oxidising mixtures at different (O_2 – CO_2) proportion. The temperature will be obtained from methane or/and carbon dioxide spectra. One dimensional instantaneous and simultaneous measurements of CH_4, O_2, CO, CO_2 and H_2O concentrations in turbulent oxyfuel flames diluted by carbon dioxide will allow a deep characterisation of the specificity of these combustion regimes.

PhD thesis program (36 months)

M0 – M6: Bibliography. Handling of Spontaneous Raman Scattering (SRS) setup in CORIA. Adaptation of the lab-scale multi-fluid oxyfuel combustion facility.

M6 – M15: Characterisation of turbulent oxyfuel flames diluted by carbon dioxide at atmospheric pressure by SRS measurements in the multi-fluid oxyfuel combustion facility in CORIA.

M15 – M24: Characterisation of turbulent oxyfuel flames diluted by carbon dioxide at high pressure by SRS measurements in pilot combustion facility in SINTEF.

M24 - M30: Post-processing of Raman spectra obtained at CORIA and SINTEF. Synthesis of results.

M30 - M36 : Writing of Thesis manuscript. Preparation of oral defense.

PhD Thesis supervisors

Armelle Cessou (armelle.cessou@coria.fr) - David Honoré (david.honore@coria.fr)

Fundings

Co-fundings from Normandie Regional Council (France) and SINTEF - NTNU (Norway)

French administrative supervision

CORIA lab is funder member of Institut Carnot ESP (Energy and Systems for Propulsion).