PhD title: Experimental study of sanitary and environmental impact of particles from wood / biomass pellet combustion villot

PhD supervision: Pasi JALAVA (University of Eastern Finland) / Y. ANDRES (IMT Atlantique)

Co-encadrant·es: A. VILLOT (IMT Atlantique)

Laboratory(ies): GEPEA (IMT Atlantique) / Department of Environmental and Biological Sciences (UEF)

Research teams: VERTE

IMT Atlantique department(s): DSEE

Is it an international co-supervised thesis? Yes

If yes, organisation with which the cotutelle is envisaged: Department of Environmental and Biological Sciences of University of Eastern Finland (UEF) through the contribution of Pasi JALAVA. He is professor of toxicology of air pollution and the research of the group concentrates on health related toxicological effects of different air pollutants, with a strong focus on emission sources such as traffic and biomass combustion. UEF inhalation toxicology laboratory is one of the leading laboratories in studying toxicology of air pollution. UEF has long experience working in multidisciplinary projects with aerosol scientists in research focused on wood combustion.

Is the proposed topic of an interdisciplinary nature? Yes

If yes, briefly explain why (2-3 lines): This PhD project targets to characterize the particles from wood (or biomass) combustion and understand / highlight the human health effects and environment. It is evident that multidisciplinarity plays a fundamental role in this endeavor and that attaining the project’s objectives will be made possible by the complementary expertise which each partner is contributing. The partnership is gathering a trans-disciplinary set of expertise of key relevance for this endeavor including particle and gas characterisation (IMT), biology & toxicology (UEF), and chemical engineering (IMT).

Is the source of co-financing identified? Yes

If yes, specify which co-financing is envisaged:
Funding for the PhD project will be applied from the doctoral school of the Faculty of Science and Forestry of University of Eastern Finland. The funding is open for applications annually and covers the salary of the applicant. The research costs will be covered from other funding sources.

Others informations:
Useful information you would like to share (if relevant):
Context or state of the art:

Describe in 5 to 10 lines the context of the thesis.

The atmospheric pollution, notably in relation with the particulate matter (PM), contributes to more than 300,000 deaths each year in Europe and close to 7 million at the World level (2020 WHO data). Fine (PM$_{2.5-0.1}$) and ultra-fine particles (PM$_{0.1}$) are the main causes of such sanitary disasters. These latest particles are especially harmful to human health, since they have sufficiently small size to penetrate the membranes of the respiratory tract and enter the blood to be transported by the olfactory nerves to the brain. PM has also an environmental impact through their contribution to the greenhouse effect and soil degradation, rock corrosion and forest dieback due to their impact on plant growth.

Wood-energy is the first renewable energy in the energy mix at the EU level. In 2016, this sector represented 10% of the total European energy mix. Considering these elements and the substantial effort required by the EU to promote renewable energies, the part of wood energy in the final energy mix may be multiplied by 2 by 2050 to achieve those objectives. Ensuring alignment of energy transition with health and environmental considerations requires development of systemic solutions considering social and environmental impact at the same level as performance. It is the reason what it is necessary to characterize accurately the wood (biomass) combustion emission. This knowing allows in the future to develop adapted remediation process.

PhD targets:

Describe in 10-15 lines the expected results.

Recently, some research has advanced the oxidative potential of particles. This topic seems to be controversial and depends on different elements, in particular of the particle origin. Recent studies have shown that the anthropogenic non-intensional particles, notably those issues from residential biomass combustion, exhibit oxidative properties. Added this, the particles are of three types: soot and organic as a result of incomplete combustion and ashes. In order to properly assess the environmental and toxilogical impact of residential wood combustion appliances, it is necessary to characterize the emission (gaseous and particles). For that, the emissions of biomass boiler with wood but also agropellets will be studied. To realise this, on-line and off-line measures will be done. Online measures related to the gas composition (O$_2$, CO$_2$, CO, NO$_x$, SO$_x$ / HORIBA, BTEX / micro-GC, FID / HAP) and particle distribution (ELPI+) and particle distribution (ELPI+). Off-line measures will be done through sorbent tubes coupled with TD-GS-MS (gaseous pollutants), and also sample of particles on hot filter (TSP according to the European EN16510 standard) and DEKATI impactor (gravimetric measurements, chemical and toxilogical analyses, SEM), taking into account that VOCs can also be absorbed at the particle surface which increase their toxicologic impact. In the project, oxidative potential of the emissions will be compared with toxicological responses in cell cultures, including multiple different endpoints to see the correlation between the oxidative properties and health-related toxicological responses caused by the biomass combustion emissions.

There are several objectives at this research work:

¤ contribute to the understanding of the link between the physicochemical properties of particles and the combustion conditions;
¤ establish, if proved, the link between the physicochemical properties of the particles and their possible oxidative potential;
¤ contribute to the development of an analysis method for particles concerning their oxidizing potential and their toxicity

Skills expected of the candidate:

List the main skills needed for this thesis topic.

Present a scientific approach; good knowledge of cell culture techniques and tools; a strong orientation for experimental research, data analysis, interest in aerosol science.