SUCCESS STORY

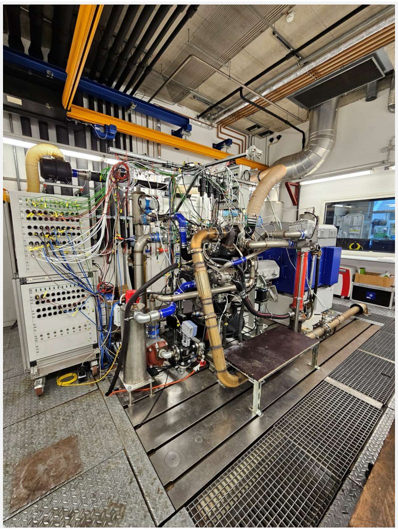
HYLLEY
Research into Competitive and Practical Heavy Duty Hydrogen Engines

Program: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Projekt

Project:

Combustion and Simulation, 1.4.2024 – 31.12.2027



METHOD FOR ASSESSING COMBUSTION ANOMALIES

IN HYLLEY, WE DEVELOPED A METHOD TO EXPERIMENTALLY ASSESS AND QUANTIFY THE OCCURRENCE OF COMBUSTION ANOMALIES ON HYDROGEN ENGINES WITHOUT HARMING THE ACTUAL TEST ENGINE. COMBUSTION ANOMALIES ARE A PARAMOUNT CHALLENGE IN HYDROGEN ENGINE DEVELOPMENT. THE DATA, GATHERED WITH THIS METHOD, WILL SERVE AS A VALUABLE BASIS FOR FURTHER DEVELOPMENT OF ENGINES AND METHODS

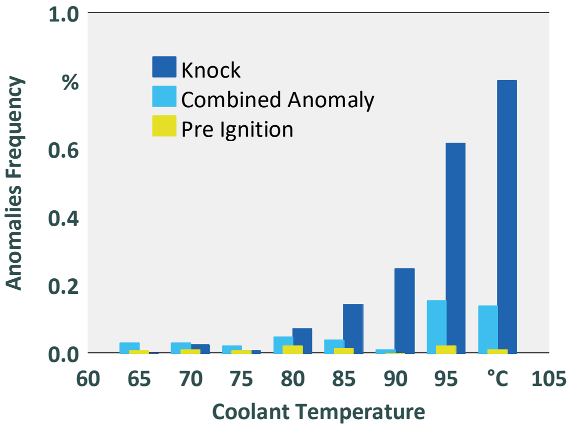
The physical properties of hydrogen make it highly susceptible to abnormal combustion phenomena, commonly known as 'anomalies'. These severely limit performance in both steady-state and transient operations because they typically occur at high loads.

Anomalies are difficult to measure consistently and reproducibly because they harm the engine. To resolve this issue, we use a medium load operating point where there is sufficient margin to the engine's mechanical limits. In this context, the mechanical limit is primarily defined by the maximum firing pressure in the cylinder.

At this operating point, we recalibrate the engine to provoke anomalies, which would not usually occur at this load. To achieve this, we use ignition timing and the air-to-fuel ratio because they enable quick and consistent control of combustion (compared to using a higher coolant temperature, for example).

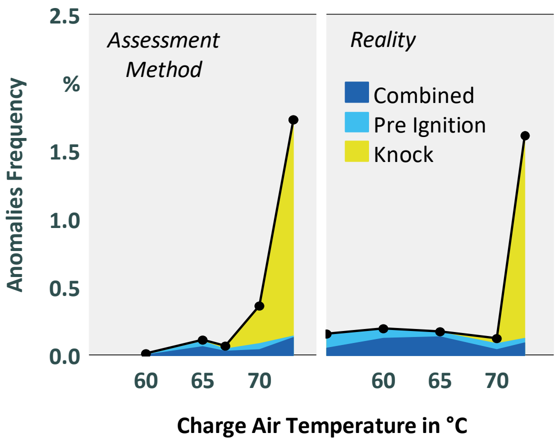
We can now investigate the impact of any parameter or engine modification on anomalies. These include ambient conditions such as temperature and air humidity, changes to the engine's control strategy, and hardware changes such as different hydrogen injectors and pistons. We use this method as standard for investigating any new engine modifications.

To this end, we have developed a fully automated procedure at the test bed that takes around 10 minutes to complete. Comprehensive post-processing, which is also automated, produces a detailed dataset listing all anomalies for each cylinder and cycle. The anomalies are counted and classified.



The picture shows a typical result of this method. As the coolant temperature increases, the frequency of anomalies rises significantly. Here, we can see that knocking is the main issue. These data are also available for individual cylinders.

To validate the method, we compared it to a standard operating point. This had to be done with the utmost caution to avoid damaging the engine. We found that the engine exhibited similar behaviour during the validation load as during the defined test run, suggesting that the results can be transferred well.



Impacts and Effects

This new method enables us to quickly assess any engine modifications in terms of anomaly occurrence in a reproducible way. Over time, by using this method, we are building a substantial database that will help us to better understand the important topic of hydrogen engine development.

Project coordination (Story)
Eberhard Schutting
General Manager
Graz University of Technology
schutting@ivt.tugraz.at

Hylley
Institute for Thermodynamics and Sustainable Propulsion Systems
Inffeldgasse 19, 8010 Graz
T +43 (0) 316-873-30001
Hylley@ivt.tugraz.at | hylley.at

Project partner

- Graz University of Technology, AUT
- Montanuniversität Leoben, AUT
- HyCentA, AUT
- AVL List, AUT
- Liebherr Telfs, AUT
- Liebherr Bulle, CH
- Liebherr Deggendorf, D
- Umicore, D
- Ventrex, AUT
- Hörbiger, AUT
- FVT mbH, AUT

This success story was provided by Gar University of Technology and by the mentioned project partners for the purpose of being published. Hylley is a COMET Project within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMIMI, BMWET, Styria and Tyrol. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet