Template for adverting PhD project on FindAPhD.com

******Please read accompanying guidance notes******

Department	School of Engineering and the Built Environment
Supervisors	Dr Stathis Tingas, Dr Chris Guiver
Funding Status	Funded PhD Project (Worldwide)
Application Deadline	14/04/2022
Project Title	A zero-carbon hydrogen fuelled thermal engine for heavy-duty transport applications

PROJECT DESCRIPTION

Two types of transport which are currently challenging to decarbonize and electrify are heavy-duty vehicles (HDVs) and ships, both predominantly powered by compression ignition (CI) engines fueled with diesel. In fact, currently there is no plan for the decarbonization of HDVs and ships in the UK or elsewhere. The proposed solutions for HDVs are overly costly (fuel cells, electric highways) or impractical (battery electric trucks) with uncertain degree of success (electric highways). Yet, in 2019, 4.3% of total GHG emissions in the UK related to HDVs, which increases to 5.6% when ships (national navigation and fishing vessels) are also considered.

Hydrogen use in CI engines has not been particularly attractive and the available literature in the area is generally limited mainly because of hydrogen's large resistance to autoignition. To overcome this undesired feature, three strategies have been proposed. The first is the use of very high compression ratios (>29:1). However, this approach is not attractive because it results in problems related to the mechanical strength of the engine structure. The second is the use of a glow plug with the purpose of preheating the intake air. This technique is generally simple but it leads to a decrease of the volumetric efficiency which results in the decrease of the indicated mean effective pressure (IMEP), the indicated thermal efficiency (ITE) and the brake thermal efficiency. In addition, the risk of preignition increases significantly, due to hydrogen's very low minimum ignition energy. The third approach concerns a dual-fuel strategy, where the ignition of the in-cylinder charge is achieved by the direct injection of a more reactive fuel, e.g., diesel. This approach is particularly attractive, because it offers a unique flexibility in the engine operation while also maintaining the benefits from the CI mode. In CI dual-fuel operation, H_2 has been mainly used with carbon-based fuels, such as (bio-)diesel, natural gas and others. Being carbon-based, the fuel blends produce carbonaceous emissions (e.g., CO_2) directly or indirectly, thus, cancelling or reducing the efforts for drastic greenhouse gases (GHG) reduction.

An alternative approach in the dual-fuel strategy is to use a non-carbon based fuel such as hydrogen peroxide which will act as an ignition promoter. Hydrogen peroxide has been used for decades as a propellant and it can be found in stable form at H_2O_2/H_2O solutions with H_2O_2 content as high as 90%. In addition, it has been used in numerous transport-related applications in thermal engines as an ignition promoter. More importantly, H_2O_2 is a substance that can even been found in diluted form in any convenience store or supermarket. So, there is already an existing logistics infrastructure for its production, transportation and storage. In addition, steam dilution is a well-documented method of emissions reduction.

In this project a novel method for hydrogen use in CI engines will be numerically explored, which will combine hydrogen with hydrogen peroxide and water. The proposed approach relies on the use of non-carbon-based fuels, hydrogen and hydrogen peroxide (which can both be produced by renewable sources), therefore, can allow for the full decarbonization of HDVs and ships. The decarbonisation technology developed in the current project aspires to combine carbon-neutrality with the simplicity and the high efficiency of the thermal engine and will have great impact not only on road transport, but also in sea transport where most modern ships use a CI engine as their prime mover.

Academic qualifications

A first degree (at least a 2.1) ideally in Mechanical Engineering or a closely related discipline with a good fundamental knowledge of thermodynamics.

Template for adverting PhD project on FindAPhD.com

****Please read accompanying guidance notes****

English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental engineering, particularly in CFD and thermodynamics.
- Competent in mathematical modelling.
- Knowledge of thermal engine layout.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:
Experience in engine simulations using (non)commercial software.
Knowledge of control theory.
Experience in undertaking independent research.
A completed or near completion MSc in a relevant subject area.

Indicative Bibliography	1. Heywood, J. B. (2018). Internal combustion engine fundamentals. McGraw-Hill Education. 2. Dimitriou, P., & Tsujimura, T. (2017). A review of hydrogen as a compression ignition engine fuel. International Journal of Hydrogen Energy, 42(38), 24470-24486. 3. Sherif, S. A., Goswami, D. Y., Stefanakos, E. K., & Steinfeld, A. (Eds.). (2019). Handbook of hydrogen energy. CRC Press. 4. Verhelst, S. (2014). Recent progress in the use of hydrogen as a fuel for internal combustion engines. international journal of hydrogen energy, 39(2), 1071-1085. 5. Fayaz, H., Saidur, R., Razali, N., Anuar, F. S., Saleman, A. R., & Islam, M. R. (2012). An overview of hydrogen as a vehicle fuel. Renewable and Sustainable Energy Reviews, 16(8), 5511-5528.
Funding notes	This project may be funded by a scholarship of the School of Engineering and Built and Environment. Please see School-funded PhD scholarships - RESEARCH AND INNOVATION (napier.ac.uk) for information on the scholarships and how to apply for them.
Enquiries	For informal enquiries about this PhD project, please contact Dr Stathis Tingas e.tingas@napier.ac.uk
Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process

School RDPL signature	
Date	Click here to enter a date.

Template for adverting PhD project on FindAPhD.com

****Please read accompanying guidance notes****

School DOR signature	
Date	Click here to enter a date.