Measurement of Refrigerant Emissions from Mobile A/C Systems

Application Note

The Problem

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

The industries involved in Mobile Air Conditioners are trying to reduce the overall emission of the frequently used coolant R134a or to introduce alternatives such as R152 or CO_2.

New methodologies for determining emission values of R134a, R152 or CO_2 based upon gas analysis using Photoacoustic Spectroscopy (PAS) are being developed and tested by the industry.

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 closed testchamber of known volume. Such measurements have been done by Delphi Thermal & Interior Technical Center, Lockport, NY using the Photoacoustic Multi-gas Monitor 1314 in their laboratory for measurements of R134a, R152 and Carbon Dioxide.

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. Unlike the traditional gravimetric method, gas analysis using PAS technology also allows separate measurements of hose permeation and coupling emission. To Delphi, the use of Photoacoustic Spectroscopy is a valuable and timesaving alternative.

INNOVA's Solution

The Photoacoustic Multi-gas Monitor 1314 is well suited for these types of laboratory measurements. The monitor is easily operated and can measure R134a, R152 and CO_2 in less that 20 seconds including compensation for water vapour. The advantage of photoacoustic infrared spectroscopy is high stability and repeatability with infrequent calibration (typical 1-2 times a year), linear response and low detection limit.

The detection limit for the Photoacoustic Multi-gas Monitor 1314 for the gases of interest are:

- 0.01 ppm for Freon 134a
- 0.002 ppm for Freon 152
- 6 ppb for CO_2

Figure 1. Test setup at Delphi Thermal & Interior Technical Center, Lockport, NY. The 1314 instrument is mounted in the top of the rack system to the right

Photoacoustic Multi-gas Monitor 1314 fits in a 19" rack system and can either be operated manually or fully controlled over the RS-232 interface from a PC using the Monitoring Software 7304.

Figure 2. The Photoacoustic Multi-gas Monitor 1314

Measurement Results

The following measurement results obtained by Delphi 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 R134a, 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

Before the measurements the test chamber is calibrated with a known leak standard to determine its specific correlation factor. A leak standard of known rate is connected to the chamber to correlate the measured gas concentration (analyzer) versus time to the known leak rate. The derived correlation depends only upon the volume of the test chamber.

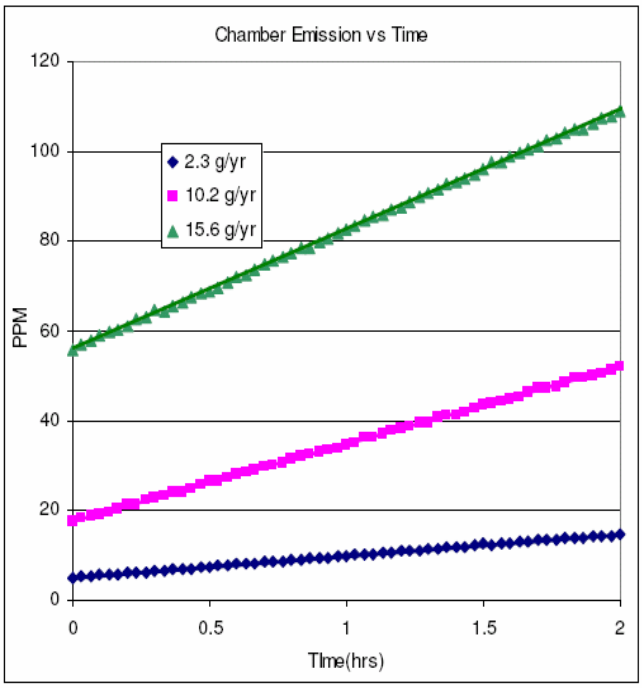
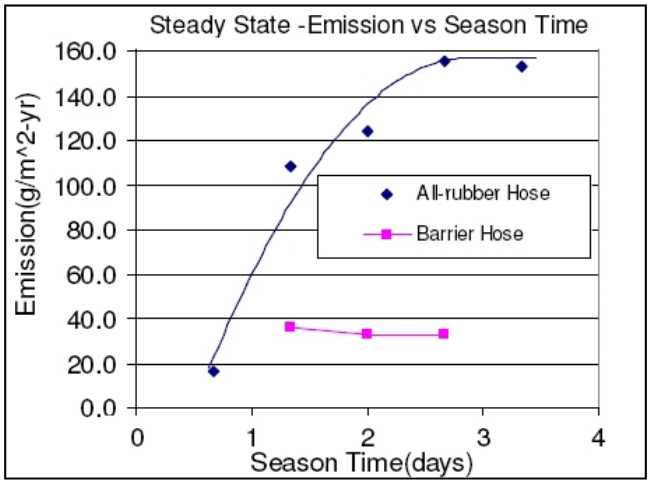


Figure 3. Leak standard rates versus measured chamber concentration in ppm

As shown below (Figure 3) three different leak rates are measured for their concentration vs. time using the Photoacoustic Multi-gas Monitor 1314.

of the measurements with the Photoacoustic Multi-gas Monitor 1314 were focused on the correlation between the time and the emission rate from two different hose materials. The graphs in Figure 4 shows that an all-rubber hose requires at least 2½ days of conditioning at 90° C whereas barries hoses are stable after almost one day.



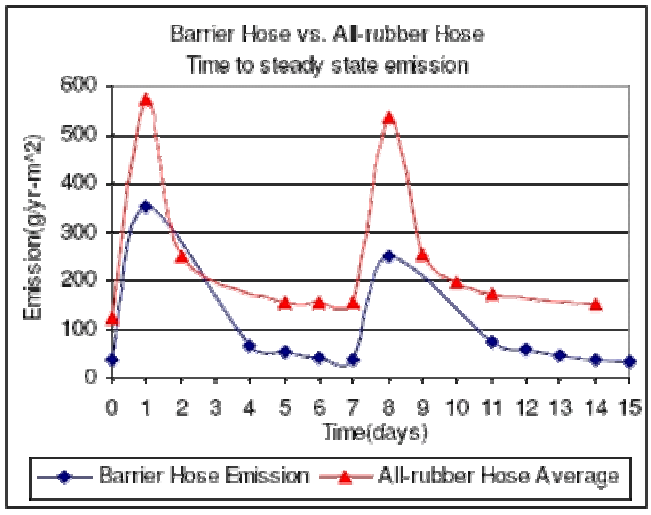


Figure 4. Two different tests on hose conditioning at 90°C.

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