OFFRE D'ALLOCATION DE THESE / PhD GRANT

ÉCOLE DOCTORALE SCIENCES EXACTES ET LEURS APPLICATIONS - ED 211 / NATURAL SCIENCES DOCTORAL SCHOOL

Avenue de l'université BP 1155 64 013 PAU Cedex – France

PhD SUBJECT

TITLE: Development of corn stover pyrolysis method for biooil production

As a major environmental and economic issue, the valorization of corn is now a priority for both industrial and academic players. Supported by the funding of three doctoral theses at the Université de Pau et des Pays de l'Adour (UPPA), this interdisciplinary project aims to develop a new pyrolysis and characterization technology, and to study the economic impact of agricultural waste recovery, particularly with a view to accelerating the integration of the circular economy into the practices of economic players in the Nouvelle-Aquitaine region. To achieve this, it relies on the close collaboration of several regional research laboratories in a complex and ambitious study, situated at the interface between physico-chemical and economic fields. Corn waste has been widely used for agronomic purposes (soil fertility/quality) and for animal feed (pasture/hay). In view of the region's high corn production, which accounts for 30% of national output, the region has significant potential for this residue compared with other parts of the country. However, the region has not yet exploited the potential of agricultural waste for energy purposes or the production of valuable goods.

Through three interconnected lines of research (PhDs), this project will benefit from the expertise developed in UPPA laboratories to improve the characterization process to understand the physico-chemical properties of corn, and the pyrolysis process to simultaneously obtain silica particles and a bio-oil with improved quality.

This PhD will be focused on the development of corn stover pyrolysis method for biooil production and the fractionation of these bio-oil for further characterization by different analytical techniques.

Keywords: Pyrolysis, Circular Economy, Fractionation

WORKING CONDITIONS

Laboratoire : UMR 5254 CNRS-UPPA, Institut des Sciences Analytiques et de Physico-Chimie pour l'Environnement et les Matériaux (IPREM)

Site web : www.iprem.univ-pau.fr

PhD Director: Frédéric Marias / Ryan Rodgers

PhD co-supervisor: Caroline Mangote

In Collaboration with:

Place: IPREM. Hélioparc, 2 Avenue du Président Angot 64053 Pau cedex 09

Start: October 2024	**Duration:** 3 years

Employeur (employer): Université de Pau et des Pays de l'Adour (UPPA)

Salaire mensuel brut (monthly salary before taxes): 2100 €

(Si enseignement : salaire mensuel brut pour 32h d'enseignement par année universitaire : 110 €)

HOST LABORATORY PROFILE

The PhD will principally work at LATEP and IPREM, specifically, he/she will be member of the Analytical Chemistry, Physical and Theoretical (CAPT) Cluster. He will be part of the iC2MC Pau group that has a vast experience on analytical chemistry, trace metal speciation in complexes matrices. To reach the outlined objectives, the project will be supported by the unique instrumental facilities of the host laboratory. This platform possesses, among others, the state of the art instruments required for these project (ICP-MS, ICP HR

MS, HPLC/GC/LA ICP MS, FT ICR MS (ESI and MALDI)).

At LaTEP, the PhD Student will be welcomed in the team devoted to the Optimization of Multi-Energy systems, which includes thermochemical conversion of Wood and Biomass. LaTEP owns a classical commercial TGA DSC and a unique high capacity Thermobalance to pyrolyse high loads of organic samples (up to 1kg) with recovery of all bio products (Char, bio-oil and permanent gases)

This PhD will be also link with TotalEnergies iC2MC part and some stay at the TRTG Research center (Gonfreville) or at the Florida State University will be possible.

See details at https://iprem.univ-pau.fr/fr/activites-scientifiques/poles-scientifiques/chimie-analytique-physique-et-theorique/capt-membres.html

MISSION - ACTIVITES PRINCIPALES / MISSION – PRINCIPAL ACTIVITIES

I. *Scientific Context*

Thermochemical conversion appears to be the most promising method for producing bio-oils and other compounds, such as silica particles. Pyrolysis has proved to be an excellent technique for increasing the value of biomass, and can be carried out on virtually any biomass source. The process involves heating biomass polymers in the absence of oxygen, enabling their depolymerization while inhibiting their combustion. From the biomass pyrolysis process, 3 phases of material can be obtained: ash (solid), bio-oil containing a mixture of water and organic matter (liquid) and non-condensable gases (gas). Then, by calcining the ash at 700°C, it is possible to obtain, when the initial material contains a significant proportion of it, silicon particles. The aim of this research is to improve the prospects for using biomass from corn production waste as a raw material for the production of bio-oil (subsequently refinable into SAF (Sustainable Aviation Fuel / Carburant d'Aviations Durable) and silica particles.

When silica particles reach the nanoscale, they begin to exhibit new characteristics, such as photoluminescence, antibacterial capacity and a size-dependent electrical band gap, which are not observed in bulk silicon. The high surface area of nano-silica makes it ideal for various applications, such as filler reinforcement in the rubber industry (tire manufacture), improving the properties of concrete, the insecticide industry, paint, the food industry, medicine [H. El-Didamonyet al 2020], adsorption for water decontamination and adsorption of contaminants in pyrolisis oils, are other possible applications. Biomass-derived nano-silica is also being investigated for various biological and biotechnological uses, such as cancer treatment, DNA transfection, drug delivery, enzyme immobilization and environmental bioremediation. Characterizing silica with regard to their properties is essential for their effective application.

Corn biomass pyrolysis oils are a complex mixture of organic compounds containing a mass of highly oxygenated compounds, including phenols, ketones, carboxylic acids, etc., which can be determined by techniques such as Gas Chromatography coupled to Mass Spectrometry (GG MS). On the other hand, FTIR spectra indicate the presence of functional groups in bio-oils. The liquid product can be valorized or used directly in boilers, diesel engines or turbines. This liquid form is much easier to transport and store than the biomass itself. Pyrolysis optimization (pretreatment, temperature, gas flow, etc.) can produce a product that can then be refined into a sustainable aviation fuel (SAF), notably through systematic monitoring by Fourier Transform Very High Resolution Mass Spectrometry (FT ICR MS).

II. *Objectives*

This thesis is dedicated to the pyrolysis and optimization of all pyrolysis parameters of the different parts of corn, taking into account the yield and quality of the products generated, notably bio-oils and silica.

1. First phase: Literature review and training in the use of thermobalance. In this first phase, the focus will be on a literature review to establish experimental parameters for the pyrolysis of different parts of maize (leaf, stalk, hulls, etc.). Training will be provided in the use of thermobalance to identify parameters that may vary in the methodologies for optimizing the performance of pyrolysis products such as bio-oils and silica.
2. Second phase: Separation of corn parts, washing and leaching of biomass. This stage of the project will focus on the separation of corn parts, washing and leaching of biomass. The aim is to optimize the washing and pyrolysis parameters for the different corn parts, based on the performance of the bio-oil and silica. An evaluation of the results obtained will enable us to define the optimum parameters for maximizing the required yields.
3. Third phase: Pyrolysis of maize parts under optimal conditions in connection with the characterization thesis. The final phase of the thesis will focus on the pyrolysis of various parts of corn production waste under the optimum conditions determined in the previous phases. This phase will include data processing, analysis of the results obtained, and the drafting of articles and theses. The ultimate aim is to make a significant contribution to the production of bio-oils and silicas, within the framework of a circular economy.

REQUIRED COMPETENCES

The candidate should have a Master (or BAC+5 homologated) on Chemistry/Chemical Engineering

Previous experience on Pyrolysis techniques would be appreciated.

CRITERIA USED TO SELECT CANDIDATE

Selection process steps:
- Establishment of the selection committee.
- Evaluation of the applicants Cv's
- Interview with the selected candidates and ranking.

Criteria used in selection of the candidate:
- The candidate's motivation, scientific maturity and curiosity.
- Previous experience on hyphenated chromatographic techniques, mass spectrometry or stable isotopes would be appreciated
- Candidate's marks and rankings in M1 and M2.
- English proficiency

REQUIRED DOSSIER, DATE

Send an e-mail with your candidature containing (with "PhD Candidate in the object of the message"):
- CV
- Cover letter detailing candidate's motivations
- Candidate's MSc marks and ranking
- Minimum two contact details for 2 referees

Limiting date:	**04/07/2024**

CONTACTS

e-mail : brice.bouyssiere@univ-pau.fr