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METHMARE

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Development and test results of a cryogenic high-pressure fuel gas system– MethMare

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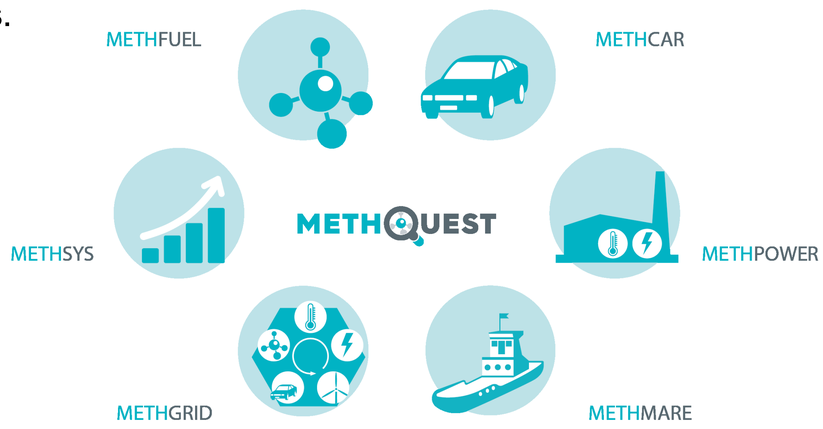
ILK Dresden

Introduction

With the aim of driving forward energy revolution, MethQuest develops and investigates technologies for efficiently producing renewable-energy (RE-) methane that can be used in both mobile and stationary applications.



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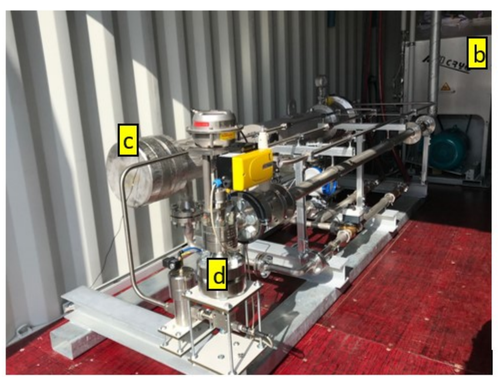
Aim in MethMare

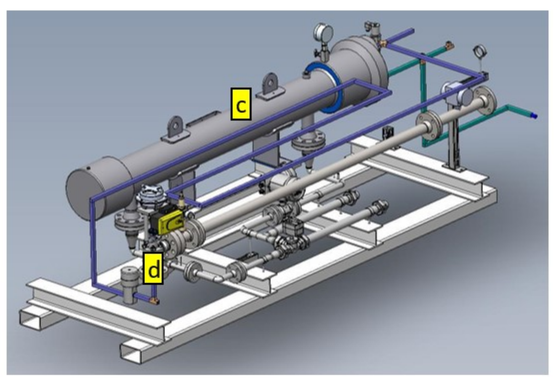
Methane generated from renewable energies is considered as clean fuel of the future for ship engines as it has less emissions (carbon dioxide, nitrous oxide, sulphur oxide, particles) than other common marine fuels. On the other hand unburned methane escaping to atmosphere reduces the climate advantage and can even cause more greenhouse gas emissions dependent on engine (Pavlenko et al. 2020).

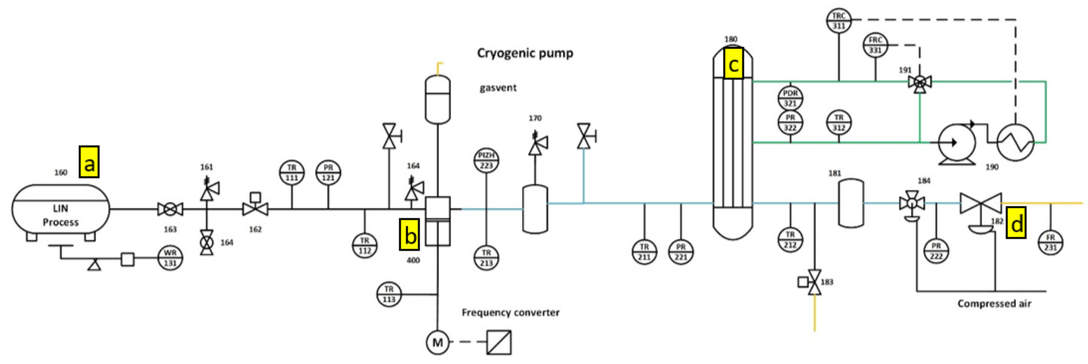
Boog et al. (2019) developed a concept for flexible, direct injecting engines for ship propulsion based on High Pressure Direct Injection (HPDI) with promising potential to minimize methane slip. They identified the high pressure supply system among other things, especially the absence of a suitable heat exchanger and lacking gas supply during high dynamic engine operation, as important basis.

Experimental setup

At the ILK in Dresden, a container-based test bench has been designed and built to emulate the methane gas system with non-combustible, safe nitrogen at a pressure of more than 400 bar, a mass flow of up 500 kg/h and the needed high dynamics in pressure and mass-flow load.



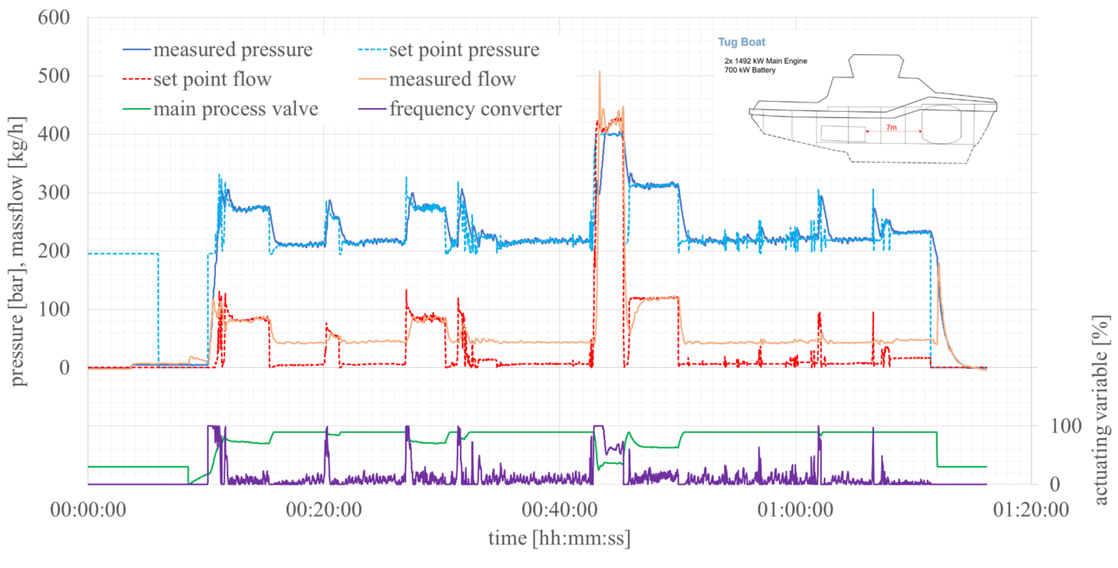




PID, 3D model and built system with the main components:
a – LIN tank on a scale
b – cryogenic high pressure pump
c – double tube safety heat exchanger
d – main process valve emulating the motor characteristic

Test results

A simulated transient profile of a tug boat during typical operation is shown as an example. The mass flow of nitrogen is controlled by the valve lift of the main process valve. The pressure is controlled by a frequency converter of the high pressure pump.



Conclusion

- **successful realisation of system demonstrator**
- **almost independent control of system pressure and flow (up to 420 bar and 500 kg/h)**
- **high dynamic operation according to the needs of operational profile demonstrated**

Outlook

- **Development of a high pressure pump with a maximum pressure of 600 bar still under progress**

Project term: 01.07.2018 – 01.02.2022

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Boog, M., Dumser, F., Bärow, E., Fink, G., Jud, M., Gleis, S., Frankl, S., 2019. Flexible, direkteinspritzende Motoren für die Schiffahrt. Schiffd & Hafen 07/2019, 12-17.

Pavlenko, N., Comer, B., Zhou, Y., Clark, N., & Rutherford, D. (2020). The climate implications of using LNG as a marine fuel. Retrieved from the International Council on Clean Transportation, https://theicct.org/publications/climate-impacts-LNG-marine-fuel-2020