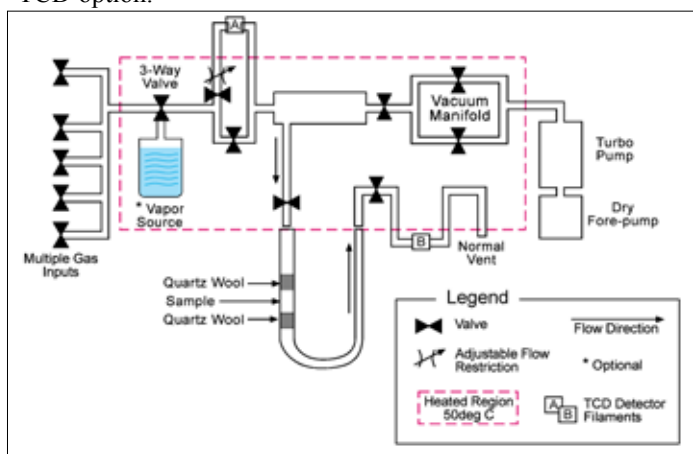


INTEGRATED, 2-IN-1 CATALYST CHARACTERIZATION SYSTEM WITH FLOW (TCD) AND VACUUM VOLUMETRIC TECHNIQUES

Autosorb[®]-1-C/TCD Benefits

- Combines gas detection by high sensitivity, thermal conductivity detector (TCD) for TPR/TPD/TPO analysis and automatic physisorption and chemisorption by precise vacuum volumetric method for analysis of BET surface area, meso- and micropore size distribution, active surface area, degree of metal dispersion, heats of adsorption, etc.
- Temperature programmed techniques (TPR/TPD/TPO) automatically performed via user programmable pre-treatment and analysis procedures including multi-step temperature ramping up to 1,100 deg C, automatic gas switching and automated data acquisition.
- Also provides for flow-based, pulse titration method for rapid determination of active surface area, degree of metal dispersion, etc.
- Available vapor generator option with heated manifold for use with water and organic vapors.
- Available, integrated mass spectrometer option for identification of desorbed gases.

The active surface of many catalysts is often found deep within pores of individual particles. This fact has a tremendous impact on catalyst performance because, even for a single solid, not all surfaces are created equal. Real surfaces are heterogeneous and their properties vary from exterior to interior as well as from one surface site to another. Textural (surface area, pore size and pore volume) properties and surface reactivity / heterogeneity can most fully be quantified and qualified by means of a complete gas sorption analyzer such as the Autosorb-1-C with TCD option.



AUTOSORB[®]-1-C/TCD



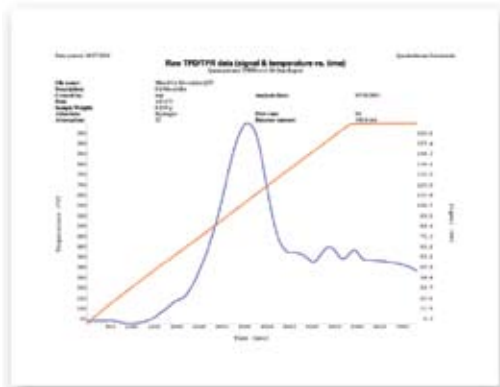
Temperature Programming

During a chemisorption analysis, the total number of active sites, or the active surface area, is evaluated. However, if one heats up the sample, the chemisorbed species tend to desorb according to how strongly they were bound to the active sites. Weaker sites normally release their chemisorbed species at lower temperatures than stronger sites.

If the sample had two distinct types of active sites, heating would release gases at two different temperatures. To quantify these released gases, one can increase the sample temperature linearly and monitor the desorption of gases with a high sensitivity thermal conductivity detector - the so-called TPD method. The reduction behavior of dispersed metal catalysts can be characterized by monitoring the rate at which a reducing gas (typically H₂ or CO) reacts as a function of temperature - the so-called TPR method. Similarly, the oxidation behavior can be characterized by flowing O₂ and tracking reaction rate with temperature - the so-called TPO method.

The Autosorb-1-C with TCD option provides for TPD, TPR and TPO analysis as well as complete active surface area, BET surface area and micro-/mesopore size analysis for comprehensive catalyst characterization.

Key Features



Hydrogen TPR of mixed Cu/Mo oxides.

- Switch from vacuum volumetric analysis to temperature-programmed, flow-based TCD analysis in less than 1 minute.
- Windows® based data acquisition for both vacuum volumetric and flow-based TCD measurement modes.
- Performs both quantitative and qualitative analysis of active sites in catalysts.
- Performs low pressure gas sorption analysis for characterization of micropore size distribution in zeolites, activated carbons, silicas, etc.
- Fully programmable gas switching and temperature ramping for maximum experimental versatility.

Autosorb-1-C/TCD Specifications for TPR/TPD/TPO

(TCD performance specifications - see Autosorb-1 brochure for full vacuum volumetric performance specifications)

Gas volume range:	1 x 10 ⁻³ cc to > 1 x 10 ² cc
Reproducibility:	typically better than 0.5%
Sensitivity:	10 positions (dynamic range: 512) plus user selectable detector current
TPR/TPD heating rates:	1°C/min to 100°C/min (up to 500°C) 1°C/min to 50°C/min (up to 750°C) 1°C/min to 30°C/min (up to 1000°C) 1°C/min to 20°C/min (up to 1100°C)
Furnace controller:	PID, featuring auto-tuning
Sample thermocouple:	positioned alongside sample
TCD filament:	tungsten-rhenium, diffusion-type, oxidation resistant
Electrical:	90 - 240 VAC, 50/60Hz
Operating environment:	20 - 80% RH, 15° to 35° C



Side-arm cell with injection port for (i) pulse titration by syringe injection, (ii) calibrating loop volumes and (iii) rapid saturation with liquids (e.g. pyridine) prior to TPD.

Optional Loop Injection Assembly

For convenient pulse titration method of determining metal area, dispersion and crystallite size. Conveniently mounts on the side of the Autosorb-1. Features quick-connect gas fitting for the titration gas for rapid switching between different active gases, and front-mounted calibration ports. Includes one each of 50, 100 and 250-microliter loops.



Optional Cold Trap Assembly

For "clean" TPR signals by preventing moisture from reaching TCD detector. Complete with bypass valve and adjustable height dewar. Also recommended for copper metal area determinations by N₂O titration.

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