Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Das Liebesleben der Maikäfer

Peter Silie[1], Max Mustermann[1], Gerhold Dosenkohl[2], Ellen Bogen[2,3]

Introduction

Regarding to the Kyoto Protocol, the European Union and its members have committed themselves to reduce the emissions of refrigerant greenhouse gases, like R-134a, during the period 2008–2012. To control the emission of refrigerant equipment, it is necessary to check the accuracy of leak detectors and room controllers. In the European standard EN 14624 it is pointed out, only to use calibrated leaks (called sniffer test leaks) based on a primary standard.

- The range of the PTB primary standard is from $4 \cdot 10^{-11}$ mol/s to $4 \cdot 10^{-9}$ mol/s which is the most needed range in industry of around 1 g loss per year of the cooling agent R134a.

  The leakrate q_{pv} is calculated by $q_{pv} = \frac{\Delta V}{\Delta t} \cdot p_{atm}$ and the molar flow follows from $q_v = \frac{q_{pV}}{R \cdot T_{wv}}$.

Measurements

There are two types of leaks, capillary and permeation leaks. Both kinds of leaks contain the gas R-134a which flow to atmospheric pressure. With the following measurements the influence of the fill pressure, the atmospheric pressure on the leak rate and stability is examined.

- The capillary leak is equipped with a pressure reducer and generates a gas flow of $q_v = 8 \cdot 10^{-3}$ Pa l/s. The measurements did not show a significant dependence on the fill pressure and the atmospheric pressure, however the repeatability is ± 3.4 %.
- The permeation leak is equipped with a Teflon membrane and generates a gas flow of $q_v = 1 \cdot 10^{-3}$ Pa l/s. In the following graph the mean leak rate is shown vs. different fill pressures. The measurements show a significant dependence on the fill pressure p_{fill} and the atmospheric pressure p_{atm}. The slope of the linear least square fit determines the atmospheric coefficients $(\Delta q_v / q_v(1010\,hPa))/\Delta p_{atm}$ of the flow rates. The uncertainty bars show the standard deviation of repeat measurements.The permeation leak is equipped with a Teflon membrane and generates a gas flow of $q_v = 1 \cdot 10^{-3}$ Pa l/s. In the following graph the mean leak rate is shown vs. different fill pressures. The measurements show a significant dependence on the fill pressure p_{fill} and the atmospheric pressure p_{atm}. The slope of the linear least square fit determines the atmospheric coefficients $(\Delta q_v / q_v(1010\,hPa))/\Delta p_{atm}$ of the flow rates. The uncertainty bars show the standard deviation of repeat measurements.

  In the next step, the data were normalized for a gas flow q_v at an atmospheric pressure of 1010 hPa. Thus the fill pressure coefficients $(\Delta q_v / q_v(1bar))/\Delta p_{fill}$ could be calculated.

Results

	capillary leak	permeation leak
$(\Delta q_v / q_v(1010\,hPa))/\Delta p_{atm}$	-	$\leq -0.0063/hPa$
$(\Delta q_v / q_v(1bar))/\Delta p_{fill}$	-	$\leq 0.46/bar$
repeatability	±3.4%	± 0.7 % · · · ± 1.6 %

So far, no temperature dependence could be measured due to consistencies probably caused by experimental shortcoming.

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

Peter Silie
9.9 Fachbereich
9.99 Arbeitsgruppe

Abbestraße 2–12
10587 Berlin
Telefon: +49-30-3481-????
Fax: +49-30-3481-????
E-Mail: Peter.Silie@ptb.de
www.ptb.de

[1] Physikalisch-Technische Bundesanstalt
[2] Muster Universität Forschungsstadt
[3] XYZ GmbH