User Story

Digital Engineering Workflow Applied to ICEs with Alternative Fuels

THE CHALLENGE

To provide detailed physico-chemical engine models to evaluate the engine-out emissions of heavy-duty ICEs running on alternative fuels

THE SOLUTION

- Apply *k*inetics & SRM Engine Suite's alternative fuel library for ICE simulations
- Leverage the MoDS-SRM Engine Suite workflow to evaluate engine-out gas-phase and particulate emissions
- Extend the analysis with multi-objective optimisation and multi-criteria decision making

THE RESULTS

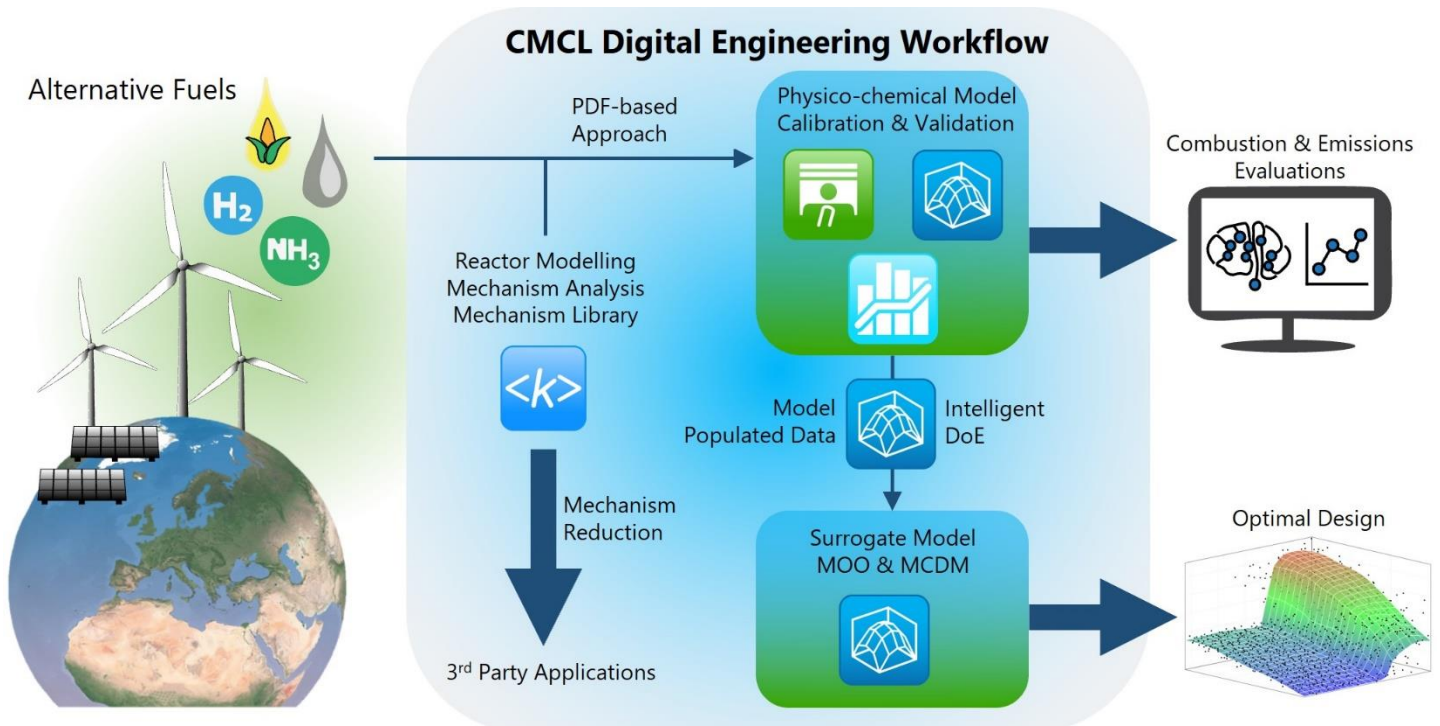
- Various alternative fuels are available in our prebuilt fuel library for ICE simulations
- MoDS-SRM Engine Suite workflow predicts combustion characteristics and evaluates emissions accurately for fuel blends (e.g. ethanol-gasoline) and dual fuelled ICEs such as hydrogen-diesel and ammonia-hydrogen

OVERVIEW

We are at the advent of massive changes to Internal Combustion Engines (ICEs) in off-highway/non-road machinery, heavy duty on-road vehicles and marines transportation. Recent development and research show that alternative fuels from various decarbonization sources/processes such as CO2 capture and utilisation, are suitable substitutions for conventional fuels in order to reduce the greenhouse gas footprint and air pollution. In addition, there is increasing interest in exploiting carbon-neutral fuels during ICE development in order to meet the ever-stringent emissions regulations.

More importantly, the combined effects of using such alternative fuels along with other promising ICE technologies (e.g., prechamber or HPDI) and combustion modes (e.g., xCCI) add yet more challenges in accurately capturing the intrinsic chemical pathways, thermodynamic behaviour, and physical phenomena resulting from alternative fuelled engines.

The use-cases demonstrate a digital workflow applied to ICEs operating on alternative fuels such as ethanol blended fuels, hydrogen fuels, and ammonia-hydrogen dual-fuels.



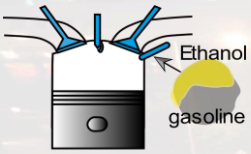
Email: enquiries@cmclinnovations.com Web: www.cmclinnovations.com

CMCL Innovations

User Story

Digital Engineering Workflow Applied to ICEs with Alternative Fuels

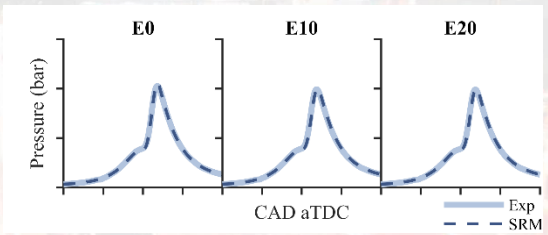
GDI SI Engine with Ethanol Blended Gasoline Fuels



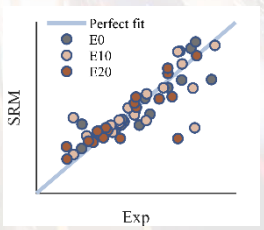
CASE DESCRIPTION

In this project, a 1 litre 3-cylinder gasoline direct-injection spark-ignition engine is used. Data for 19 load-speeds points are collected over three different volume fractions of ethanol contents (E0-pure gasoline, E10 and E20).

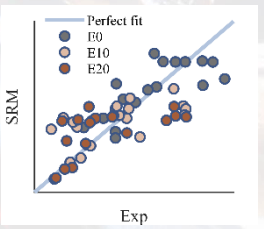
SRM Engine Suite's built-in fuel mechanism library is applied. The E0 data is used to calibrate the engine model with the MoDS-SRM workflow. Then, the model is validated satisfactorily by using the data with increased ethanol volume fractions at E10 and E20.



In-cylinder Pressure

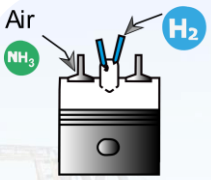


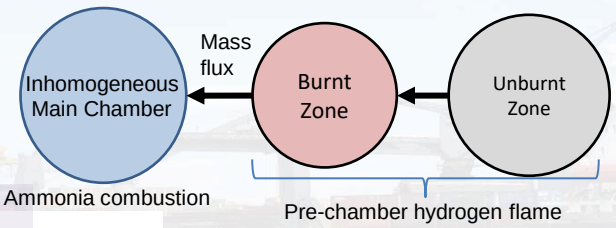
Unburnt Hydrocarbon

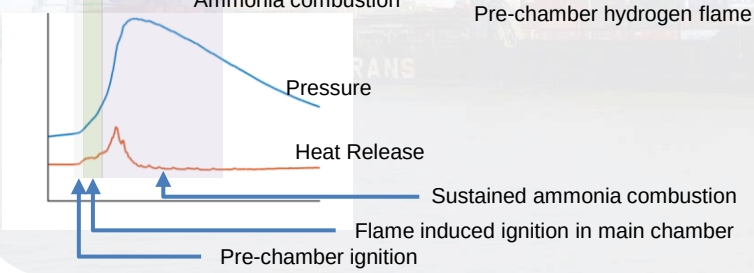


Particulate Number

Ammonia-hydrogen Pre-chamber Engine



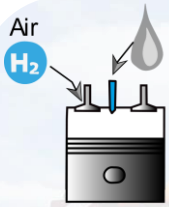




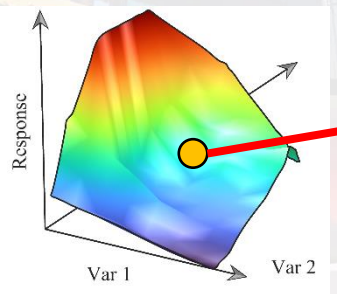
CASE DESCRIPTION

In this use case, a marine engine is modified into a pre-chamber configuration. The engine is fuelled with hydrogen and ammonia. SRM Engine Suite's multi-zonal model is applied to simulate pre-chamber and main chamber in order to understand the impact of the engine design parameters and the effects of different engine operating conditions on the combustion behaviour and emissions.

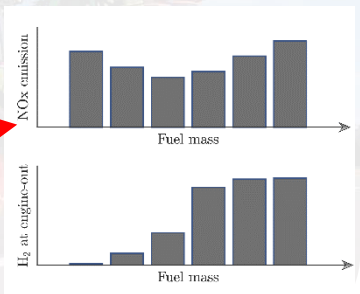
Heavy-duty Dual Fuel (H_2 + Diesel) Engine



Global Response



Local DoE



CASE DESCRIPTION

MoDS-SRM workflow is applied to model a heavy-duty dual fuel engine with various injection strategies to obtain the optimal combination of initial mixture composition and diesel injection pulses to mitigate NO_x and other emissions without sacrificing the engine power output

Email: enquiries@cmclinnovations.com Web: www.cmclinnovations.com

CMCL Innovations