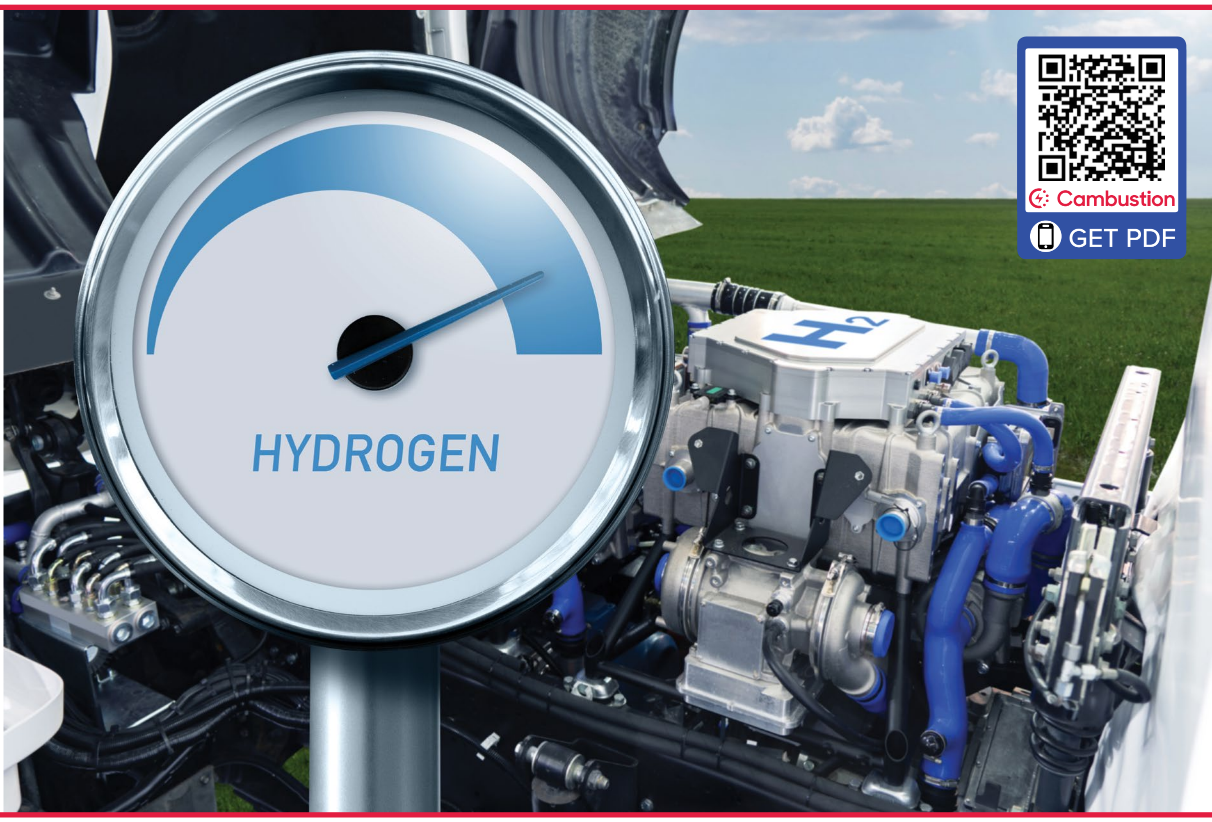
Hydrogen engine & after-treatment



Cambustion

Gas and particle equipment for H_2 ICE Emissions

Existing internal combustion engine technology can be modified to burn hydrogen, either as a sole fuel or as a partial replacement for hydrocarbon fuels, offering support for CO_2 reduction programmes.

Engine calibrators and after-treatment engineers are familiar with the operating maps of conventional ICE's and the after-treatment challenges they pose, but Hydrogen ICE brings several novel emissions challenges:

Particle emissions

The clean combustion of hydrogen (compared with hydrocarbon fuels) offers significant potential for reduced tailpipe emissions of particles. However, due to combustion differences in the cylinder (a thinner quench layer), solid particles derived from increased oil consumption in the cylinder can produce a high number of small sized ash particles.

These particles typically overlap the sizes where Euro 6 and the proposed Euro 7 have their "cutoff" (either >23nm or >10nm). This means that small changes in the precise size of these particles can greatly affect whether they are counted or not on homologation testing, leading to significant changes in cycle emissions.

Exhaust filter clogging

The particles from increased oil consumption should be stopped from reaching the tailpipe, since they will otherwise be counted for engine emissions. A particle filter can capture these particles, but since the particles have a large solid component, sintering could cause irreversible changes in the filter. The smaller size of particles (compared with diesel soot) means that different choices regarding filter materials and specifications should be evaluated.

NO_x after-treatment

The use of AdBlue injection to support SCR for NO_x after-treatment has been proven as an effective technology, but as ever, accurate dosing is required to avoid ammonia slip while controlling NO_x to acceptable levels. Real-time prediction of transient NO_x emissions and calculation of appropriate dosing, informed by both modelling and transient validation, is essential to meet the challenge. In addition, cyclic variability in lambda control can have a significant effect on engine-out NO_x. Cycle-by-cycle NO and NO_2 measurement allows for precise steady-state and transient control.

Formation of N_2O in after-treatment systems can have a significant contribution to total greenhouse gas emissions, and should be minimised to ensure an effective CO_2 reduction for the use of hydrogen and alternative fuels.

Measurement and testing solutions

With over 35 years experience in supporting engine and after-treatment development, Cambustion offer a range of products to meet these new challenges.

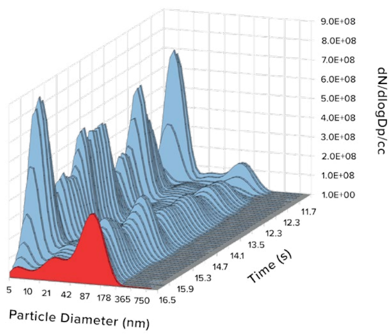
Cambustion's analysers all feature industry leading time response ($T_{10\text{-}90\%}$). Steady state combustion is more easily controlled, while changes in speed / load present a more complex set of challenges, which high frequency data is an effective tool to understand and mitigate.

It is worth noting that Cambustion's analysers have no cross-interference to H_2O, and as such are also suitable for measurement of very low concentrations of NO, NO_2, THC, CO and CO_2.

Particle size, number & mass

Measuring the full size distribution, DMS500 data is also output as a total number (which can easily be selected in software to be >10 or >23nm), supporting rapid development and allowing measurement of pre- and post-filter for bare brick efficiency measurements.

The DMS500 software also calculates estimated mass, supporting filter development projects.



NO & NO_2

The CLD50 offers measurement of both NO and NO_2 concentrations simultaneously. This offers users detailed understanding of transient and cyclic NO_x emissions, and allows calibration of models with enhanced accuracy and efficiency.

N_2O

The N_2O50 offers measurement of N_2O in the exhaust, allowing users to calibrate transient after-treatment performance and efficiently minimise incidental greenhouse gas emissions.

Filter Testing System

The DPG offers users a standalone automated filter testing system, with high repeatability and rapid testing.

The DPG offers standardised measurements of Δp and filtration efficiency, and the ability to load and regenerate filters in a highly controllable manner.

An optional ash doping system offers increased ash loading rate for rapid evaluation.

Cambustion (founded 1987) is an independent, privately owned company with headquarters in Cambridge, UK and customers in more than 35 countries worldwide.

Cambustion continue to research & develop novel instrumentation, and now also offer Measurement Consultancy; helping our global clients to solve a wide range of particle and gas measurement issues.

Cambustion

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