Launch of the MaritimeMET project: Metrology for green maritime shipping: Emission control through traceable measurements and machine learning approaches

Press release – for immediate release

October 2024 - The maritime shipping sector is seeking to embrace alternative fuels such as green ammonia, hydrogen, synthetic fuels, and Power-to-X (PtX) solutions like methanol and biomethane to reduce their environmental impact. This transition demands the development of engine technologies to adapt to these new fuels and a growing need for accurate and traceable measurement systems to support these advancements and validate their performance. Accurate pressure, temperature, and emission concentration measurements are essential for research and development in this sector and at the same time, benefit related sectors.

In this context, the MaritimeMET project was selected for funding as part of the European Partnership on Metrology call, co-financed by the European Union Horizon Europe Research and Innovation Programme and from the Participating States. The project will advance the methods and techniques to control and monitor engine emissions through traceable measurements of pressure, temperature, and emission compositions and apply them in real-world maritime applications. The project will exploit the advances in machine learning approaches and modelling to optimise the power units and exhaust after-treatment systems significantly.

It will do this by:

- Developing new and improving existing traceable emission measurement methods for online and in-situ measurements of typical gaseous and PM, black carbon (BC) emissions generated with the use of Power-to-X (PtX) fuels
- Establishing quality-assured dynamic measurements of the in-cylinder dynamic pressure and temperature necessary for assessing and optimising the quality and efficiency of the energy conversion processes using renewable fuels.
- Creating predictive models for engine emissions and performance using chemical kinetics and machine learning. Furthermore, virtual sensor concepts will be developed based on data-driven and physics-based models to estimate hard-to-measure quantities or substitute costly sensors.
- Facilitating the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (e.g. accredited laboratories, instrument manufacturers), standards developing organisations (e.g. ISO, CEN/CENELEC), end users (e.g. marine, power and aviation industries), and via the European Metrology Networks (such as Energy Gases, Pollution Monitoring, Climate and Ocean Observation, and Mathematics and Statistics).

The project, coordinated by PTB, officially kicked off this September 2024, in Braunschweig, Germany. Seventeen partners (PTB, CMI, DFM, ENSAM, RISE, TUBITAK, VSL, VTT, DTI, DTU, FORCE, GERG, Instrumatic, LEC, TUBS, WÄRTSILÄ, AMVALOR) will work together on this project for 36 months. The consortium comprises National Metrology Institutes, Designated Institutes, research organisations, manufacturers, technology companies and universities.

The participants of the project are:

PTB (DE): PTB is the German National Metrology Institute and two departments will contribute to this project; 1) Department 3.3, "Physical Chemistry", covers a breadth of knowledge of reaction kinetics and developing laser spectrometers for treatable measurements of dynamic quantiles (pressure, temperature, mole fraction), and 2) Department 3.4, "Analytical chemistry of the gas phase", has in-depth experience in the development of spectrometers for different applications, including natural, emissions, and environmental monitoring through their experience on IR-spectrometric gas metrology, as well as experience in measurements of PN, particle mass and black carbon mass. PTB website www.ptb.de

CMI (CZ): CMI the Czech Republic's national metrology institute, specialises in ITS-90 realisation (-189 °C to 1800 °C), including contact and radiation thermometry. CMI has a strong industrial metrology focus, partnering with various organisations. Active in CCT and EURAMET TC-T, CMI have extensive experience leading WPs and participating in EMRP and EMPIR projects on temperature and humidity. In WP2, CMI primary role is developing traceable calibration methods for Dynamic Gas temperature measurement. The gas mixture laboratory (WP1) boasts GC-MS, GC-TOF, and GC-PDD instruments, preparing over a hundred cylinders annually for metrological traceability in breath analysers and process gas chromatograph verification. CMI website www.cmi.gov.cz

DFM (DK): DFM is the Danish national metrology institute with 20+ years of experience in quantitative optical spectroscopy of molecules, including custom-made spectral fitting procedures. In addition, DFM has recently developed new compact field deployable spectrometers for onsite gas analysis, measurements relevant to the monitoring community. DFM will use this expertise and its laser facilities to support the work in WP1. DFM website www.dfm.dk

ENSAM (FR): ENSAM is the French DI that develops and maintains the French standards for dynamic pressure metrology since 1981. It has shock tubes, chronometric shock tubes and fast opening for dynamic pressure calibration from 100 kPa to 5 MPa and a frequency range from 1 Hz to 30 kHz. ENSAM will contribute to WP2 by further developing its shock tube and fast-opening devices to measure dynamic pressure to ensure the traceability of the measurements up to 30 MPa and 100 kHz and reduce the uncertainties to meet the industry's new requirements. ENSAM website www.artsetmetiers.fr

RISE (SW): RISE the Swedish National Metrology Institute, has capabilities, expertise, and competence in dynamic pressure measurements and optical measurement techniques related to this project. RISE has a developed shock tube and can fully characterise dynamic pressure measurement systems in the range from 0.1 MPa to 30 MPa and frequency range from 0.5 kHz to 500 kHz. RISE will mainly contribute to WP2 by further developing its shock tube and applying a quantum-based method for simultaneous measurement of dynamic pressure and temperature to ensure the accuracy and reliability of the measurements and reduce the uncertainties to meet the industry requirements. RI.SE website www.ri.se

TUBITAK (TR): TUBITAK is the Scientific and Technological Research Council of Türkiye. TUBITAK is the National Metrology Institute (NMI) of Türkiye and operates under the umbrella of TUBITAK. TUBITAK has primary pressure standards from 10-4 Pa to 7 MPa. TUBITAK will contribute to the project under WP2 by further developing their drop-weight calibration device to improve the accuracy and reliability in the pressure range between the 5 MPa and 30 MPa to enable in-cylinder pressure sensor calibrations and including validation and characterisation of developed calibration and measurement methods. TUBITAK website www.tubitak.gov.tr

VSL (NL): VSL is the Dutch national metrology institute that develops and maintains the Netherlands' primary standards for thermometry and optics (among many others). In WP2, VSL will develop a thermometric radiation-based fibre-optic spectrometer reference standard for dynamic in-engine gas temperature measurements. Additionally, VSL will further develop its pulsed laser-based radiance facility to provide temporal and radiance traceability for characterising the reference standard. In WP3, the Data Science and Modelling group at VSL will quantify the uncertainty of the prediction of the emission models. VSL website www.vsl.nl

VTT (FI): VTT, the Technical Research Centre of Finland Ltd. is an impartial, fully state-owned, non-profit Research and Technology Organisation (RTO). Within VTT, MIKES Metrology serves as the National Metrology Institute (NMI) of Finland. VTT's main activity will be to develop a new primary standard for dynamic pressure to reach the uncertainty requirement of 1 %. The dynamic pressure standard will be applied to characterise the performance of state-of-the-art cylinder pressure sensors used in engine testing at Wärtsilä to demonstrate improvements in measurement accuracy achieved through improved calibration methods (WP2). Moreover, VTT will contribute on the development of a good practice guide regarding dynamic pressure calibrations (WP4). VTT website www.vttresearch.com

DTI (DK): DTI is the Danish Technological Institute. DTI will provide engine test bed facilities where the combustion of alternative fuels (methanol and ammonia) can be tested for marine engine-like conditions. One heavy-duty (truck engine) cylinder is used for testing dual fuel and premixed combustion of alternative fuels. The engine will generate emission and operating data for emission modelling and machine learning activities and will serve as a platform for testing different novel and low-cost exhaust gas sensors. DTI website www.dti.dk

DTU (DK): DTU is the Technical University of Denmark. In this project, DTU will further develop, characterise, and test the in-situ spectroscopy-based sensors and methods for simultaneous pressure and temperature measurements in a combustion chamber (WP2). The activities will include emission measurements after the engine cylinder (WP1). DTU's high temperature/high-pressure facilities will be exploited for studying the influence of pressure and temperature on the performance of the sensors developed in this project. DTU Website www.dtu.dk

FORCE (DK): FORCE is FORCE Technology. FORCE will perform accreted emissions measurements of PM at engine test bed facilities according to ISO8178. Measurements of BC will likewise be performed. Furthermore, continuous measurement of formaldehyde and methanol will be performed during the engine test of methanol using a PTR-ToF-MS, making it possible to detect smaller quantities of specific organic compounds with high time resolution in the exhaust gas. FORCE website www.forcetechnology.com

GERG (BE): GERG (The European Gas Research Group) is the European Association representing the collaborative R&D needs of the European Gas Industry. Along with its member organisations, GERG works with the European energy community to develop innovative solutions connecting European gas infrastructure to the evolving energy system. GERG coordinates corresponding efforts of its members on an EU level and membership includes TSOs, DSOs, major NG suppliers, universities, and international research institutes, as well as international standardisation organisations. GERG partners with related organisations globally to ensure international alignment of its work and maximum effectiveness of its programmes. Moreover, GERG has experience leading Dissemination and Communication activities in several EU projects. GERG Website www.gerg.eu

Instrumatic (BE): Instrumatic develops and manufactures sampling systems and gas sensors/monitors for Continuous Emission Monitoring Systems (CEMS) for portable and fixed-installed monitoring systems. Instrumatic will contribute to developing a suitable dilution sampling system for PAS and low-cost sensors, besides participation in real-life testing. INSTRUMATIC Website www.instrumatic.com

LEC (AT): LEC is an Austrian research institution for sustainable large-engine technologies. With its profound knowledge and extensive experience in predictive simulation and modelling of ignition, combustion, and emission formation, LEC will contribute to developing hybrid simulation models combining physics-based and machine learning algorithms. LEC Website www.lec.at

TUBS (DE): TUBS is the Technical University Braunschweig. The Institute of Internal Combustion Engines and Fuel Cells (IVB) is involved in this project. TUBS is well experienced in experimental and theoretical engine investigations, including large bore engines. TUBS will develop models for combustion and emissions involving machine learning algorithms. TUBS Webite www.tu-braunschweig.de

WÄRTSILÄ (FI) : WÄRTSILÄ develops and manufactures power and energy solutions for the marine and stationary energy markets based on internal combustion engines and other power sources such as batteries. Wärtsilä will contribute to the research by giving user perspective on the technologies and simulation models investigated. Wärtsilä will also provide an opportunity to experiment with the investigated measurement technologies on appropriate laboratory engines and combustion research test rigs, such as Rapid Compression Expansion Machine and Optical Spray Combustion Chamber. WÄRTSILÄ website www.wartsila.com

AMVALOR (FR): AMVALOR will provide ENSAM with personnel and equipment resources to achieve the project's objectives of dynamic pressure references. The organisation also assists ENSAM in its business relationships with its customers. AMVALOR is an affiliated entity affiliated to beneficiary ENSAM. AMVALOR website www.artsetmetiers.fr

About the European Partnership on Metrology. The European Partnership on Metrology research funding programme is co-funded by the Member States and the EU (under Horizon Europe). The programme was proposed by EURAMET and it follows EMRP and EMPIR funding programmes. More information on previous and current calls can be found via https://www.metpart.eu/

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MaritimeMET Press Release ends.

For further information about MaritimeMET and interviews
please contact Ajoy Ramalingam (email : ajoy.ramalingam@ptb.de)