ENERGETICS

WARTSILA/Denerg - Model-Based Design for future ICE fuels

Funded By	WARTSILA ITALIA S.P.A. [P.iva/CF:00917620320] Dipartimento DENERG
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Context of the research activity	Adoption of future fuels (e.g. hydrogen, ammonia, methanol) to enable decarbonization of marine transportation and energy market poses many new challenges. In this framework, the main target of this Doctoral research is to accelerate decarbonisation process by: • Investigating innovative combustion system with low carbon footprint and capable of operating with alternative fuels • Developing modelling and simulation methodologies, including XiL applications, for the development of new concepts and retrofit opportunities
Objectives	Adoption of future fuels (e.g. hydrogen, ammonia, methanol) to enable decarbonization of marine transportation and energy market poses many new challenges both from operability and control points of view, extending and modifying engine operation to critical map areas. Furthermore, the general trend to powertrain hybridization and electrification opens new dimensions for engine layout and powertrain optimization. To fulfil new operability and safety requirement, various technologies for internal combustion engines are being developed, leading to an increased system complexity. Hence, system integration, optimization, and testing are of utmost significance for the development process. In this framework, the possibility to integrate a model-based approach into the product development process would be a breakthrough solution for reducing prototype costs, speeding-up testing and product validation by achieving early assessment of system behaviour. X-in-the-loop (XiL) simulations, covering different in-the-loop applications like model-in-the-loop (MiL), software-in-the-loop (SiL), and hardware-in-the-loop (HiL), have become powerful tools to reduce overall validation efforts. They enable the simulation of closed-loop interaction between the various submodules and provide clear time/cost advantages compared to the usage of a physical prototype in later stages of the development program. However, the establishment of a feasible simulation environment faces specific challenges, especially if real-time capability is required. The main target of this Doctoral research, which will be carried out in close collaboration with Wartsila, is to accelerate decarbonisation process by:

	• Investigating innovative combustion system with low carbon footprint and capable of operating with alternative fuels • Developing modelling and simulation methodologies, including XiL applications, for the development of new concepts and retrofit opportunities • Demonstrating the potential to reduce time-to-market of innovative and flexible solutions towards zero CO2 emission. A short overview of the PhD activities is listed below: • Development of 0/1-D phenomenological/ predictive combustion model for hydrogen and methane blending • Development of co-simulation environment to enable modular structure for system integration and testing purposes (virtual test bench) • Development and optimization of new control functionalities by implementing XiLcapabilities. • Calibration and validation of innovative technological solutions.

Skills and competencies for the development of the activity	• Excellent knowledge of fluid-dynamics and engine thermodynamics • Knowledge of 1D/3D CFD simulation codes (such as GT-SUITE, CONVERGE CFD)