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The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Steven Tipler**

The public defense will take place on **Thursday, 20th May 2021 at 4pm.**

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CHARACTERIZATION OF A LIGHT PETROLEUM FRACTION PRODUCED FROM AUTOMOTIVE SHREDDER RESIDUES

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Abstract of the PhD research

Wastes have a real potential as being players in the energy mix of tomorrow. They have a high heating value, which makes them good candidates to be converted into liquid fuel via pyrolysis. Among the different types of wastes, automotive residues are expected to rocket due to the increasing number of cars and the tendency to build cars with more and more polymers. Moreover, the existing regulations concerning the recycling of end-of-life vehicles become more and more stringent.

Unconventional fuels such as those derived from Automotive Shredder Residues (ASR) have a particular composition which tend to increase the amount of pollutants comparing with conventional fuels. Relying on alternative combustion modes, such as Homogenous Charge Compression Ignition (HCCI), is a solution to cope with these pollutants.

However, the unknown nature of the fuel creates a high failure risk for the engine in which it is burnt. Thus, being able to predict its features is a key aspect for a safe usage. Predicting methods exist but had never been tested yet with fuels derived from automotive residues.

With petroleum products, usual prediction methods stand at three different levels: the chemical composition, the properties, and the reactivity in an appliance. The fuel is studied at these three levels. First, the composition gives a good overview of the fuel auto-ignition. Second, the octane numbers are good indicators of the fuel IDT. Precisely, the octane numbers depict the resistance of a fuel towards an end-gas auto-ignition. Last, the IDT was studied in a rapid compression machine.

The existing methods to estimate the composition were updated to predict the n-paraffin, iso-paraffin, olefin, naphthene, aromatic, oxygenate (PIONAOx) fractions. A good accuracy was achieved compared with the literature.

Two methods to predict the octane numbers were developed based on Bayesian inference, Principal Component Analysis (PCA) and Artificial Neural Network (ANN). The first is a Bayesian method which modifies the Pseudo-component (PC) method. It introduces a correcting factor which correct the existing formulation of the PC method to increase its accuracy. The second method is based on PCA and ANN. 41 properties are studied among which reduced set of principal variables are selected to predict the octane numbers.

Measurements of the IDT in a Rapid Compression Machine (RCM) of a fuel produced from ASR were realized. They are the first measurements in such a machine ever made. This provide experimental data to the literature. Moreover, these experimental data were used to formulate a surrogate fuel. Surrogate fuels can be used to realize simulations under specific conditions. The current thesis investigates fuels derived from ASR. It was showed that this fuel can be burnt in engines as long as their properties are carefully monitored. Among others, the IDT is particularly important. Nevertheless, additional experimental campaigns and simulations in engine are required to correctly assess all of the combustion features of such a fuel in an engine.