micromeritics®
Effective Solutions for Material Characterization

SPECIFICATION SHEET

ICCS – *IN-SITU* CATALYST CHARACTERIZATION SYSTEM

The Micromeritics *In-situ* Catalyst Characterization System (ICCS) is a new instrument that complements any dynamic laboratory reactor system such as the Micromeritics Micro-Activity Effi and Solo, bringing new capabilities to catalyst researchers. It adds two key characterization techniques to the functionality of an existing reaction system – Temperature Programmed Analyses (TPx) and Pulse Chemisorption. There is also an optional facility to add physisorption. These well-known and time-tested techniques may now be performed on a fresh catalyst and then repeated on a used catalyst without removing the material from the reactor. Users benefit from obtaining both TPx and pulse chemisorption data for the same aliquot of sample used for reaction studies. Performing these analyses *in-situ* virtually eliminates the possibility of contamination from atmospheric gases or moisture which may damage the active catalyst and undermine the relevance of post-reaction characterization data.

Principle of Operation

The typical operation of the ICCS begins with loading of the catalyst into the reactor system. The catalyst may then be characterized by the temperature programmed methods; temperature programmed reduction (TPR) is commonly used for supported metal catalysts while temperature programmed desorption (TPD) may be the best choice for acidic or basic catalysts. The TPx is often followed by pulse chemisorption to determine the number of active sites. This use of TPx and pulse titration provides a description of the fresh (unused) catalyst under representative conditions (notably at elevated pressure).

After performing this initial characterization, a user may then proceed with reaction studies on the exact same sample without adding any additional catalyst or transporting the catalyst to a different device.

Upon deactivation or simply after a prolonged period of testing, the used catalyst may then be analyzed in the same way as the fresh material employing TPx and pulse chemisorption under identical conditions. This strategy provides a method for comparing the key characteristics of the catalyst such as number of active sites before and after use without removing the catalyst from the reactor.

ICCS – Key Features & Benefits

The ICCS provides representative *in-situ* characterization of catalysts, catalyst supports and other materials at elevated pressure and temperature, with no risk of exposure to the external environment.

- Two high performance mass flow controllers for precise, fully automated gas flow control to enable TPx and pulse chemisorption analyses.
- Fully contained *in-situ* testing to allow multiple characterizations of the same catalyst using the same sample.
- A high precision Thermal Conductivity Detector (TCD) to monitor changes in the concentration of gases flowing into and out of the sample reactor in real-time.
- A touch screen, intuitive software and a graphical interface for straight-forward, streamlined operation and the easy visualization and manipulation of alarms, commands and control parameters.
- A temperature-controlled stainless-steel flow path to ensure an inert and stable operating environment and reduced potential for condensation in the flow path. Two internal temperature control zones may be operated independently.
- An internal cold trap with additional temperature control zone for the removal of condensable fluids (e.g. water produced during reduction of oxides).
- An ultra low volume flow path to minimize peak broadening and significantly enhance peak resolution.
- Corrosion-resistant detector filaments for durable compatibility with most commonly utilized TPx and pulse chemisorption gases.
- Interactive peak editor package to enable researchers to conveniently convert data to information. Adjusting peak boundaries is a matter of simply pointing and clicking.

Analysis Capabilities

The ICCS offers a range of characterization techniques that can be applied to quantify critical attributes of both the active catalyst and the support to investigate activity, selectivity, deactivation, poisoning and regeneration.

Apply pulse chemisorption to determine:

- Metal surface area
- Metal dispersion
- Average active particle size
- Number of active sites

Apply TPx to, for example:

- investigate regeneration (temperature programmed oxidation - TPO)
- characterize binding strength (TPD)
- generate a 'fingerprint' for the catalysts and assess the impact of promoters and alternative catalyst supports (TPR)

Apply physisorption (optional) to quantify surface area.

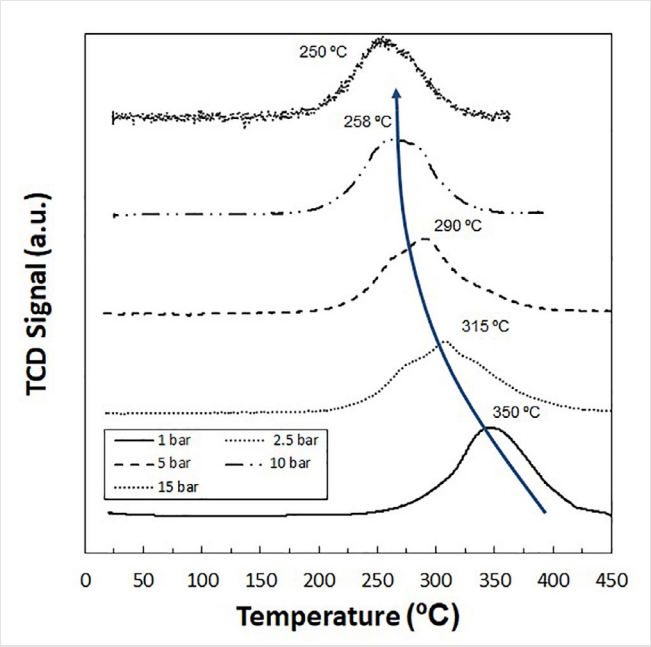

Figure 1: Example data illustrates the impact of increasing pressure upon reduction temperature

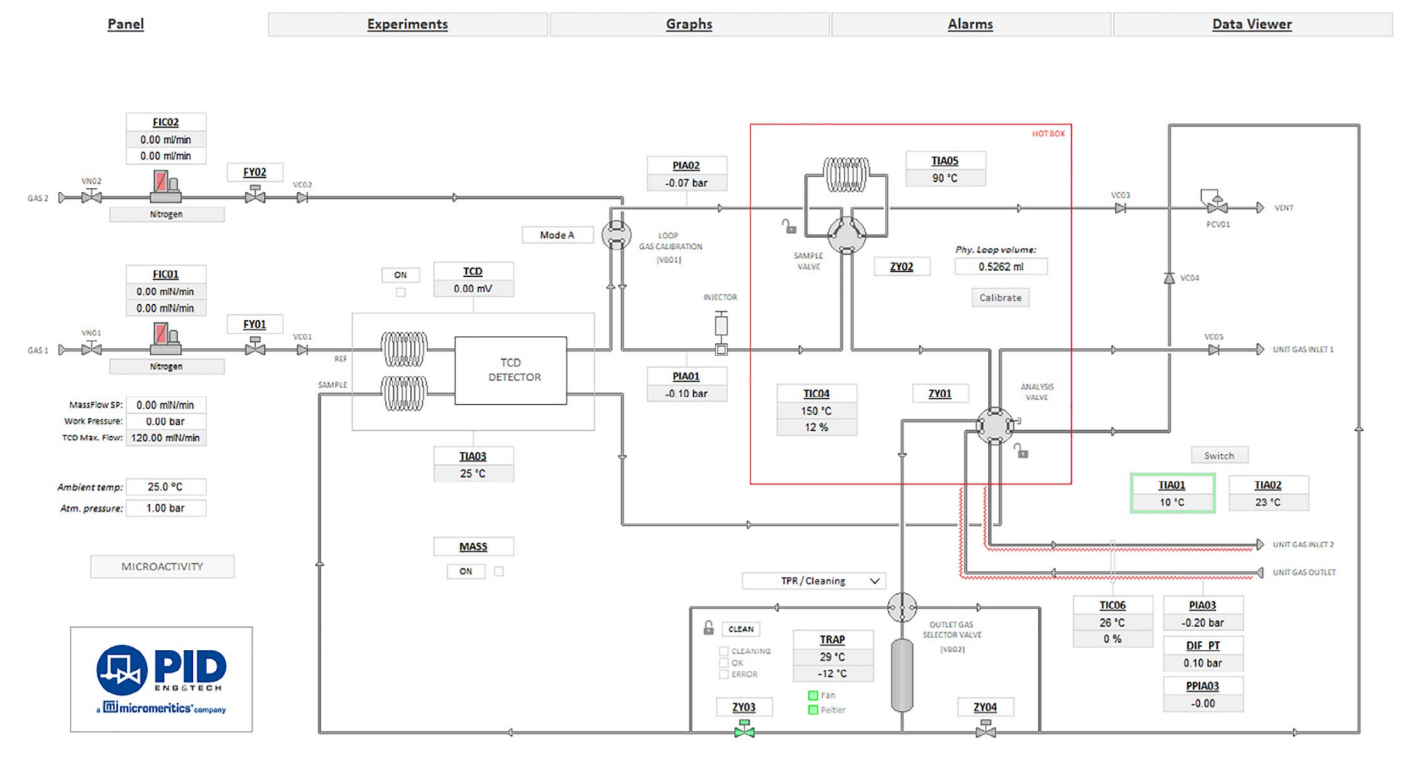

Figure 2: System Diagram

European Directives Conformity

PED – Directive 2014/68/UE
Pressure Equipment Directive (PED)
The plant meets Directive 2014/68/UE of the European Parliament on the approximation of the laws of the Member States concerning pressure equipment, and RD 709/2015, passing the applicable regulations relative to the design, manufacture and evaluation of the conformity of pressure equipment, based on said directive.

The equipment will be delivered with the mark according to current regulations.

EMC – Directive 2014/30/UE
Electromagnetic Compatibility Directive (EMC)

- Test of EMC immunity according to Standard EN 61326
- Test of EMC emissions according to Standard EN 61326

LVD – Directive 2014/35/UE
Low Voltage Directive (LVD)

- Test of electrical safety according to Standard EN 61010-1

ATEX – Directive 2014/34/UE

- Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)
- This equipment is excluded and should not be used in potentially explosive atmospheres

RoHS – Directive 2011/65/UE
Restriction of Hazardous Substances

Specifications

Electrical

Voltage	240 VAC 10 A, single phase
Frequency	50 – 60 Hz
Power	10 A, single phase

Control Module: Minimum Requirements

Processor	Intel Core I3 or equivalent
Operating Systems	Windows 7/8/10 (32/64 bits)
RAM	4 GB
Hard Drive	500 GB

Temperature System

Valve Box	Up to 180 °C
Heated Line	Up to 180 °C
Cold Trap	By a Peltier system from -15 °C up to 70 °C

Pressure System

Operating Pressure	Up to 20 bar(g) max.

Options

Loop Volume	0.5 cc and 1.0 cc

Gas Flow Rate

Number of Mass Flow Controller	2	
Max. Required Inlet Pressure	30 bar	
Flow Range	MFC1 Range 1: 0 – 800 mlN/min Range 2: 800 – 3000 mlN/min	MFC2 Range: 0 – 150 mlN/min

Gas Delivery

Requirements	Pressure of 30 bar and vent connections with 1/8" connection. Connectors to cylinders are not included and to be provided by the customer.

Physical

Height	445 mm (17.52 ")
Width	545 mm (21.46 ")
Length	500 mm (19.69 ") (without computer)
Weight	40 kg (88.2 lbs.)

Environment

Temperature	10 – 35 °C operating
Humidity	10 – 60 % without condensation
Recommendation	Avoid direct sunlight, and direct cool or hot sources

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