IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

unibz
Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

DOCTORAL POSITION – JOINT THESIS PROGRAM 2020-2023

Title: Industrial char recoveries in a perspective of circular economy in the wood gasification industry

Keywords: activated carbons, carbon composite polymers, circular economy, energy recovery, industrial chars, syngas purification, wood pyro-gasification

Context: Among renewable energies, bioenergy has one of the biggest potentials. Biomass can be used as feedstock not only for heat and power generation, but also for the production of biofuels with properties similar to conventional ones. This highlights the flexibility of the biomass to energy sector and contributes to establish the industrial development of wood gasification. From this process, a syngas regarded as renewable energy carrier is produced as well as a solid by-product (chars) which is still considered as waste needing to be treated. Char utilization is a critical aspect for the management of the existing gasification plants representing thus an actual loss for the plant owners. In a perspective of circular economy, a panel of char recoveries has to be found in order to increase the environmental and economic performance of these industries. Depending on the feedstock and the technology of production, chars can exhibit different features in terms of chemical composition, porosity, mechanical strength leading to various potential uses. Tailored catalysts for gas purification, activated carbons for tertiary treatment of domestic wastewaters, polymer fillers to perform carbon composite materials with new characteristics (enhanced mechanical strength or conductivity) or new uses (powdered char processing for environmental applications) are among the targeted recoveries either because they reply to a real industrial need either they are more prospective in polymer eco-design.

Among the EU Member States, France produced close to 52 million m3 of roundwood with respectively 26 million of fuel wood and 26 million of industrial roundwood in 2016. Close to 40 % of South Tyrol (northern Italy) is covered by forest and the timber industry represented 844 369 m3 of wood in 2014. In particular, considering this Italian region as a benchmark, 1300 tons of char is produced over the entire region every year. The substantial char yield is an outcome of 46 small-scale gasification plants, with an average electrical output ranging from 25 - 440 kW and operational as on 2018. Wood and waste from the timber industry are thus produced locally and can answer to the European Green Deal objectives in the context of energy transition. This challenge contributes to increase the wood value chain and to enhance the sustainability in the energy sector.

This PhD is a joint PhD between the Free University of Bolzano (Unibz) in Italy and IMT Atlantique, Nantes Campus (France). This joint PhD is based on the expertise and complementary of two research teams already recognized by their previous works. Unibz has carried out many research projects dealing with the experimental and modelling characterization of thermochemical conversion processes applied to lignocellulosic biomass, including gasification and pyrolysis, as well as innovative valorization pathways (e.g. hydrothermal carbonization, reforming, methanation and Fischer-Tropsch syntheses). The study of innovative valorization strategies for gasification char have been also analyzed through experimental laboratory characterization, finding promising industrial and agronomical valorization routes. The research is carried out at different process scales, ranging from the micro scale, studied in controlled lab conditions to the real scale, studied through the on-site monitoring of plants in actual operation. Extensive experimental activities have been carried out in South-Tyrol at real small-scale gasification plants (50-250 kWel), coupled with internal combustion engines for onsite energy production, taking advantage of an intense cooperation with local private companies and public stakeholders. IMT Atlantique has developed many research programs on thermo-chemical conversions of a wide range biomass and more especially oriented to the control and the reduction of their environmental impacts (syngas purification, chars and bio-oils recoveries …). On the other hand, the expertise of the research team in environmental processes and particularly adsorption processes by using activated carbons for water and gas effluents is well established. This expertise relies on solid skills in designing instrumented pilots in 1800 m^2 research hall completely equipped with analytical devices.

Required skills

- Scientific knowledge in energy engineering, chemical engineering, environmental engineering
- Motivation for multidisciplinary approaches related to energy and environmental transitions
- Practical knowledge: experimental work in laboratory, data analysis and modelling
- Intrapersonal competence: analytical and synthesis skills, rigorous approach, skills in scientific writing, motivation to work in a European context
- Fluent in English

Location: Unibz (Bolzano, Italy) and IMT Atlantique (Nantes, France)

Funding: Cotutelle between French and Italian institutions

Thesis supervision: Marco Baratieri (Marco.Baratieri@unibz.it) and Claire Gérente (claire.gerente@imt-atlantique.fr) as supervisors and Audrey Villot (audrey.villot@imt-atlantique.fr) as co-supervisor

Deadline to apply: 13th July 2020

How to apply: refer to https://www.unibz.it/en/faculties/sciencetechnology/phd-sustainable-energy-technologies/

Start date: November 2020