Application Note

MEASUREMENT OF REFRIGERANT EMISSIONS FROM MOBILE A/C SYSTEMS

Figure 1: Test setup at IPETRONIK, Germany, with an evaporator air module. The Photoacoustic Gas Monitor INNOVA 1512 is mounted close to the MAC test bench.

The Opportunity

Determining emission values of mobile A/C systems is crucial when evaluating risk to the atmosphere.

The emission of man-made gases into the atmosphere has been associated with potential future adverse affects on the global climate.

The automotive industry incorporates Mobile A/C and is compelled to reduce the overall emission of the frequently used coolant R134a or to introduce alternatives such as Tetrafluoropropene HFO-1234yf or CO_2.

New methodologies for determining emission values of R134a or HFO-1234yf or CO_2 based upon gas analysis using Photoacoustic Spectroscopy (PAS) are being developed and tested by the automotive industry and their part suppliers.

The Monitoring Need

In order to evaluate refrigerant emission from mobile A/C systems or its components such as hoses, seals, O-rings, or joints, the change in concentration of refrigerant versus time is measured in a tight test chamber of known volume. IPETRONIK, using their KBA (Kratfahrt Bundesamt) accredited laboratory, completed such measurements using the Photoacoustic Gas Monitor INNOVA 1512 for measurements of R134a and HFO-1234yf and CO_2.

The PAS technique provides an accurate and rapid result with a high rate of repeatability, even at very low emission rates, such as those that occur at low to moderate temperatures. To IPETRONIK, the use of Photoacoustic Spectroscopy is a valuable and reliable solution. IPETRONIK's complete leak rate test benches are accredited by the German KBA (Kratfahrt Bundesamt).

Our Solution

The Photoacoustic Gas Monitor INNOVA 1512 is well suited for these types of laboratory measurements. The monitor is easily operated and can measure R134a and HFO-1234yf in less than 20 seconds including compensation for water vapor. The advantage of Photoacoustic Spectroscopy is high stability and repeatability with infrequent calibration (typically 1-2 times a year), linear response, and low detection limit.

The detection limits for the Photoacoustic Gas Monitor Innova 1512 for the gases of interest are:

- 0.01 ppm for R134a
- 0.2 ppm for HFO-1234yf
- 1.5 ppm for CO_2

The Photoacoustic Multi-gas Monitor INNOVA 1512 fits in the test bench system and can either be operated manually or fully controlled over either the USB or the Ethernet interface from a PC using the LumaSoft Gas 7810 monitoring software.

Figure 2: INNOVA 1512 Photoacoustic Gas Monitor.

Measurement Results

The following measurement results are all related to hose assemblies in the A/C system and the impact of different rubber materials and various types of oil (both vapor and liquid) in the R134s, where four different cases were studied:

- Characteristics of hose permeation in response to the effect of oil in R134a.
- Condition of the hose material over time to reach steady state R134a emission.
- The relative contribution of hose permeation and coupling emission.
- Transient emission rates due to transient temperature and pressure conditions.

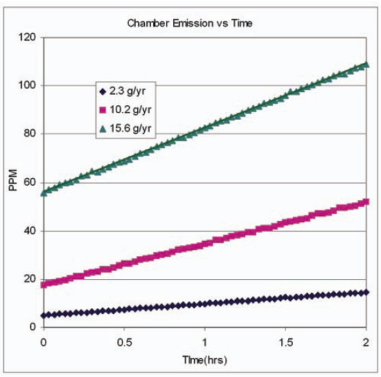

Figure 3: Leak standard rates versus measured chamber concentration in ppm.

The change in gas concentration versus time is measured inside the calibrated chamber. Taking into account the real net chamber volume, the concentration increase over time can directly be converted into leak rates in g/year. As shown in Figure 3, three different leak rates are measured for their concentrations versus time using the Photoacoustic Gas Monitor INNOVA 1512.

The measurements with the Photoacoustic Gas Monitor INNOVA 1512 were focused on the correlation between the time and the emission rate from two different hose materials. The graphs in Figure 4 and Figure 5 show that an all-rubber hose requires at least 2.5 days of conditioning at 90 °C whereas barrier hoses are stable after almost one day.

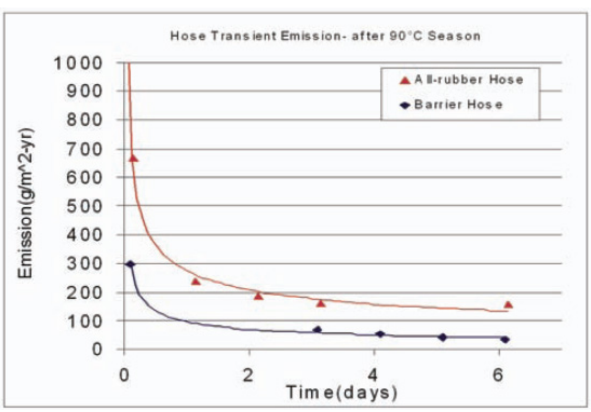

Figure 4: Hose transient emission after 90 °C season.

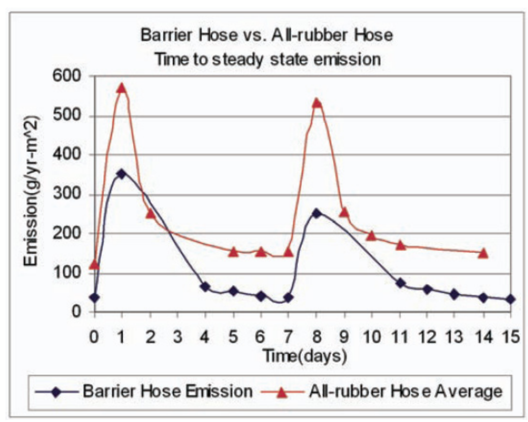

Figure 5: Two different tests on hose conditioning at 90 °C.

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