SUCCESS STORY

HYLLEY.
Research into Competitive and Practical Heavy Duty Hydrogen Engines

Program: COMET – Competence Centers for Excellent Technologies

Förderlinie: COMET-Projekt

Project: System and Materials, 1.4.2024 – 31.12.2027 strategic, multi-firm

Engine, 1.1.2024 – 31.12.2027 nonstrategic, multi-firm

HIGH-RESOLUTION SPARK PLUG IMAGING

SPARK PLUGS FOR SPARK-IGNITED HYDROGEN INTERNAL COMBUSTION ENGINES PRESENT ENGINEERS WITH NEW CHALLENGES REGARDING MATERIALS AND PRELIMINARY SPARK PLUG ELECTRODE WEAR. FOR SUPPORT OF RESEARCH ACTIVITIES HIGH RESOLUTION MICRO- AND MACROSCOPIC IMAGING IS PRODUCED AS EXCELLENT VISUAL SUPPORT TO SHOW WEAR MECHANISMS WITHIN HYLLEY.

In comparison to regular types of fuel, e.g. petrol or diesel, hydrogen has a couple of rather special properties with different impact on wear requiring closer examination during usage.

Scientific literature shows an influence of hydrogen-rich environments on several types of metals including platinum and iridium – precious metals often used in spark plugs for improved wear stability. In combination with high-energy environments inside the combustion chamber preliminary electrode wear can be observed. For better understanding and documentation of effects on the spark plug optical observations prove to be inevitable. As various spark plug types are in use within the project it can further be researched how e.g. different electrode layouts influence wear and general degradation of spark plugs. The picture in the header shows a resulting image - which magnifying range is such that even lubrication residuals etc. can be seen.

Method

An important factor is the reproducibility and standardization of the images. To enable continuous high quality of the images a specialized photography rig was custom built.

The picture on the next side shows Hylley´s photo rig with a usual consumer camera and additional equipment installed during a typical photo session. It is partly painted green to allow for chroma keying effects if necessary.

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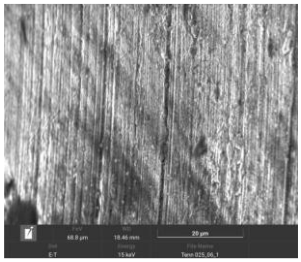
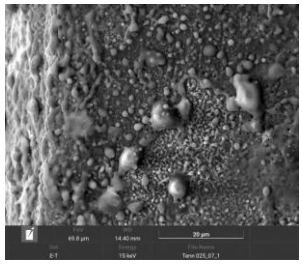
To compensate for the limited focal depth of field-range the method of 'focus-stacking' is used. It works such that a succession of photos with varied focal points is taken. Specialised software then is able to merge the photos taken into one overall focused high-resolution image of the entire spark plug.

SEM examinations

Accompanying the photographs close microscopic examinations of the spark plugs using scanning electron microscope (SEM) technology are undertaken, to collect further information about the microstructure of the surface.

With SEM it was possible to detect microscopic changes to the metal surface of the electrodes which would otherwise be unrecognizable to the naked eye. Exemplary the two pictures below show dramatic changes even after a short amount of run-time with the standard settings for spark energy. The left picture shows the surface of a factory-fresh spark plug with only production marks visible.





In direct comparison the picture on the right shows the same type spark plug after only 8 operating hours. As can clearly be seen molten surface material has already started to form beads on the surface and degrade spark plug performance.

Results

High-resolution photography supported through additional SEM examinations provide an excellent support for conducted spark plug research, allowing for quick and otherwise unnoticeable insight into the degradation mechanisms of various spark plugs in conjunction with hydrogen environment usage.

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- HyCentA, AUT
- AVL List, AUT
- Liebherr Telfs, AUT
- Liebherr Bulle, CH
- Liebherr Deggendorf, D
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