http://www.laplace.univ-tlse.fr **2023 / 2024**	**Offre de Stage** Thématique(s) concernée(s) : ☐ Electromagnétisme ☐ Matériaux ☐ Mathématiques Appliqués x Plasmas x Systèmes Electriques ☐ Autre(s) :

Titre : Eco-friendly Gas circuit breaker development – Study of decomposition and chemical kinetics of the insulating gas during arc extinction

Hyosung Heavy Industries exports its products to many parts of the world including North America, the Middle East and Europe. This company is considered extremely valuable not only in the field of electrical power equipment such as transformers and circuit breakers, but also in the field of electric motors, gearboxes and generators for providing complete system solutions. In addition, Hyosung has core technologies required to build the power grids of the future, including Energy Storage Systems (ESS), STATCOM and Smart Grid solutions. Based on this, Hyosung is determined to lead the era of low-carbon green life.

Hyosung Heavy Industry has continued to develop its products and services over the past four decades since the gas circuit breaker (GCB) for 170 kV was first developed in 1978. Over time Hyosung has successfully shipped their products with rated voltages up to 800kV to over forty different countries.

Hyosung‘s high-voltage circuit breakers are designed to be compact and easy to maintain.

Hyosung research activities are focused on environmentally friendly products. Due to the characteristics of eco-efficient gas or vacuum, the switching behavior in high-voltage circuit breakers has a higher degree of difficulty in breaking and dielectric behavior compared to traditional SF_6 gas. In particular, at the time of breaking, the thermal and dielectric stress of a switch is severe, ultimately increasing the complexity of the design of the breaker.

Hyosung Heavy Industry is taking on the challenge of collecting advanced information and basic data, in addition to the SF_6 gas that has been standard up to now, in order to advance the interpretation of design standards for eco-efficient gas and vacuum interrupters. Accordingly, it is planned to develop eco-friendly gas and vacuum breakers and improve eco-efficient breaker design technology by promptly hiring experts and engineers who are interested in this topic and want to work in this environment. We will focus on the topic of eco-efficient spring-operated hybrid switch in the range from 145 kV to 420 kV.

Topic :

Among many options, CO_2 and C-4 mixtures are one of the SF_6 alternative that offers many advantages. Nevertheless, when an arc occurs in this mixture it generates some byproducts such as CO and carbon powder. The target of this study is to better understand the mechanism behind the production of this elements, and more precisely can we influence this playing on the temperature, the pressure or any other physical parameter.

To determine the decomposition components of a gas we can consider a chemical equilibrium, therefore the resulting particles are only determined by the initial mixture. In reality, in arc quenching the time for reaction is such small that we have to consider the speed of the chemical reactions in order to determine the quantity of byproducts and this might be dependent on some thermodynamic conditions (temperature and pressure).

During the internship, the following work will be performed:

- Under the assumption of chemical equilibrium, calculation of the plasma composition during the arc extinction;
- Characterization of decomposition by-products (CO, solid carbon in particular) as a function of pressure and initial gaseous mixture;
- Building of a chemical kinetic scheme for the development of a collisional-radiative model of the arc extinction.

Connaissances requises :

1) Requested skills/capacity

① Good knowledge in the plasma physics and understanding the thermodynamic phenomena

② Coding skills

③ Willing and leading project activities and smaller project team

2) Essential requirements

① Fluent language proficiency in English

② Fast learner with high self-motivated attitudes

③ Team player with active initiatives

Responsable(s) :

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Lieu du stage et conditions particulières :

LAPLACE site UPS, Equipe ScIPRA

Possibilité de poursuite en thèse : oui

This internship could be followed by a PhD and an integration in Hyosung Heavy Industries.