Job offer: PhD Thesis in Energetics

Theme of the thesis: Combustion study of energetic materials

Topic of the thesis: Joint influence of physicochemical parameters on combustion velocity of pyrotechnic compositions

Description: Pyrotechnic compositions are a family of energetic materials that are used in various applications. Their compositions can be extremely diverse. Combustion velocity of such reactive mixtures is one of their fundamental characteristics. Mastering this velocity requires a detailed understanding of the complex physicochemical phenomena involved during ignition and combustion propagation. The pyrotechnic compositions studied in this thesis will consist of an oxidizer and a metallic reducer. They will be manufactured in the laboratory as tablets, and their combustion rates will be measured in a reactor.

A parametric study will first be conducted regarding the effects on the velocity of various parameters (composition, porosity, atmosphere, and even the presence of additives). These new results could be used to improve a methodology previously developed for studying various parameters affecting combustion velocity (methodology based on the establishment of dimensionless numbers and multilinear regressions).

Secondly, the kinetics of these reactions will be studied. Global kinetic parameters will be estimated for the raw compounds and compositions using classical thermal analysis techniques (TGA, DSC). Intermediate reactions will then be added. The flash pyrolyzer coupled with gas chromatograph-mass spectrometer (Py-GC-MS) could be used to estimate intermediate species.

The thermal and thermodynamic properties of these species will also be studied. Previous studies have shown that particular attention must be paid to estimate the thermal conductivity of these heterogeneous oxidizer-reducer mixtures. This will be carried out in the framework of this thesis, particularly using the Hot Disk experimental device. Simulations will then be performed using a kinetic calculation code, and the results compared to experimental data obtained in the first part.

Ultimately, the production of these new data will provide both input and validation data for a combustion simulation code for pyrotechnic compositions.

Place: Combustion-Explosions team of PRISME laboratory (https://www.univ-orleans.fr/fr/prisme/la-recherche/axe-combustion-explosions), located in Bourges University Institute of Technology (IUT de Bourges).

Salary: 2100 € gross / month. Institutional funding.

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Start of contract: 1st October 2024 (for 3 years). Applications accepted until May 2024.