

## CATALYST BED REACTOR SYSTEM

The CATATEST is a laboratory-scale catalytic testing system designed to evaluate the performance of heterogeneous catalysts under controlled reaction conditions. The system typically consists of a continuous-flow fixed-bed catalytic reactor where reactant gases or liquids pass through a packed bed containing the catalyst. The unit allows precise control of temperature, pressure, flow rate, and reactant composition, enabling researchers to study catalyst activity, selectivity, and stability during chemical reactions.

### CONFIGURATIONS

The CATATEST can be configured for 7 different processes:

- 1 **Steam / Dry Reforming** – Hydrogen & Syngas production
- 2 **Hydrogenation / Hydrotreating** – Refining & Fuel upgrading
- 3 **Ammonia synthesis** – Haber Bosch process
- 4 **Ammonia decomposition** – H<sub>2</sub>&N<sub>2</sub> production
- 5 **Methanol synthesis** – Chemical feedstock & Fuel
- 6 **Fischer-Tropsch synthesis** – Synthetic fuel from syngas
- 7 **Methanation (Sabatier)** – Power-to-Gas & CO<sub>2</sub> Utilization



The CATATEST is fully automated, user-friendly, with high safety and minimal maintenance.

▣ SIMULATION OF INDUSTRIAL PROCESSES

📖 WIDE RANGE OF REACTIONS

📁 CONTINUOUS-FLOW OPERATION



### KEY SPECIFICATIONS

	TYPE I	TYPE II
CATALYST CAPACITY:	10ml	15ml
MAXIMUM PRESSURE:	10 BARG	200 BARG
REACTOR VOLUME:	30 cc	40 cc
MAXIMUM TEMPERATURE:	850°C	550°C
MATERIAL:	INCOLOY 800H	SS316



**COMPACT DESIGN** Small footprint, easy lab integration



**REAL-TIME MONITORING** Temperature, pressure and flow control



**DATA LOGGING** Automatic Excel export for reporting

- 1 Reforming   2 Hydrogenation   3 Ammonia Synthesis   4 Ammonia Decomposition   5 Methanol   6 Fischer-Tropsch   7 Methanation

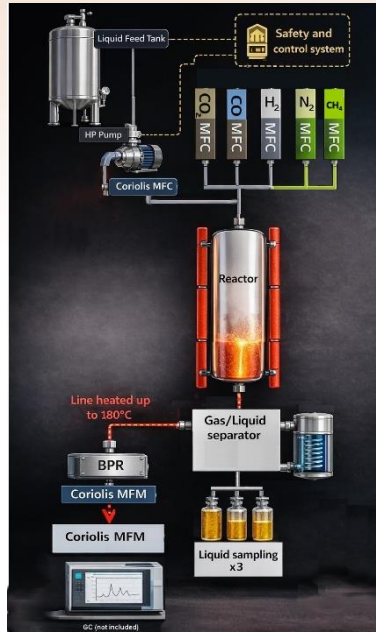
These catalytic processes convert methane via Steam Methane Reforming (SMR) and Dry Reforming of Methane (DRM) into synthesis gas (syngas) which is a mixture of hydrogen (H<sub>2</sub>) and carbon monoxide (CO) widely used for hydrogen production and chemical synthesis.

H<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, and CH<sub>4</sub> are delivered via individual MFCs for precise flow control.

Water is injected using an HPLC pump and measured by a Coriolis meter for accurate dosing.

Reactants are fed into the catalyst bed under controlled temperature and pressure conditions.

The effluent enters a separator where liquids are sampled, while gases are pressure-regulated, measured by a Coriolis meter, and sent to a GC.



## REACTION

### STEAM METHANE REFORMING (SMR)

Reaction:  $\text{CH}_4 + \text{H}_2\text{O} \Rightarrow \text{CO} + 3\text{H}_2$

Catalyst: Ni-based catalysts

Typical conditions: 800–850 °C, 1-10 bar

Products: Hydrogen (H<sub>2</sub>), carbon monoxide (CO)

### DRY REFORMING OF METHANE (DRM)

Reaction:  $\text{CH}_4 + \text{CO}_2 \rightarrow 2\text{CO} + 2\text{H}_2$

Catalysts: Ni, Rh

Typical conditions: 700–850 °C, 1-10 bar

Products: Carbon monoxide (CO), hydrogen (H<sub>2</sub>)

## REACTOR SPECIFICATIONS

CAPACITY	Up to 15 cc of catalyst		
VOLUME	30 cc	TEMPERATURE	850°C
PRESSURE	10barg	MATERIAL	Incoloy 800H

## APPLICATIONS

HYDROGEN PRODUCTION



SYNGAS GENERATION



CO<sub>2</sub> UTILIZATION



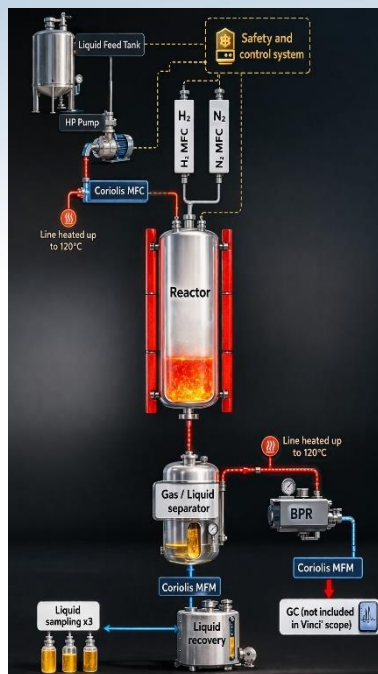
Hydrogen-assisted catalytic reactions upgrade hydrocarbons, remove impurities (S, N) and convert heavy feedstocks into valuable fuels.

H<sub>2</sub> & N<sub>2</sub> gas flows are precisely regulated by MFCs, while hydrocarbon feeds are pumped and heated.

Reactants pass through the catalyst bed under controlled temperature and pressure conditions.

Products are separated, pressure-regulated, and measured using Coriolis flow meters for liquid and gas phases.

Liquid hydrocarbons can be recovered and sampled while gas flow can be sent to a GC for analysis.



## APPLICATIONS



## REACTION

### HYDROGENATION ADDITION OF HYDROGEN TO UNSATURATED HC

Reaction:  $C = C + H_2 \rightarrow C-C$   
Catalysts: Pd, Pt, Ni  
Typical conditions: 100–300 °C, 1–100 bar

### HYDROTREATING REMOVAL OF SULFUR AND N<sub>2</sub> USING H<sub>2</sub>

Example reaction:  $R-S + H_2 \rightarrow H_2S + R-H$   
Catalysts: Co-Mo/Al<sub>2</sub>O<sub>3</sub>, Ni-Mo/Al<sub>2</sub>O<sub>3</sub>, Ni-W/Al<sub>2</sub>O<sub>3</sub>  
Typical conditions: 300–400 °C, 30–130 bar

### HYDROCRACKING: CRACKING HEAVY HC WITH H<sub>2</sub> TO PRODUCE LIGHTER FUELS

General reaction: heavy hydrocarbons + H<sub>2</sub> → lighter hydrocarbons  
Catalysts: Ni-Mo/Al<sub>2</sub>O<sub>3</sub>, Ni-W/Al<sub>2</sub>O<sub>3</sub>, Pt/zeolites  
Typical conditions: 350–450 °C, 80–200 bar

## REACTOR SPECIFICATIONS

CAPACITY	Up to 15 cc of catalyst		
VOLUME	40 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS316

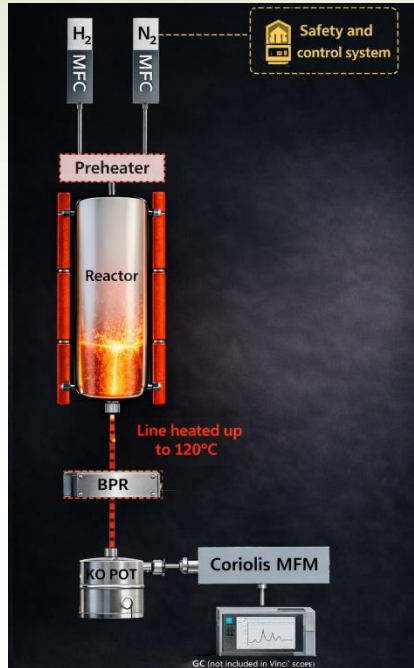
The CATATEST allows simulation of the industrial Haber-Bosch process, a catalytic reaction that produces ammonia from N<sub>2</sub> and H<sub>2</sub> at laboratory scale.

H<sub>2</sub> and N<sub>2</sub> gas flows are controlled by MFCs and preheated before entering the catalyst bed.

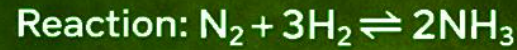
A dome-loaded BPR ensures stable pressure throughout the reaction.

Liquid and gas products are separated in a knock-out pot.

The gas phase is measured using an MFM and sent to a GC for analysis.



### REACTION

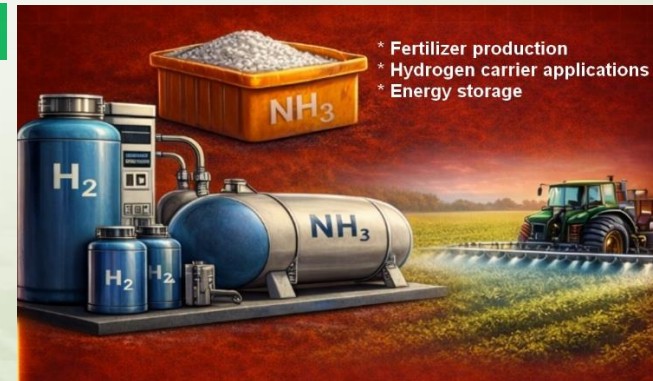


Catalyst: Iron-based catalysts

Typical conditions: 400–500 °C, 150–200 bar

Products: Ammonia (NH<sub>3</sub>)

### APPLICATIONS



### REACTOR SPECIFICATIONS

<b>CAPACITY</b>	Up to 15 cc of catalyst		
<b>VOLUME</b>	40 cc	<b>TEMPERATURE</b>	550°C
<b>PRESSURE</b>	200 barg	<b>MATERIAL</b>	SS316

The CATATEST system is configured to perform ammonia decomposition, a catalytic reaction that produces hydrogen and nitrogen from ammonia.

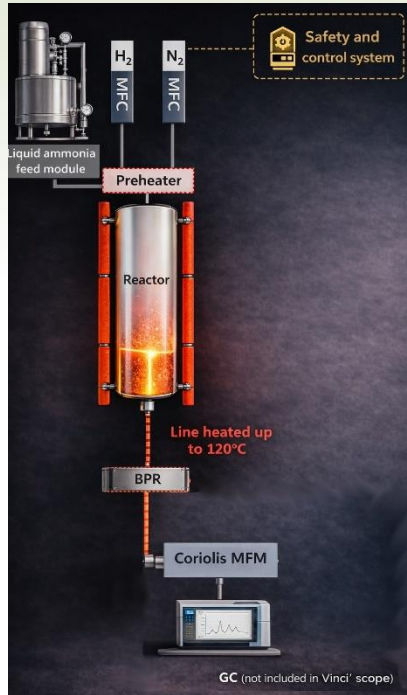
The liquid ammonia feed module converts gaseous ammonia into liquid by increasing pressure and temperature, then cooling it before feeding the reactor.

H<sub>2</sub> and N<sub>2</sub> flows are controlled by MFCs.

Feeds are preheated before entering the reactor.

The effluent flows through a heated BPR to maintain stable pressure.

The gas flow is then measured with a Coriolis meter and can be analyzed by GC.



## REACTION



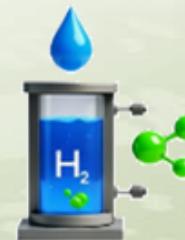
**Catalysts:** Ruthenium-, nickel, or iron-based catalysts

Typical conditions: 400–800 °C, atmospheric to moderate pressure (10 barg)

**Products:** Hydrogen (H<sub>2</sub>) and nitrogen (N<sub>2</sub>)

## APPLICATIONS

HYDROGEN PRODUCTION



NITROGEN PRODUCTION



## REACTOR SPECIFICATIONS

CAPACITY	Up to 10 cc of catalyst		
VOLUME	30 cc	TEMPERATURE	850°C
PRESSURE	10 barg	MATERIAL	Incoloy 800H

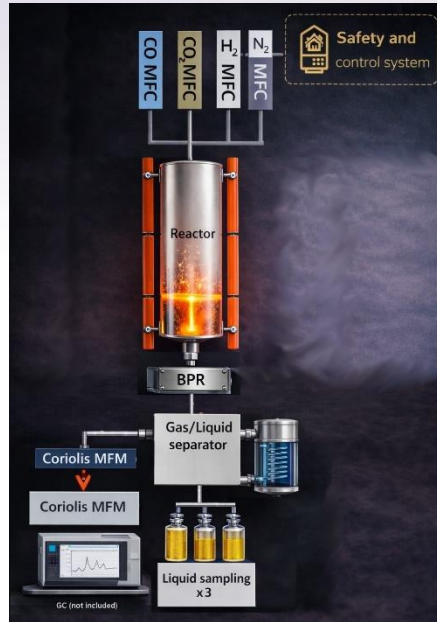
The CATATEST system is configured to perform methanol synthesis, a catalytic process that produces methanol from carbon monoxide, carbon dioxide, and hydrogen.

Gas feeds (CO, CO<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>) are controlled by MFCs and supplied to the reactor.

The outlet passes through a BPR to maintain pressure, then to a gas-liquid separator.

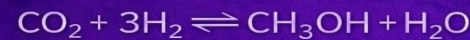
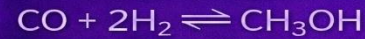
The effluent enters a gas-liquid separator cooled by a condenser to enhance separation.

Liquid products are sampled, while gas flow is measured and can be analyzed by GC.



## REACTION

Reactions:



Catalyst: Cu/ZnO/Al<sub>2</sub>O<sub>3</sub>-based catalysts

Typical conditions: 200-300 °C, 50-100 bar

Products: Methanol (CH<sub>3</sub>OH)

## APPLICATIONS

## REACTOR SPECIFICATIONS

<b>CAPACITY</b>	Up to 15 cc of catalyst		
<b>VOLUME</b>	40 cc	<b>TEMPERATURE</b>	550°C
<b>PRESSURE</b>	200 barg	<b>MATERIAL</b>	SS316

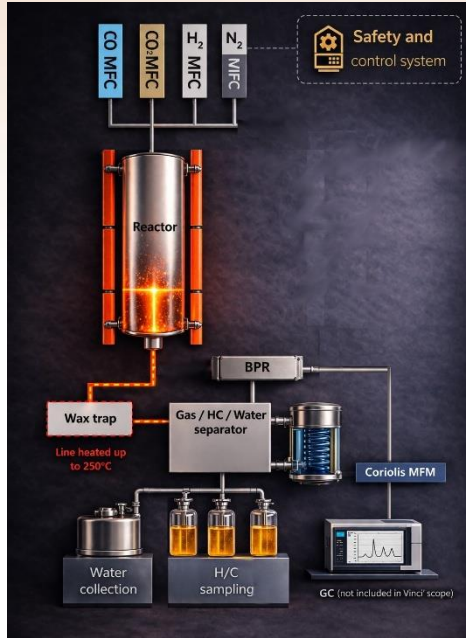
<p><b>Chemical Feedstock</b></p> <ul style="list-style-type: none"> <li>Formaldehyde</li> <li>Acetic acid</li> <li>DME, MTBE</li> </ul>	<p><b>Fuel &amp; Energy</b></p> <ul style="list-style-type: none"> <li>Fuel for vehicles</li> <li>Marine fuel</li> <li>Fuel cells (reformer)</li> </ul>	<p><b>Plastics &amp; Materials</b></p> <ul style="list-style-type: none"> <li>Polyolefins</li> <li>Resins</li> <li>Solvents</li> </ul>	<p><b>Energy Storage &amp; Hydrogen Carrier</b></p> <ul style="list-style-type: none"> <li>Seasonal energy</li> <li>e-Methanol (PtX)</li> <li>Hydrogen transport</li> </ul>
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The CATATEST system provides a suitable platform for studying Fischer–Tropsch synthesis, which converts synthesis gas (a mixture of CO, CO<sub>2</sub>, and H<sub>2</sub>) into liquid hydrocarbons.

Feed gases (CO<sub>2</sub>, CO, H<sub>2</sub>, N<sub>2</sub>) are regulated by MFCs and introduced into a fixed-bed reactor.

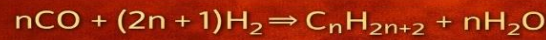
The effluent passes through a heated wax trap to remove waxes, then a three-phase separator to divide water, hydrocarbons, and gas, with liquids collected and sampled.

The gas stream is pressure-regulated, measured by a Coriolis meter, and can be analyzed by GC.



## REACTION

Reaction:



High-temperature Fischer-Tropsch (HT-FT)

Iron-based catalysts, 350 °C, 30 barg

Hydrocarbons with gasoline-range hydrocarbons C<sub>5</sub> to C<sub>12</sub>

Low-temperature Fischer-Tropsch (LT-FT)

Cobalt-based catalysts, 220 °C, 30 barg

Hydrocarbons with diesel-range hydrocarbons C<sub>12</sub> to C<sub>20</sub>.

Products: Hydrocarbons (C<sub>n</sub>H<sub>2n+2</sub>), water (nH<sub>2</sub>O)

## APPLICATIONS



## REACTOR SPECIFICATIONS

CAPACITY

Up to 15 cc of catalyst

VOLUME

40 cc

TEMPERATURE

550°C

PRESSURE

200 barg

MATERIAL

SS316

The unit is designed for gas-phase catalytic methanation processes, enabling the study of reactions that convert carbon oxides, carbon dioxides and hydrogen into methane.

Hydrogen, CO<sub>2</sub>, CO, and N<sub>2</sub> are supplied via individual MFCs to precisely control flow rates, then mixed and preheated before entering a fixed-bed catalytic reactor.

The effluent passes through a back-pressure regulator to maintain stable pressure, followed by a gas-liquid separator to remove water.

The remaining gas is measured by a Coriolis flow meter and can be sampled for



### REACTION

#### REACTIONS



CATALYSTS: Ni-based catalysts | Ru

TYPICAL CONDITIONS: 200–400 °C | 1–30 bar

PRODUCTS: Methane (CH<sub>4</sub>) | Water (H<sub>2</sub>O)

### APPLICATIONS

#### Methane Storage

Green H<sub>2</sub> + CO<sub>2</sub> → SNG:  
inject into existing gas grid or store



#### CO<sub>2</sub> Utilization (CCU)

Capture CO<sub>2</sub> and convert it into methane, utilizing renewable energy surplus.



### REACTOR SPECIFICATIONS

CAPACITY

Up to 15 cc

VOLUME

40 cc

TEMPERATURE

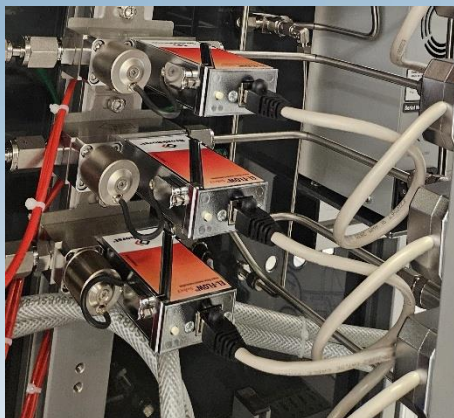
550°C

PRESSURE

200 barg

MATERIAL

SS316



### GAS FEED MODULE

Up to six gas lines can be installed in the system. Gases such as  $\text{CH}_4$ ,  $\text{CO}$ ,  $\text{CO}_2$ , air,  $\text{H}_2$ , and  $\text{N}_2$  are regulated by mass flow controllers (MFCs) before being delivered to the reactor.

Each gas line is equipped with an automatic isolation valve, a mass flow controller, and a check valve. Nitrogen is used for leak testing as well as for inerting and flushing operations.



### LIQUID FEED MODULE

Up to two liquid feed lines can be provided for injecting fluids into the reactor, such as liquid hydrocarbons or water. Each liquid line is equipped with a 2.0 L borosilicate glass sample vessel. The lines can optionally be heated when hydrocarbon liquids are used. Liquid delivery is achieved using an HPLC pump with a flow range of 0–150 cc/h and a maximum pressure compatible with the process design. A liquid Coriolis mass flow controller (MFC) is installed downstream of the HPLC pump to accurately control and measure the actual liquid flow rate delivered to the system.



### LIQUID AMMONIA FEED MODULE

The liquid ammonia feed module converts gaseous  $\text{NH}_3$  into liquid form for controlled delivery to the reactor. The process involves heating to stabilize the gas, compression to enable condensation, and cooling until liquefaction occurs. The resulting liquid ammonia is stored and then injected into the reactor at a controlled flow rate using a high-pressure dosing pump.



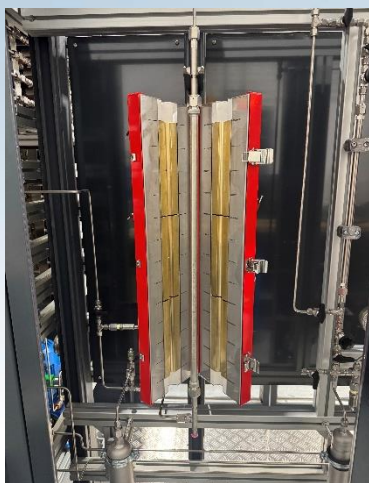
### STATIC GAS MIXER

Gases are thoroughly mixed using a miniature stainless-steel static mixer installed in a 1/8" tube, ensuring effective homogenization of the gas streams before the reaction.



## PRE-HEATER

The pre-heater conditions reactants before reactor entry, using inert packing to enhance heat transfer and mixing for uniform temperature distribution. It operates in down-flow isothermal mode with precise temperature control, a 20 ml volume, and a maximum operating pressure of 200 barg. It is constructed from stainless steel 316 for strength and corrosion resistance.



## REACTOR & FURNACE ASSEMBLY

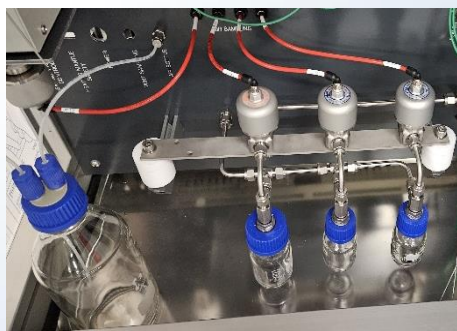
The reactor chamber contains the catalyst where reactions occur, designed to withstand high temperature and pressure conditions. It includes safety and monitoring features such as a pressure relief valve, thermocouple, and pressure transducer.

The furnace incorporates three independent heating zones to maintain a highly precise isothermal profile. Depending on the temperature requirements, two furnace configurations are available: a radiation furnace operating between 400–900°C and a conduction furnace operating between 50–550°C.



## BACK PRESSURE REGULATOR

The Back Pressure Regulator (BPR) ensures accurate and automatic pressure control regardless of the effluent flow rate or phase. The BPR is suitable for gas, liquid, and gas–liquid mixed phases. The desired pressure setpoint is defined directly from the computer control station, allowing precise and stable reactor pressure regulation. The BPR can be heated to prevent condensation or solidification of liquid products.



## LIQUID SAMPLING AND RECOVERY

The liquid product is continuously withdrawn from the separator and sent to a sampling system for analysis. It includes three 50 mL vented borosilicate glass bottles and a pressure control valve to maintain constant separator pressure during withdrawal. Sampling is automated via pneumatically actuated valves for sequential bottle selection, and when not sampled, the liquid is routed to a 1-liter recovery bottle.