APPLICATION NOTE

GASERA ONE SHED for evaporative emissions testing in the automotive industry

Application

The Sealed Housing Evaporate Determination (SHED) test monitors evaporative emissions in the automotive industry to ensure compliance to the regulatory requirements. Evaporative emissions testing is mandatory for new vehicles before commercialization. Photoacoustic IR spectroscopy (PAS) is used for the SHED testing and it is the most practical one from various measurement methods (e.g. GC-FID, PTR-MS). The method is approved by the US Environmental Protection Agency (EPA) and the California Air Resources Board (CARB).

Vehicles are tested in the SHED chamber for several days. The ambient temperature in the SHED chamber is changed to follow the prescribed temperature profile. Measured components are ethanol, methanol and refrigerants (R-134a and HFO-1234yf). Simultaneous analysis of ethanol and methanol is challenging for other PAS analyzers that are currently used in the SHED application. This is due to cross-interference that can lead to false-positive results as methanol is permeating from hoses and tanks in the vehicle.

The use of biofuel-gasoline blends, such as E10, is increasing. Evaporative emissions of ethanol originate from fuel handling systems. Ethanol can evaporate from the tank and permeate through fuel hoses. The measurement of ethanol is regulated and mandated by various government regulations. Methanol and refrigerants are measured for additional information.

Technology

GASERA ONE SHED allows simultaneous, accurate and sensitive measurement of all target components. Current technologies that are used for the emissions detection do not meet the government requirements completely. The capability of the GASERA ONE SHED multi-gas analyzer in this application outperforms conventional analyzers.

Figure 1. A US vehicle OEM has tested GASERA ONE SHED instruments against the US EPA Tier III standard and found them suitable for vehicle testing.

The GASERA ONE SHED is an automatic and standalone measurement system that uses an external cavity quantum cascade laser (EC-QCL) as the light source. The ultra-high sensitivity is achieved by the use of a patented silicon MEMS cantilever sensor coupled with an optical interferometric readout system and high optical power provided by the widely tunable laser source operating in the mid-infrared region. Due to the high resolution of the laser source, ethanol and methanol can be accurately distinguished from each other. Also, interference of CO_2 and H_2O are minimized.

Conventional PAS analyzers that are currently used in the SHED application, use a broadband IR-source and band-pass optical filters instead of a high resolution laser source.

This conventional technology requires a nitrogen purge to avoid influence of ambient CO_2 and humidity. This is not required for the GASERA ONE SHED. Measurement results are fully pressure compensated in the GASERA ONE SHED. This is critical as ambient pressures may fluctuate over the 2-3 days testing period. The required detection limit for ethanol is 36 ppb and the GASERA ONE SHED complies with it, while the conventional analyzer achieves only 60 ppb.

The GASERA ONE SHED is designed in a 19" rack enclosure, which can be easily integrated into a SHED test bench. Sampling is done directly from the SHED chamber offering online monitoring capability and minimal operating workload.

Measurements

Table 1. shows the achieved performance with the GASERA ONE SHED in the experiment.

Table 1. Detection limits.

Gas	Detection limit (ppb)
EtOH	23
MeOH	24
R-134a	7
HFO-1234yf	7

Figure 2. shows comparison of the GASERA ONE SHED to a conventional infrared filter-based PAS analyzer. Ambient air measurement in the SHED chamber gives an indication of the performance. Both peak-to-peak variation and standard deviation are significantly better with the GASERA ONE SHED.

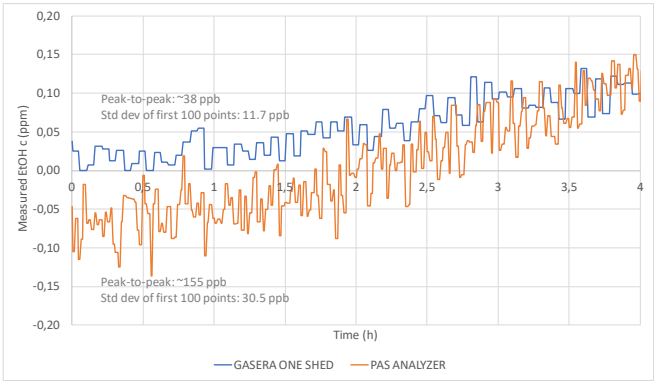

Figure 2. Comparison of the GASERA ONE SHED and a conventional PAS analyzer.

Figure 3. shows a 3-day CARB diurnal test result. The SHED chamber volume is fixed and the temperature is varied between 18 and 40 °C. During heating cycles, the internal pressure in the SHED chamber increases and measured amount of air is removed to keep the internal pressure and volume constant. During cooling cycles, clean and dry zero air is added to the SHED chamber.

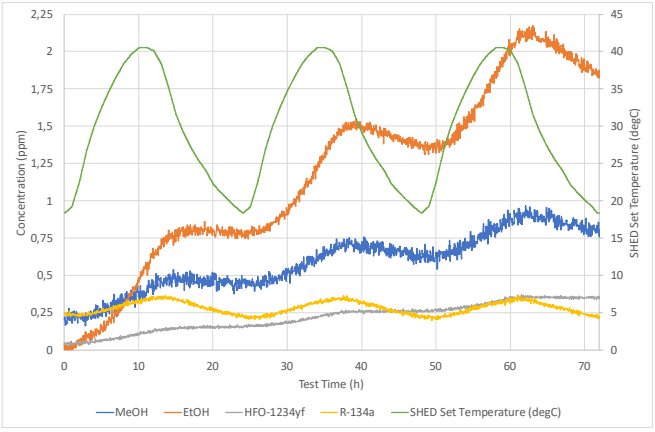

Figure 3. A 3-day CARB diurnal test shows simultaneous measurement of all the components of interest.

Conclusions

The GASERA ONE SHED multi-gas analyzer was tested against requirements for the SHED application. It meets measurement specifications required by the application. It measures ppb-levels with excellent accuracy and repeatability providing stable and reliable measurements.

The GASERA ONE SHED performs well in the true SHED chamber environment containing H_2O and CO_2. Ethanol and methanol can be measured simultaneously and distinguished from each other instead of giving false-positive readings for ethanol in the presence of methanol. Detection limits are superior to previously used instrumentation.

GASERA ONE SHED

- Meets the current EPA measurement specifications
- Detection limits are superior
- Simultaneous and selective measurement of ethanol and methanol
- No need for nitrogen purge to avoid influence of ambient CO_2 and humidity
- Measurement results are fully pressure compensated