VPA-8000

Vapor Pressure Analyzer

The VPA measures the vapor pressures of solids, liquids, and oils using the Knudsen effusion method.

The vapor pressure is an important physical property that defines the amount of vapor phase material that exists in equilibrium with the original material. All materials enter the vapor phase by sublimation (solid - gas) or evaporation (liquid - gas). The vapor pressure of a material at thermodynamic equilibrium is a fundamental property of the material and is only a function of temperature.

Knowledge of vapor pressure is highly desirable for many materials including pesticides and pharmaceutical samples in order to avoid the atmospheric accumulation of toxic compounds.Indeed, the vapor pressure is directly related to the Gibbs free energy of the original solid/liquid material.

The vapor pressure of material is required to be registered with the EPA (US Environmental Protection Agency) or the EC (European Community). The Knudsen effusion method used here is approved by the Organization for Economic Cooperation and Development and it is outlined in its Vapor Pressure OECD/OCDE Guideline 104

Knudsen effusion method

The Knudsen effusion method is a dynamic gravimetric technique based on the rate of escape of vapor molecules through an orifice of known dimensions in a Knudsen cell into a vacuum at a known temperature. The rate of mass loss through the orifice is measured by the ATL UltraBalance within the VPA system. Sample masses from 1 to 100mg can be studied typically in the temperature range from 20 to 400°C

In a typical experiment, the sample is placed in a Knudsen cell made of titanium containing an orifice of known area and heated to experimental temperatures. The rate of mass loss is related to vapor pressure of condensed phase, P, by the Knudsen equation (Equation 1), where dm/dt is the rate of mass loss inside the Knudsen cell with time,M is the sample molar mass (mol/g), R is the universal gas constant, A is the area and T is the temperature.

$$P = \frac{\left(\frac{2\pi RT}{M}\right)^{1/2}\left(\frac{dm}{dt}\right)}{A}$$

Dm/dt is the slope value from a least square regression fit to the experimental mass data over a certain period of time. The dm/dt is used to calculate the vapor pressure using Equation 1. A series of measured vapor pressures at differing temperatures are used to determine the constants A and B in the Clausius-Clapeyron equation (Equation 2) and thus calculate enthalpy of vaporization, ΔH, or heat of sublimation.
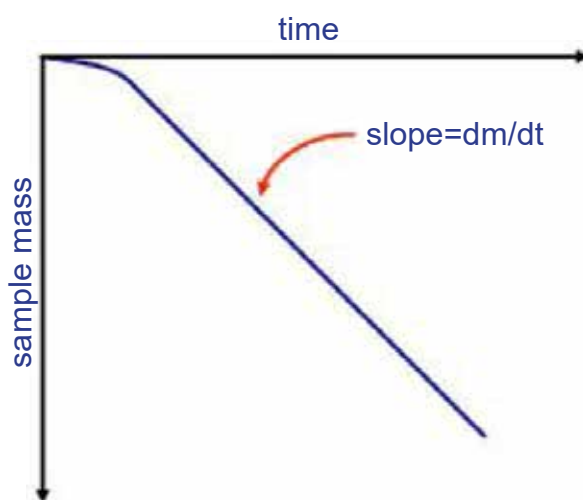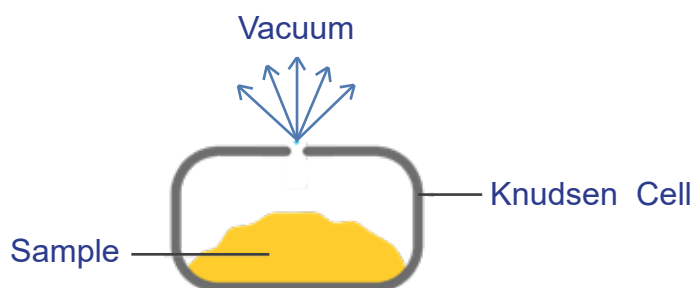
$$\log_{10}(p/Pa) = A - \frac{B}{T/K}$$

Figure 1 mass versus time data from knudsen cell

▶▶ Knudsen cell
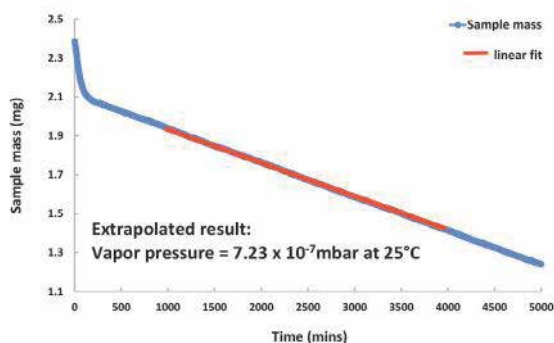
▶▶ Experimental Data

Figure 1. Vapor pressure of Bifenthrin is too low to be measured at 25°C, but can be extrapolated from the DVS Vacuum data recorded at 65°C.
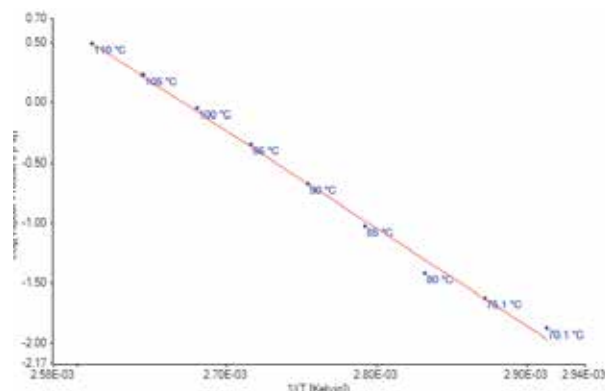

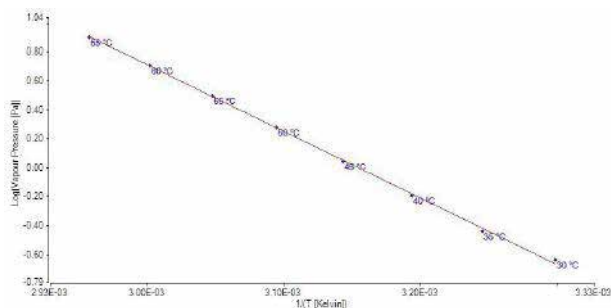Figure 2. Plot of vapor pressure data for Bifenthrin.

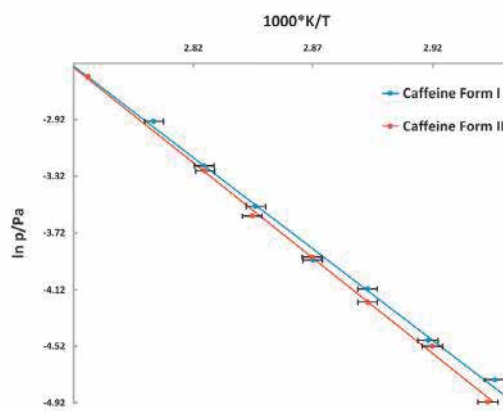Figure 3. Plot of vapor pressure data for benzoic acid.

Figure 4. Vapor pressure of Caffeine vs temperature stability study. The lower vapor pressure of Form II shows it to be the more stable polymorph.

▶▶ VPA analysis software: DVS Vacuum Analysis

includes the following features:
- Windows®-based graphical interface
- Data plotting
- Knudsen vapor pressure analysis
- One-click data analysis and report generation
- Flexible data-range selection
- Easy importing of results from different methods for simultaneous analysis

▶▶ VPA analysis software: DVS Standard Analysis:

Includes the following features:
- Plot manager
- Isotherm manager
- Baseline correction
- Vapor content offset
- Partial pressure check
- Drift and noise check
- DVS method report

▶▶ VPA control software: DVS Vacuum Control

includes the following features:
- Windows-based interface
- Quick-set methods
- Easy creating, editing, saving and restoring of methods
- Real-time display of experiment progress
- Data saved in a tab-separated values (TSV) file
- Turbo pump control
- Balance tare and calibration wizards
- Incubator and pre-heater temperature control
- Live system information

▶▶ Specifications and Schematic

Temperature-controlled incubator

The incubator provides a controlled and stable temperature environment for experiments:
- Range : 20°C to 85°C
- Stability : ±0.2°C (20°C to 85°C)

High-temperature pre-heater
- The local sample pre-heater heats the sample up to 400°C.

Vacuum system
- Rotary pump can produce minimum vacuum pressure of 1×10^{-3} Torr.
- Turbomolecular pump in combination with rotary pump provides lower vacuum pressure down to 1×10^{-7} Torr.

Vacuum Gauge
- Ultimate vacuum pressure is measured using vacuum transducer operating in the range from 760 to 1×10^{-8} Torr.

Vacuum manifold
- Constructed primarily of 316 stainless steel for chemical inertness, KF flanges and VCR sealed (Cu) fittings

Ultra microbalance

Measures the sample mass in real time at a given temperature and high vacuum.
- Sample mass : up to 1.0g
- Mass change : up to ±150mg
- Resolution (precision) : 0.1 µg
- Stability: ≤15 µg Experimental Conditions: 12 hours at 25ºC and 0% P/P0
- Peak to peak noise : ≤ 0.3 µg
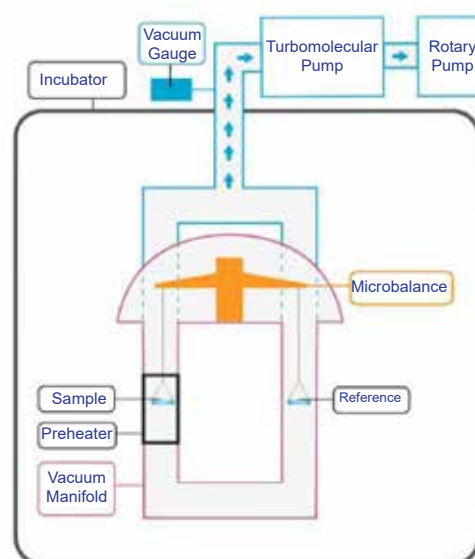
Regulatory compliances

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2. Improving quality of life by offering YOGA Training courses, Work shops/Seminars etc.

3. ANALYTICAL FOUNDATION aims to DETOXIFY human minds,souls and body by means of yoga, Meditation, Ayurveda, Health Care, Awards, Media, Events, Camps etc.

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