MCB

MICRO CATALYST BED REACTOR SYSTEM

The MCB 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 micro-scale continuous-flow fixed-bed catalytic reactor where reactant gases or liquids pass through a packed bed containing the catalyst. The MCB 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 MCB 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_2&N_2 production***
5. **Methanol synthesis** – ***Chemical feedstock & Fuel***
6. **Fischer-Tropsch synthesis** – ***Synthetic fuel from syngas***
7. **Methanation (Sabatier)** – ***Power-to-Gas & CO_2 Utilization***

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

SIMULATION OF INDUSTRIAL PROCESSES

WIDE RANGE OF REACTIONS

CONTINOUS-FLOW OPERATION

KEY SPECIFICATIONS

	TYPE I	TYPE II
CATALYST CAPACITY:	3cc	3cc
MAXIMUM PRESSURE:	10 BARG	200 BARG
REACTOR VOLUME:	10 cc	10 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

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STEAM & DRY REFORMING

1

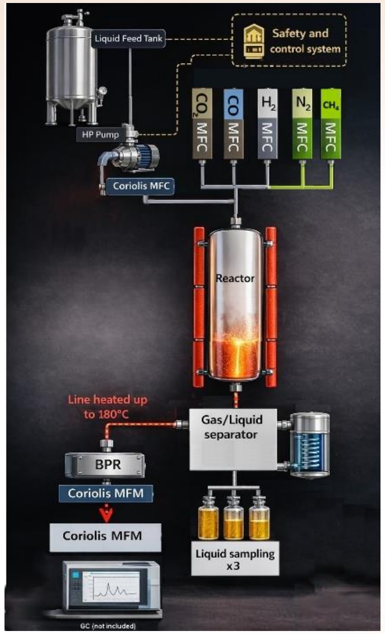
These catalytic processes convert methane via Steam Methane Reforming (SMR) and Dry Reforming of Methane (DRM) into synthesis gas (syngas) which is a mixture of hydrogen (H2) and carbon monoxide (CO) widely used for hydrogen production and chemical synthesis.

H_2, N_2, CO, CO_2, and CH_4 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: $CH_4 + H_2O \Rightarrow CO + 3H_2$

Catalyst: Ni-based catalysts

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

Products: Hydrogen (H_2), carbon monoxide (CO)

DRY REFORMING OF METHANE (DRM)

Reaction: $CH_4 + CO_2 \rightarrow 2CO + 2H_2$

Catalysts: Ni, Rh

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

Products: Carbon monoxide (CO), hydrogen (H_2)

REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	850°C
PRESSURE	10barg	MATERIAL	Incoloy 800H

APPLICATIONS

HYDROGEN PRODUCTION

SYNGAS GENERATION

CO2 UTILIZATION

HYDROGENATION - HYDROTREATING HYDROCRACKING

2

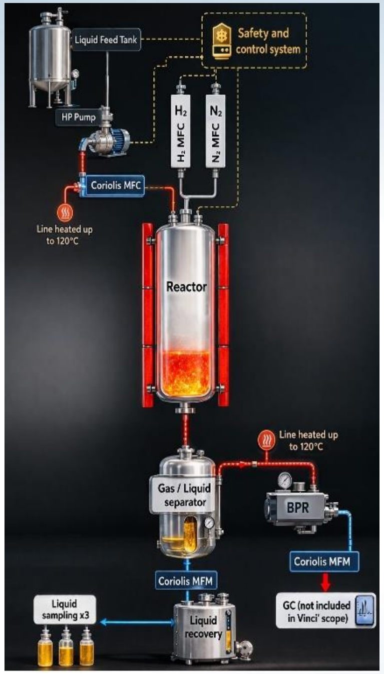
Hydrogen-assisted catalytic reactions upgrade hydrocarbons, remove impurities (S, N) and convert heavy feedstocks into valuable fuels.

H2 & N2 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_2 USING H_2

Example reaction: $R–S + H_2 \rightarrow H_2S + R–H$
Catalysts: Co–Mo/Al_2O_3, Ni–Mo/Al_2O_3, Ni–W/Al_2O_3
Typical conditions: 300–400 °C, 30–130 bar

HYDROCRACKING: CRACKING HEAVY HC WITH H_2 TO PRODUCE LIGHTER FUELS

General reaction: heavy hydrocarbons + H_2 →lighter hydrocarbons
Catalysts: Ni–Mo/Al_2O_3, Ni–W/Al_2O_3, Pt/zeolites
Typical conditions: 350–450 °C, 80–200 bar

REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS 316

VINCI TECHNOLOGIES

AMMONIA SYNTHESIS

Haber-Bosch Process

3

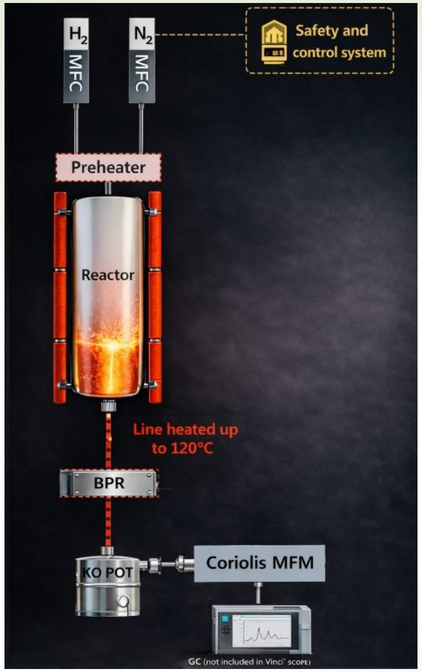
The MCB allows simulation of the industrial Haber-Bosh process, a catalytic reaction that produces ammonia from N2 and H2 at laboratory scale.

H_2 and N_2 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

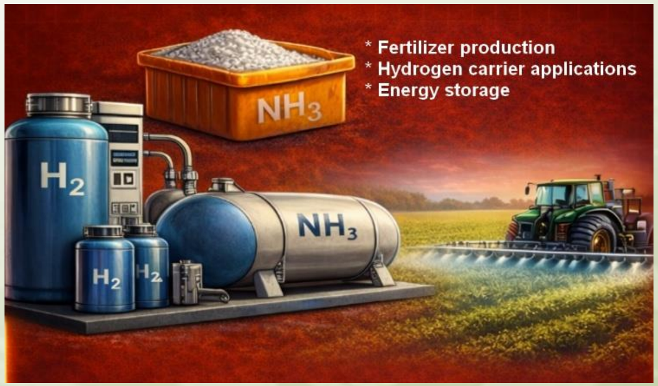
Reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Catalyst: Iron-based catalysts

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

Products: Ammonia (NH_3)

APPLICATIONS



REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS 316

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AMMONIA DECOMPOSITION

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

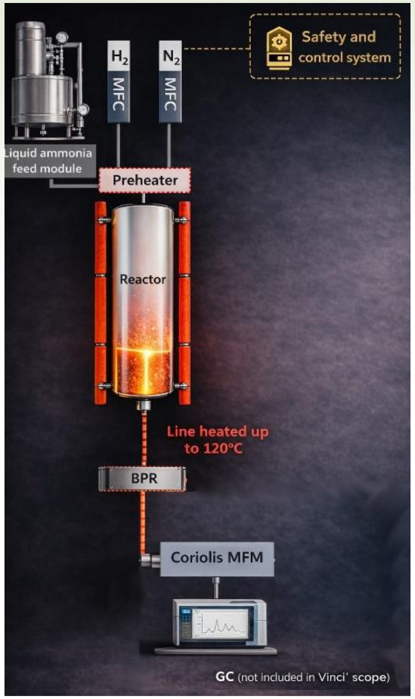
The liquid ammonia feed module converts gaseous ammonia into liquid by increasing pressure and temperature, then cooling it before feeding the reactor.

H_2 and N_2 flows are controlled by MFCs.

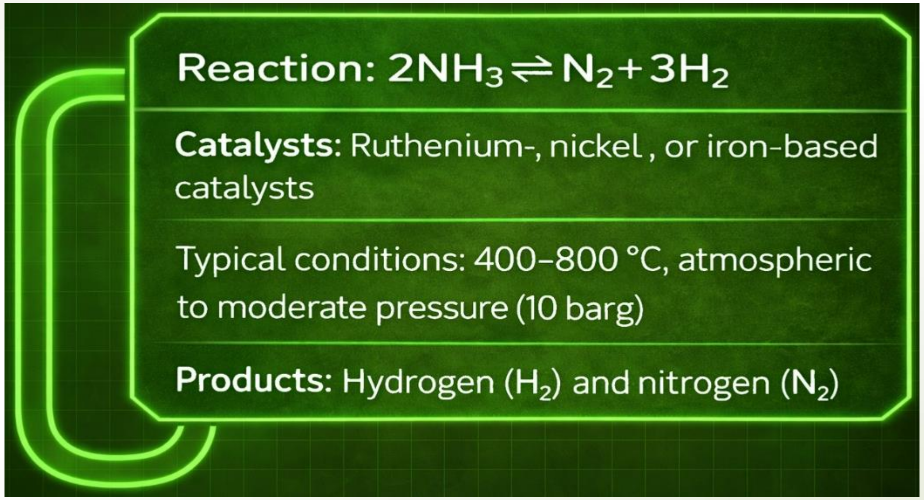
Feeds are preheated before entering the reactor.

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.

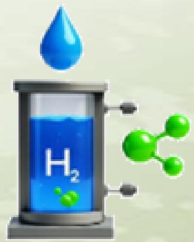


REACTION



APPLICATIONS

HYDROGEN PRODUCTION



NITROGEN PRODUCTION

REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	850°C
PRESSURE	10 barg	MATERIAL	Incoloy 800H

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METHANOL SYNTHESIS

5

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

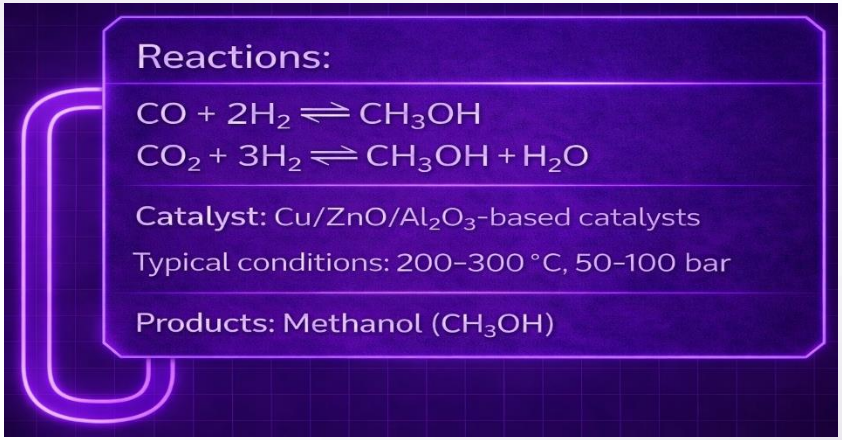
Gas feeds (CO, CO_2, H_2, N_2) are controlled by MFCs and supplied to the reactor.

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



APPLICATIONS

REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS 316

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FISCHER-TROPSCH SYNTHESIS

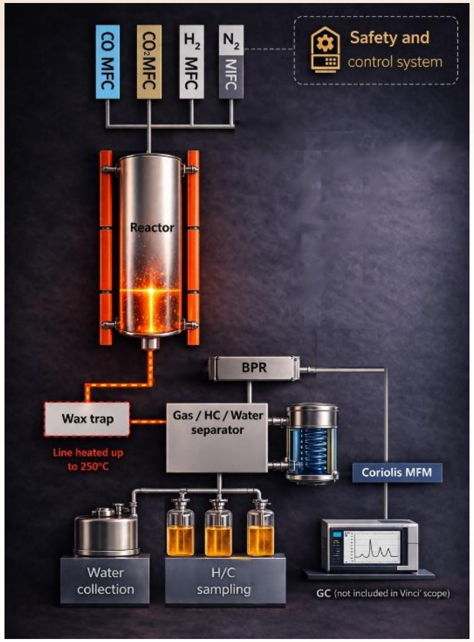
6

The MCB system provides a suitable platform for studying Fischer–Tropsch synthesis, which converts synthesis gas (a mixture of CO, CO_2, and H_2) into liquid hydrocarbons.

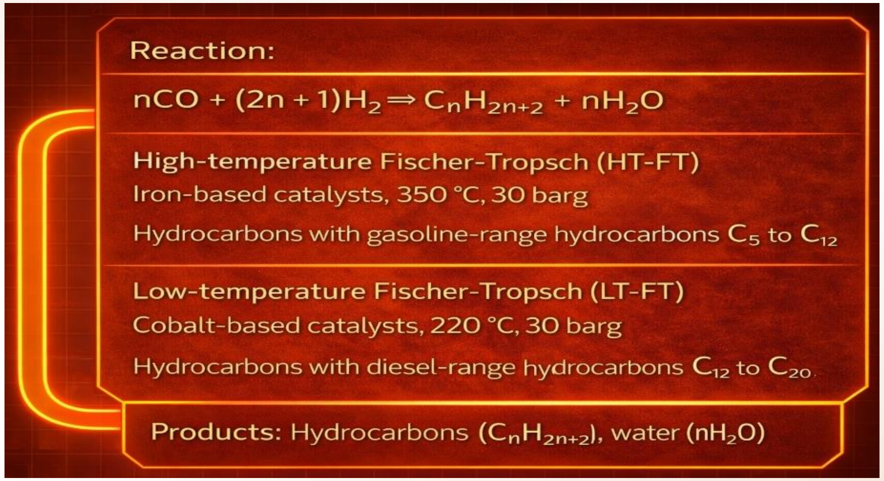
Feed gases (CO_2, CO, H_2, N_2) are regulated by MFCs and introduced into a fixed-bed reactor.

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



APPLICATIONS

REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc of catalyst		
VOLUME	10 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS 316

METHANATION

SABATIER REACTION

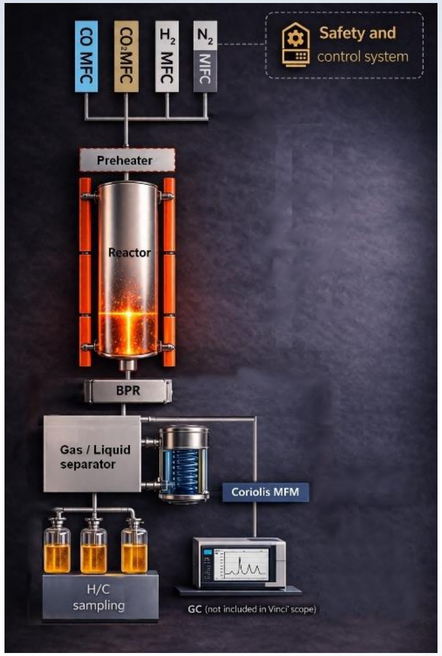
7

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.

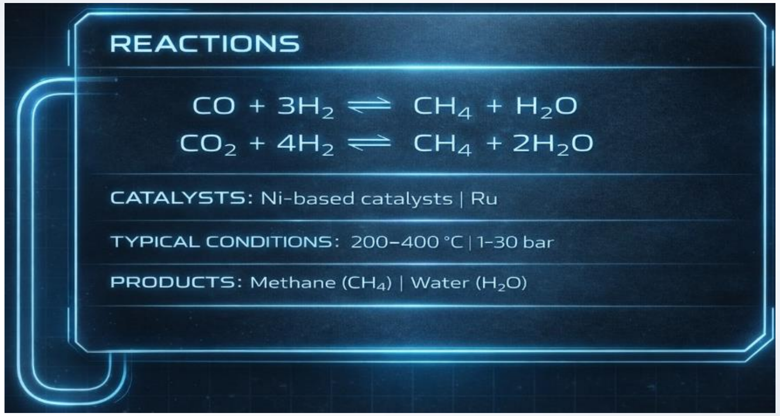
Hydrogen, CO_2, CO, and N_2 are supplied via individual MFCs to precisely control flow rates, then mixed and preheated before entering a fixed-bed catalytic reactor.

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

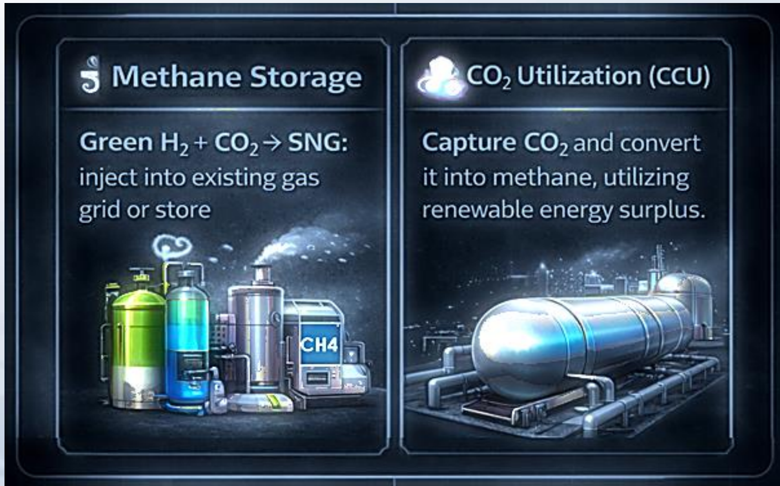
The remaining gas is measured by a Coriolis flow meter and can be sampled for



REACTION



APPLICATIONS



REACTOR SPECIFICATIONS

CAPACITY	Up to 3 cc		
VOLUME	10 cc	TEMPERATURE	550°C
PRESSURE	200 barg	MATERIAL	SS 316

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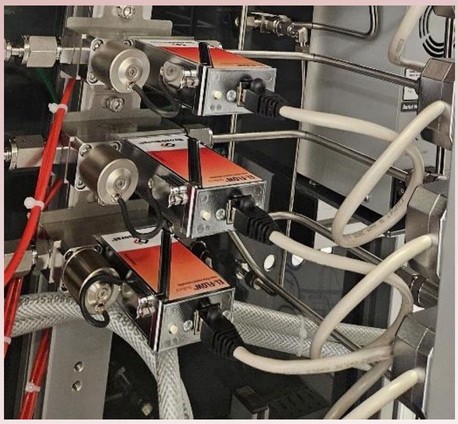
MCB

KEY COMPONENTS



GAS FEED MODULE

Up to six gas lines can be installed in the system. Gases such as CH_4, CO, CO_2, air, H_2, and 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 AMMONIA 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 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.

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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.

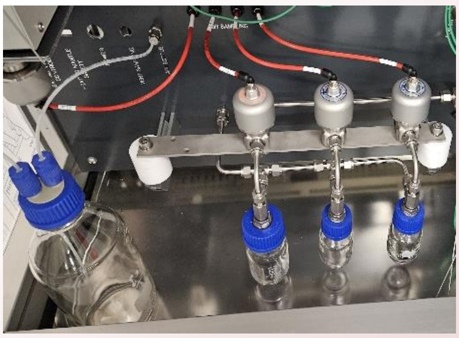
REACTOR & FURNACE ASSEMBLY

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 a single heating zone 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.