Optimizing powertrain testing procedures through the use of cooled mirror hygrometers

Application background

Emissions' testing is an important environmental requirement in the design and production of any engine which uses the internal combustion process. Included in this category are petrol and diesel engine motor vehicles, trucks, diesel locomotive engines, aircraft engines and gas turbines. Testing is regulated by the Environmental Protection Agency (EPA) in the USA and in Europe is covered by various EC legislative standards.

Engine test cell

Typical emissions which are monitored and regulated by various government agencies include NO, NO_2, N_2O_4, SO_2, SO_3, CO, CO_2, Pb and residual hydrocarbons.

Powertrain testing is also particularly important in the development of performance and race engines. As emissions are a strong indication of the combustion process, this knowledge can also be used to tune engines for optimum performance. The quality and relative concentrations of these emissions for any given engine are affected by various factors, including temperature, pressure, humidity, fuel and conditions of use. Measuring and controlling these factors in the inlet air to the engine is critical to emissions reduction or optimum performance tuning.

Studies carried out in the USA by the Environmental Protection Agency (C D Paulsell, Moisture and Humidity, 1985: pp 735-744, Instrument Society of America) illustrated that the most successful method of determining the ambient humidity for the correction of the emissions concentrations was to use a cooled mirror dew-point hygrometer. Up until that time it was common for ambient humidity to be measured with a psychrometer. Paulsell's research showed that such instruments are extremely prone to errors in measurement due to a wide variety of factors and, even if used under carefully controlled conditions, have no significant advantages over the use of a cooled mirror hygrometer. Users should also be aware of the dangers of using capacitive type %rh probes that can be prone to large errors and drift in such applications.

Various standards have been introduced around the world to reduce engine emissions to improve air quality by reducing hydrocarbons, NOX, CO and particulates in vehicle exhaust. Examples include the EU's 'Stage V' and 'Stage VI', and China's 'National V' and 'National VI' standards.

Measurement technique

S8000 Remote

In order to properly control tests on performance and emissions, it is very important to measure the temperature, pressure and humidity of the inlet air to the engine. The Michell Optidew 501 or S8000 Remote Precision Cooled Mirror Hygrometers are ideal products for this application. They offer accurate and continuous measurement of the ambient dew point in an engine test cell and perhaps more importantly, are capable of extended service without drift and with full confidence (the Optidew 501 is accurate to within 0.15°C and the S8000 Remote to 0.1°C). Every instrument is delivered fully calibrated, traceable to National Standards - we maintain direct traceability to NPL (London, UK) and NIST (Washington DC, USA) through our UKAS accredited Humidity Calibration Laboratory. This satisfies the most stringent of quality system requirements and gives ultimate confidence in the measurement being made. Both instruments are capable of measuring temperature to an accuracy of 0.1°C.

Optidew 501 key specifications:

Optidew 501

- Highly cost-effective: it is the most economical chilled mirror instrument in its performance category.
- Providing a fast, dynamic response with the latest chilled-mirror hybrid sensor.
- Dew point accuracy ± 0.15 °C, temperature accuracy ± 0.1 °C.
- Measurement range: Dew point: -40 ~ + 120 ° Cdp, Temperature: -40 ~ + 120 ° C, Relative humidity: 0.45 ~ 100% rh.
- Optional modes of communication, including Modbus TCP Ethernet communication for network convenience.
- Optional pressure transmitter in ppm_V & g/kg.

The above notes relate specifically to emissions in motor vehicle testing. Similar applications apply in truck, locomotive and aero testing for similar reasons. In the particular case of aero engine testing the analysis is more targeted to obtaining optimum performance from the aero engine rather than to minimizing emissions.

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