

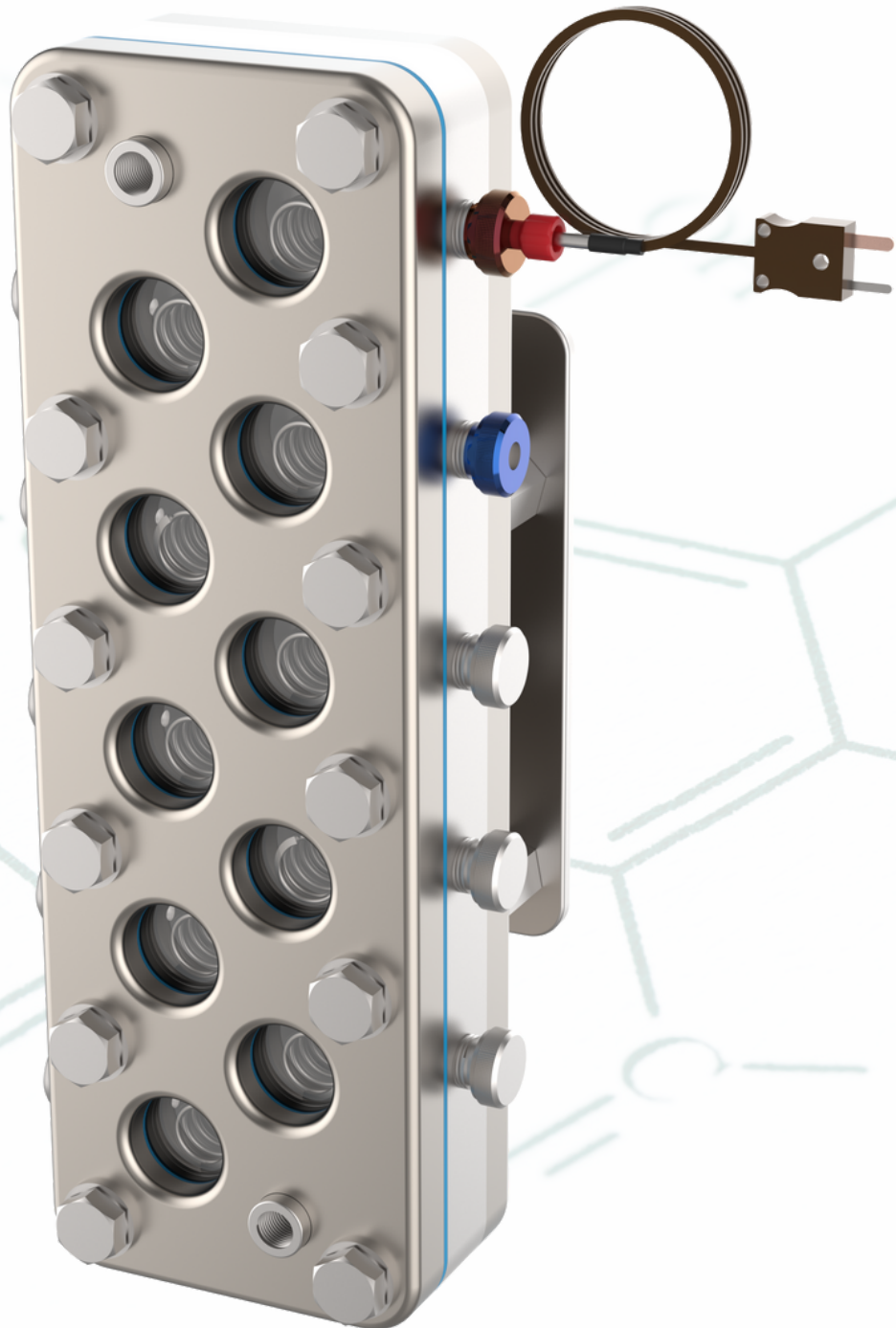


**AM Technology**

Engineering Chemistry

# Coflore<sup>®</sup> ACR

**Agitated Cell Reactor**



[www.amt.uk](http://www.amt.uk)

[sales@amt.uk](mailto:sales@amt.uk)

Issue Date: Feb23



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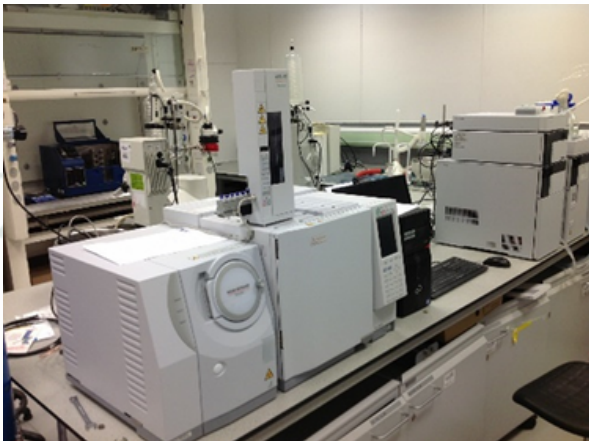
**Coflore<sup>®</sup> ACR**

# Company Overview

**AM Technology** designs and manufactures continuous flow reactors and chemical plants.

Our multi-disciplinary team of experts work together with customers from process R&D all the way through to chemical plant design, installation & commissioning.

Our patented Coflore active mixing technology unlocks the benefits of continuous flow to a wide-range of chemical processes from benchtop R&D to multi-tonne production plant.



Certificate Number: 12703  
ISO 9001

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# Flow Chemistry

In a traditional batch process, such as a reaction performed in a flask, or jacketed glass reactor, the vessel contents alters over time as starting reagents are converted to product.

**Flow Chemistry** enables a chemical reaction to be run continuously, through constant addition starting reagents to a reactor whilst simultaneously removing chemical product.

In a flow reactor, reaction time is a function of distance through the reactor.

**Flow reactors process multiple reactor volumes without interruption**, making them inherently more productive than their batch counterparts.

Smaller working reactor volumes offer advantages such as increased heat transfer efficiencies and mixing efficiencies and reduced risk associated with handling hazardous reaction mixtures.

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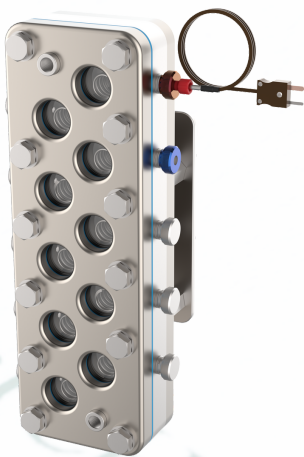


# Coflore Flow Reactors

**Coflore Flow Reactors** are dynamically mixed reactors. This means that mixing is applied to the flow reactor via an external energy source, similar to how the contents of a batch reactor is mixed with an overhead stirrer.

**Dynamic mixing** is key to ensuring wide process compatibility, with Coflore reactors able to handle an extensive range of chemistry including multiphase reactions such as liquid/liquid, liquid/gas and liquid/solid/gas.

The Coflore range covers production scale from grams to kilotonnes.



**Grams /  
Kilograms**



**Kilograms /  
Tonnes**



**Tonnes /  
Kilotonnes**

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## Coflore ACR



The **Coflore Agitated Cell Reactor** is a dynamically mixed flow reactor designed for R&D and kilogram scale production.

The ACR consists of a reactor cell block comprising 10 CSTRs in series connected by interstage channels. Each of the 10 reactor cells has two dedicated inlet/outlet ports as standard, for ultimate flexibility.

Suitable for a wide-range of processes, the ACR is compatible with both single-phase and multi-phasic chemistry.

The ACR is ideal for establishing and developing continuous processes prior to scale up, or when only limited quantities of material are available or required.

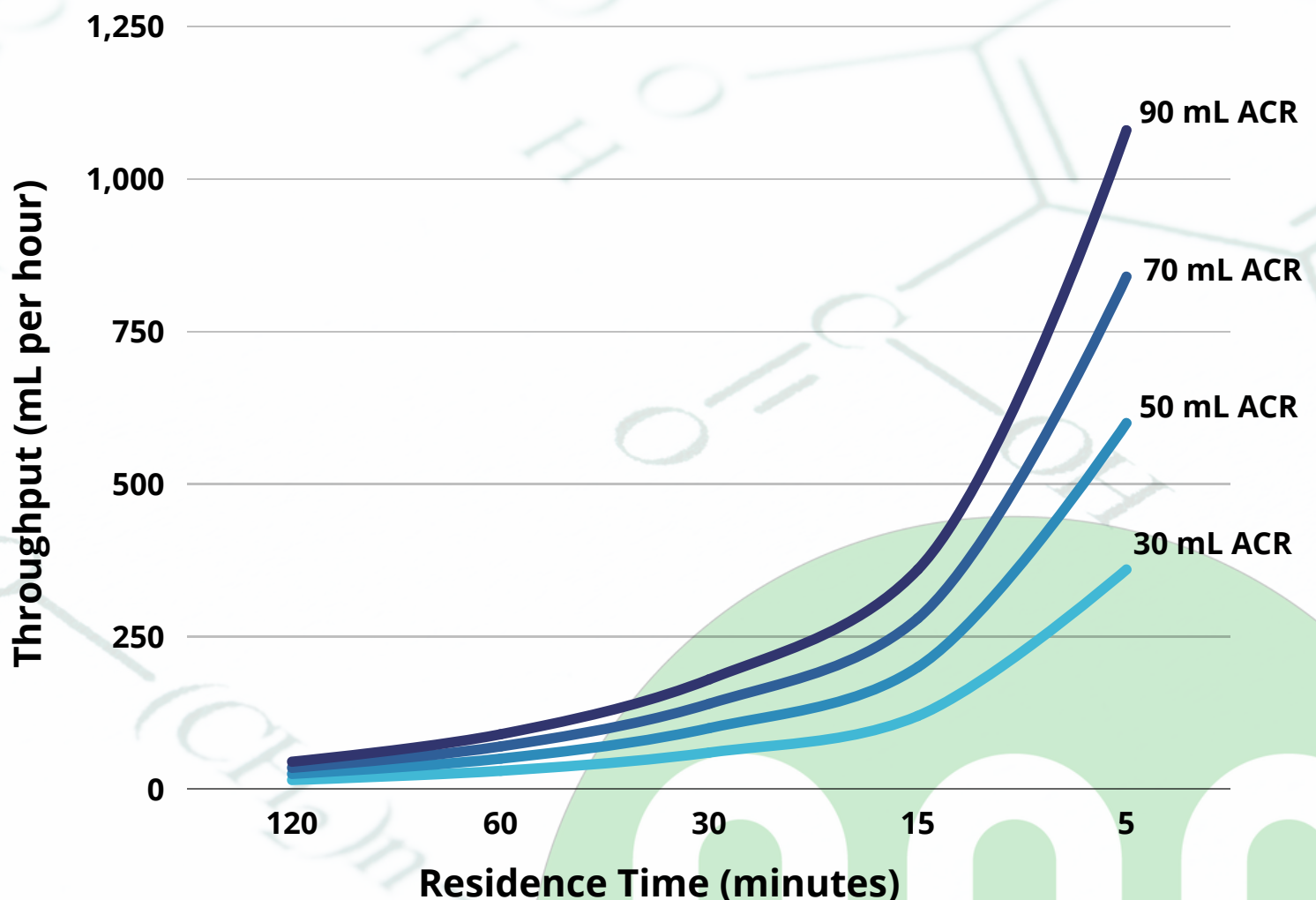
Processes developed on an ACR platform have a straight-forward path to scale up via the larger volume **Coflore ATR** pilot-scale flow reactor and **Coflore RTR** production-scale flow reactor.

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# Coflore ACR Productivity

Whilst primarily an R&D machine, the Coflore ACR is capable of kilogram-scale production of material. A 90 mL ACR has a throughput of over 1,000 mL/hour for 5-minute residence time reactions.



In any flow process, **productivity is directly linked to the reaction residence time**. A shorter residence time allows for greater productivity from a single system.

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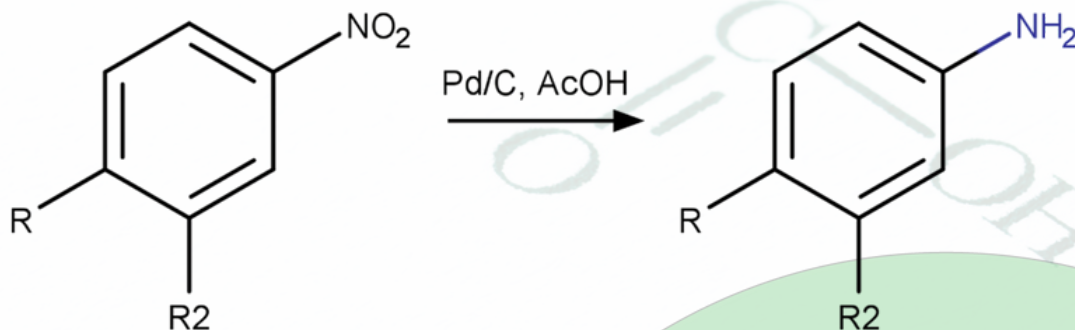


# Hydrogenation in Coflore

## Flow Case Study

Catalytic hydrogenation remains an industrially prominent yet difficult process to manage using conventional plant equipment, largely due to the safety concerns and costs associated with processing hydrogen at high pressures using large reaction vessels.

AM Technology have developed and validated multiple methods of performing hydrogenation chemistry in Coflore systems more efficiently, and safer, than batch.



Hydrogenation of an aromatic nitro compound to yield the corresponding amino compound has been performed at pressures under 10 bar and with rates of conversion **twice as fast** as equivalent batch processes reported in the literature.

The versatility of Coflore systems afforded through dynamic mixing allows for simple operation of **both homogenous and heterogenous catalysis** in flow.

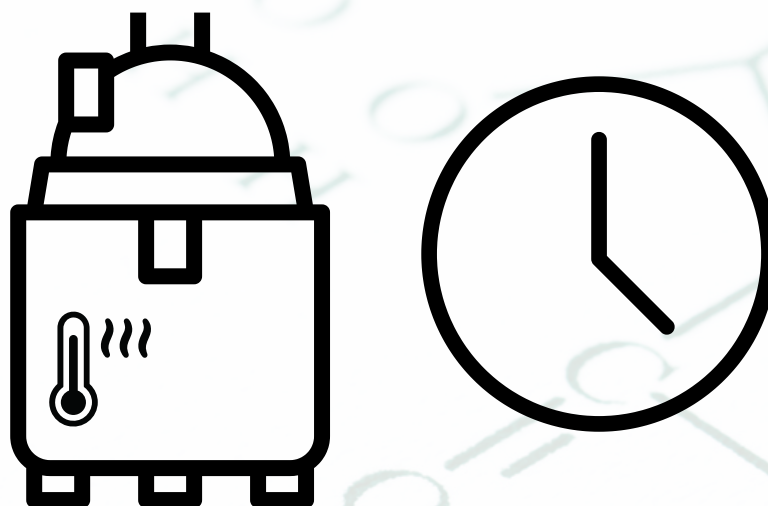
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# Nitration in Coflore

## Flow Case Study

Highly exothermic reactions, such as nitration reactions, often require dropwise addition of reagent over several hours in batch manufacturing processes.



A key advantage of Coflore flow reactors is their **greatly improved heat-transfer coefficient** compared to batch reactors, meaning that exothermic reactions can be performed much more efficiently and safely, through greater control of process temperatures.

Various nitration reactions performed by AM Technology as part of customer feasibility work have demonstrated that a continuous approach to manufacturing utilising Coflore offers efficiency improvements orders of magnitude greater than existing batch methods, allowing chemical manufacturers to **produce material more quickly, safely and at lower cost**.

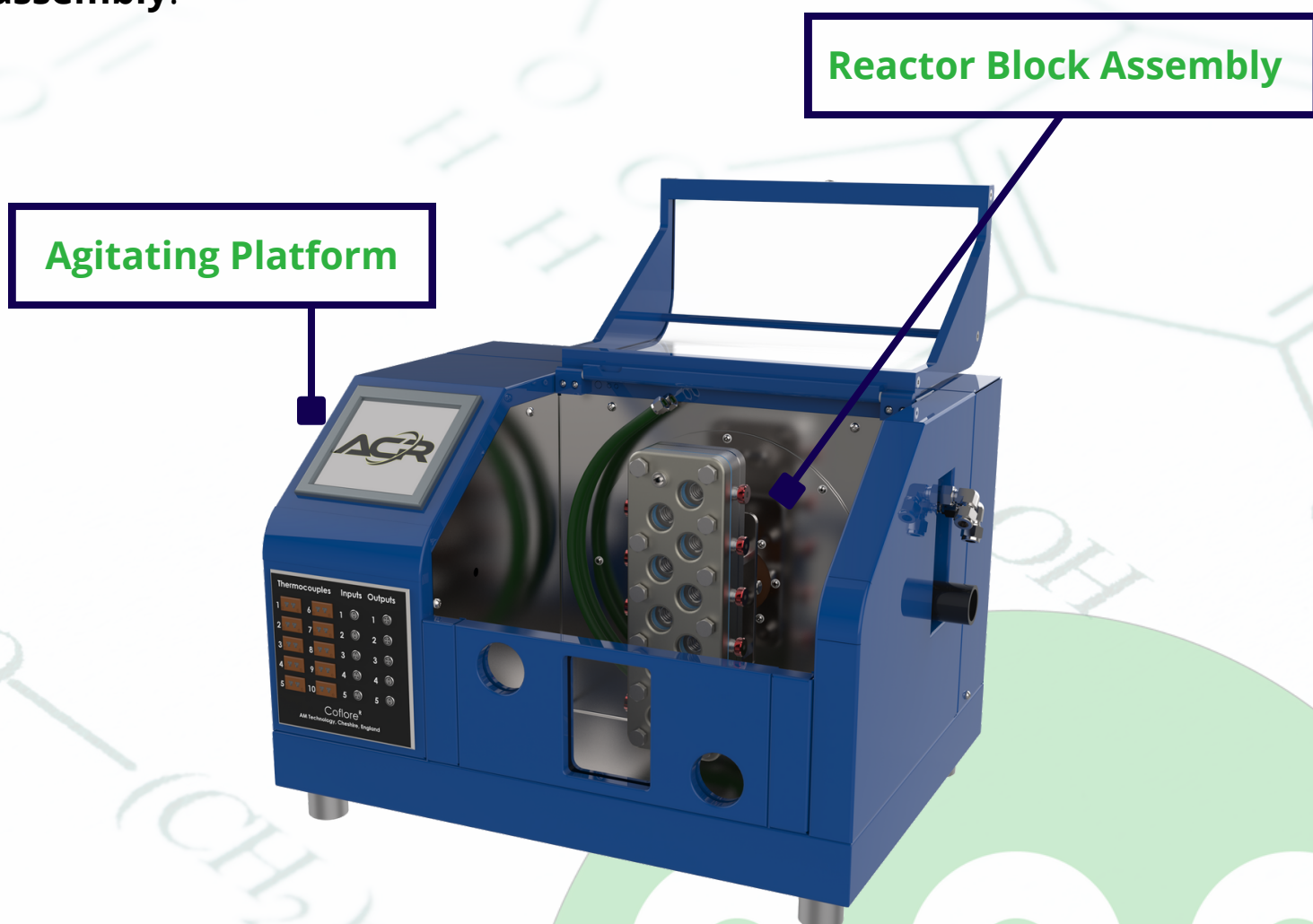
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# Coflore ACR System

The **Coflore ACR** consists of an **agitating platform** and **reactor block assembly**.



The **Agitating Platform** provides lateral motion to the reactor block, generating mechanical mixing.

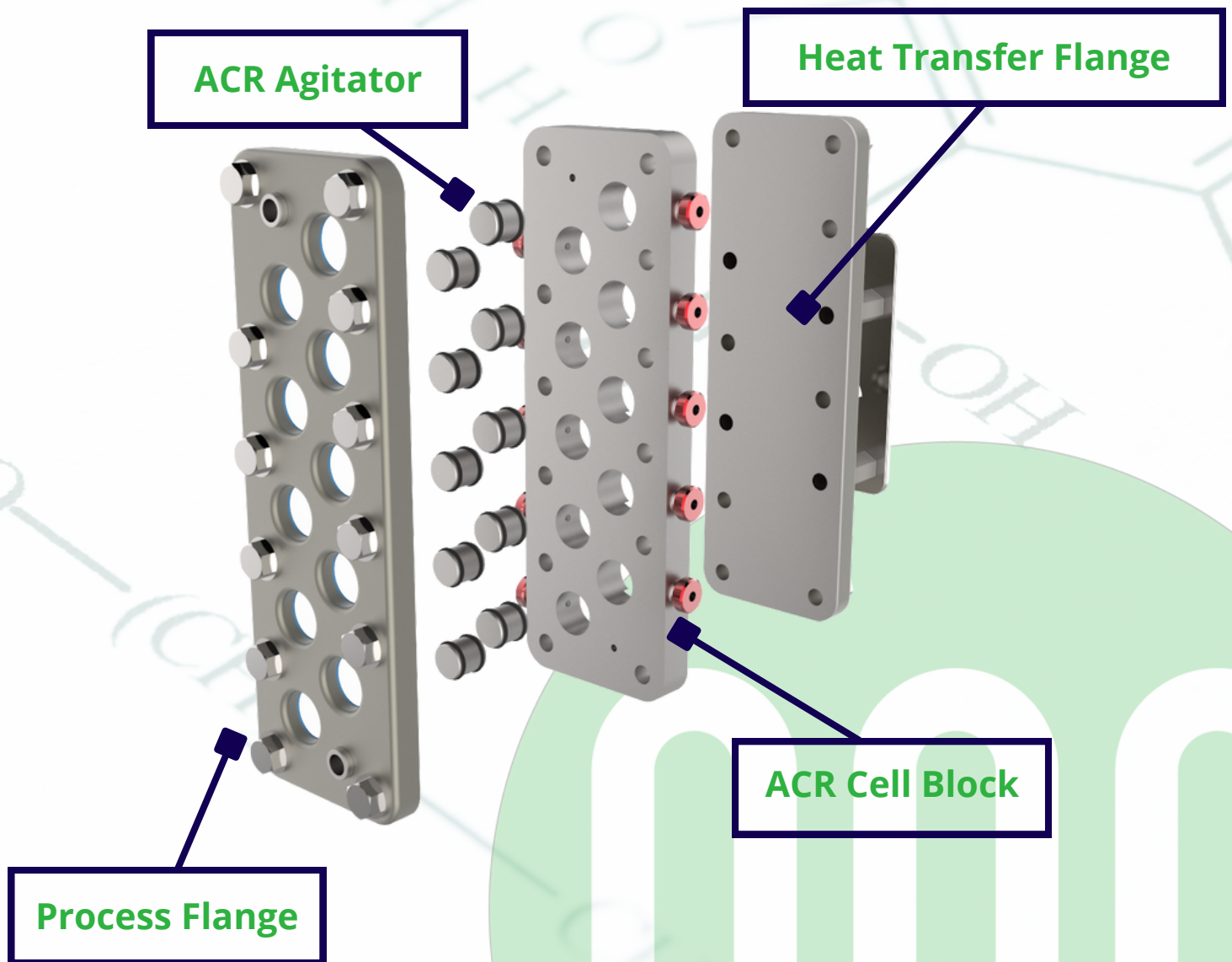
The **Reactor Block Assembly** consists of 10 cells in series, connected by interstage channels.

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# ACR Reactor Block

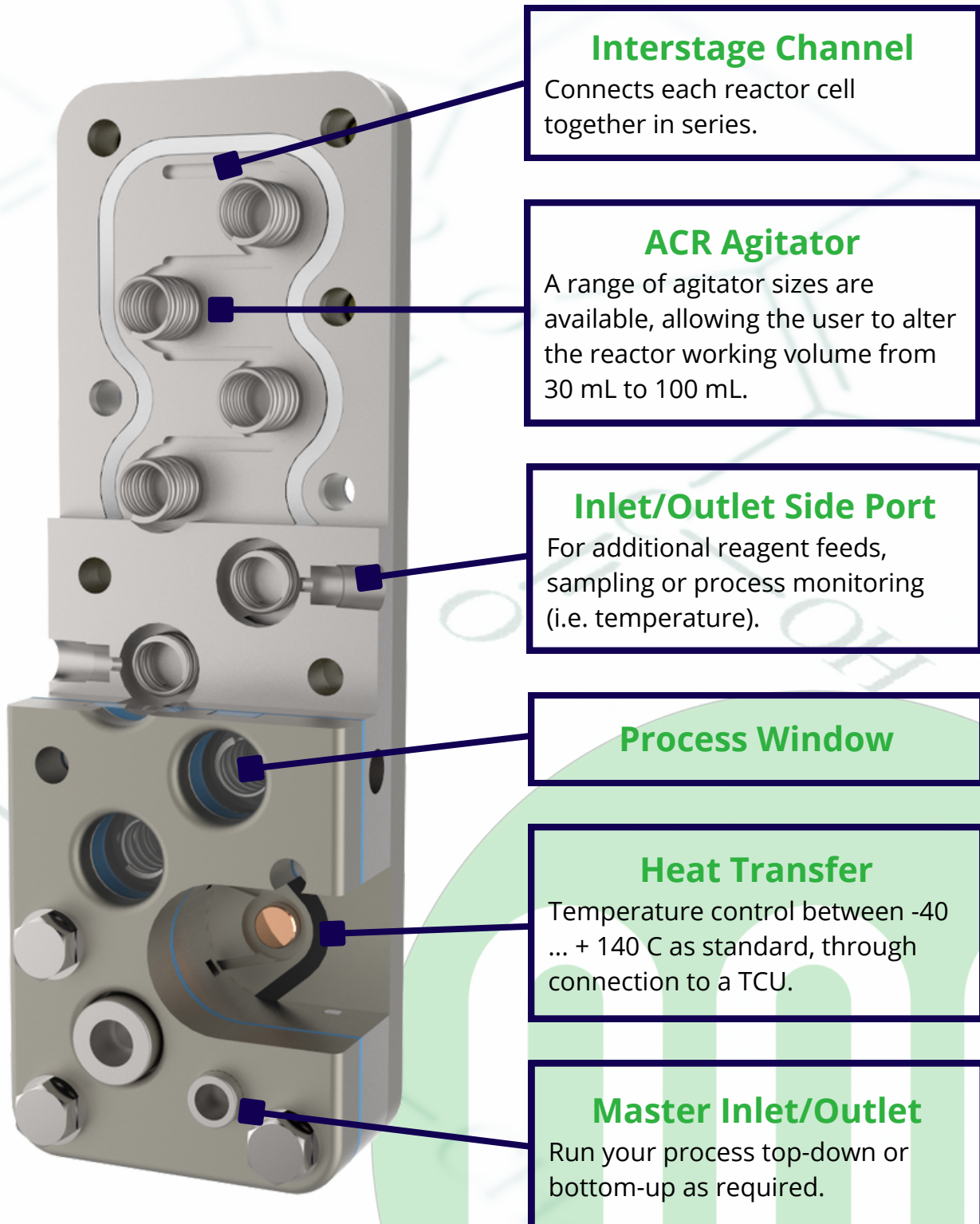
The **Reactor Block Assembly** consists of a process flange, ACR cell block, and heat transfer flange. An agitator is housed within each cell, to actively mix the reaction mixture.



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# ACR Reactor Block



## Interstage Channel

Connects each reactor cell together in series.

## ACR Agitator

A range of agitator sizes are available, allowing the user to alter the reactor working volume from 30 mL to 100 mL.

## Inlet/Outlet Side Port

For additional reagent feeds, sampling or process monitoring (i.e. temperature).

## Process Window

## Heat Transfer

Temperature control between -40 ... + 140 C as standard, through connection to a TCU.

## Master Inlet/Outlet

Run your process top-down or bottom-up as required.

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# ACR Connections

## Master Inlet/Outlet

1/8" BSPP Female Thread

## Thermocouple Assembly

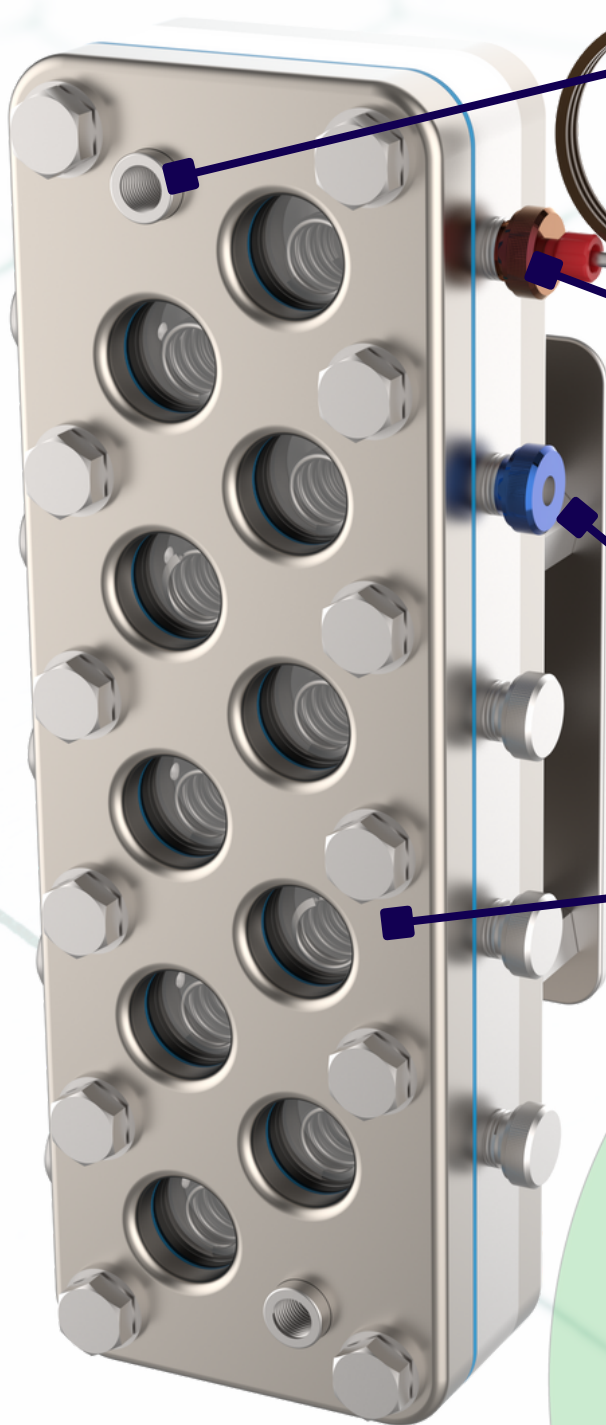
T-Type Thermocouple

## Injection Plug

Converts 1/4" BSPP to 1/4-28 UNF

## Injection Nozzle Assembly

Converts window to 1/4" BSPP Female Thread



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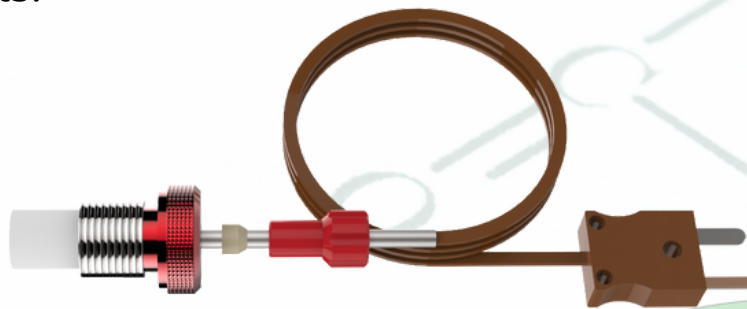


# ACR Temperature Control

Temperature control in the **Coflore ACR** is achieved through connection to an external Temperature Control Unit (TCU). Thermal fluid is recirculated through the heat transfer flange and can be arranged to flow co-current or counter-current to your process.

As standard, the Coflore ACR temperature range is -40 ... +140 C.

If you require an alternative range please contact us directly to discuss your requirements.



Internal process temperatures can be monitored with an ACR Thermocouple Assembly, pictured above. Multiple thermocouples can be placed within the ACR block, allowing the user to monitor temperature across the block, for example to monitor an exotherm.

The thermocouples have T-Type connectors and will connect to standard T-Type thermometers. The Pro and Ultimate control systems have in-built I/O to connect up to 8 ACR thermocouples and monitor temperature through the control interface.

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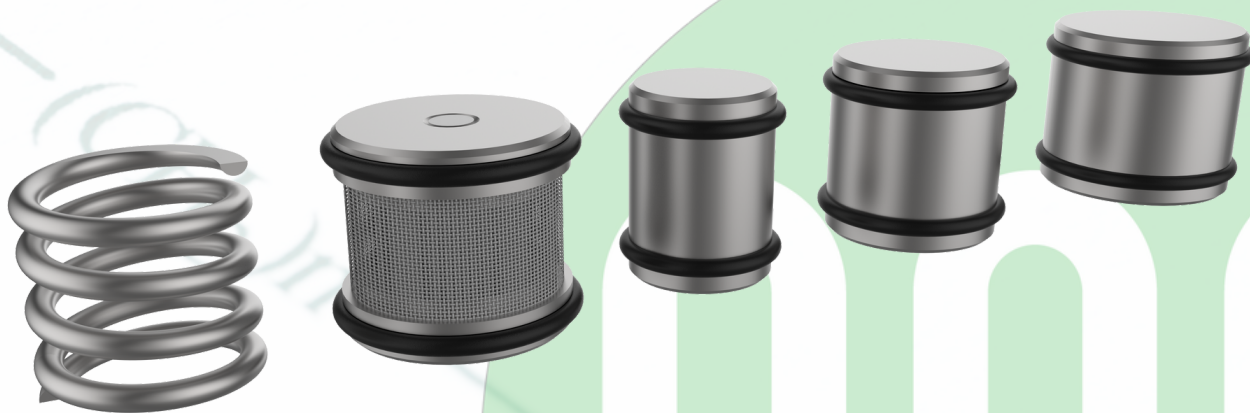
# ACR Agitators

The five types of **ACR Agitators** shown below from left to right are: 10% Spring Agitators, Catalyst Baskets, 30% Volume, 50% Volume, and 70% Volume agitators.

Simply by changing the agitators within the ACR Reactor Cell Block, the user can adjust the reactor working volume between 30 mL and 90 mL.

Catalyst basket agitators allow the user to immobilise catalyst pellets within the ACR, for example when performing catalytic hydrogenations, greatly simplifying the reactor set up.

All agitators are constructed from hastelloy C-276, with FFKM o-rings preventing metal-to-metal contact between the agitator and the ACR cell block wall.



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# Control System Overview

The **Coflore ACR** has three main control system options, offering the user flexibility based upon what they require. All control system options can be integrated into your existing DCS.

## Essential

The Essential control system offers On/Off control with agitation frequency selection from 2-6 Hz.

*Please note, a PC is required.*

## Pro

The Pro control system builds upon the Essential system with the inclusion of an I/O interface incorporating:

8x T-Type Thermocouple inputs

4x Analogue ports (4-20 mA, 2x input, 2x output)

6x Digital ports (3x input, 3x output)

*Please note, a PC is required.*

## Ultimate

The range-topping Ultimate control system includes an in-built industrial PC SCADA system and Pro I/O interface, data logging and programmable alarm capabilities.

The Ultimate control system can conform to CFR21 if required.

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# Technical Details

Wetted Materials	<b>Hastelloy C-276, PTFE, FFKM</b>
Temperature Range	<b>-40 ... +140 C*</b>
Pressure Range	<b>Vacuum ... 10 BarG*</b>
Reactor Volume	<b>30 ... 90 mL</b>
Process Connections	<b>1/4" BSPP Side Ports 1/8" BSPP Master Inlet/Outlet</b>
Agitation Frequency Range	<b>2 - 6 Hz</b>
Table Footprint	<b>1062 mm by 726 mm</b>
Noise Output	<b>&lt; 70 dBA</b>

*\*As standard. Contact us if you have specific requirements outside of this range.*

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# Technical Details

## Requirements:

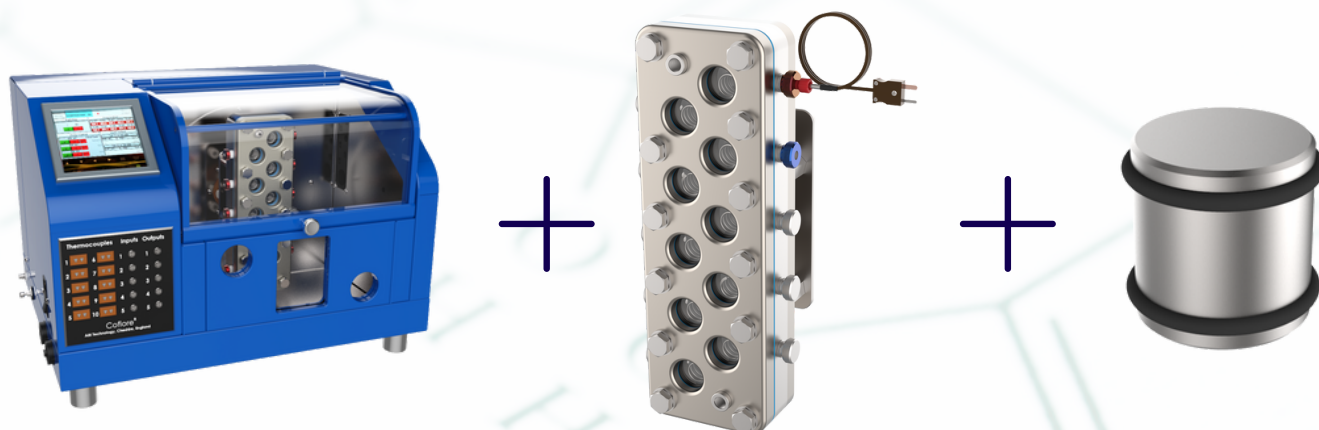
Compressed Air	<b>3 bar, 3.2 CFM oil free clean air</b>
Maximum Air Pressure	<b>6 bar</b>
Power Supply	<b>100-240 vac, 50/60 Hz, 2A max</b>
Compressed Air Connection	<b>6 mm push fit</b>
Heat Transfer Connection	<b>M16 x 1.0</b>

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# ACR Essential Package

Part Number: ACR-230



The **ACR Essential Package** is an entry level package, ideal for those looking for...

- 1x Coflore ACR Agitation Platform
- 1x Essential control system software
- 1x ACR Reactor Cell Block
- 10x ACR Agitators\*
- 4x ACR Injection Plugs
- 1x ACR Seal Kit
- 1x ACR Tool Kit

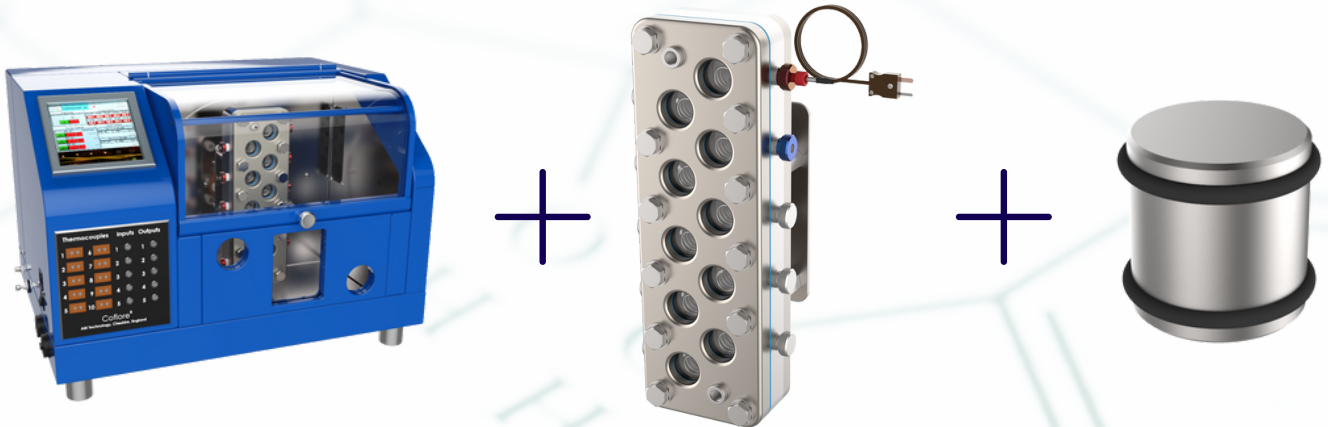
\*Customer choice, excludes catalyst basket agitators.

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# ACR Pro Package

**Part Number: ACR-240**



The **ACR Pro Package** incorporates I/O, allowing users to control various peripheral equipment such as pumps, and display temperature data from ACR thermocouples within the control system interface.

- 1x Coflore ACR Agitation Platform
- 1x Pro control system software
- 1x ACR Reactor Cell Block
- 10x ACR 10% "Spring" Agitators
- 10x ACR 30% Agitators
- 10x ACR 50% Agitators
- 10x ACR 70% Agitators
- 10x ACR Injection Plugs
- 8x ACR T-Type Thermocouple Assemblies
- 1x ACR Seal Kit
- 1x ACR Tool Kit

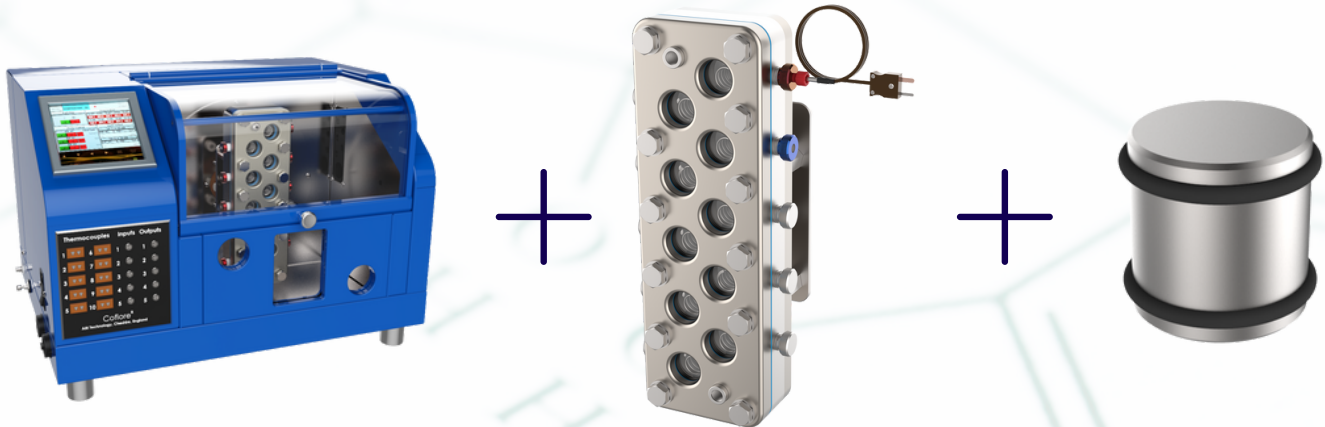
**Part Number: ACR-231**

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# ACR Ultimate Package

Part Number: ACR-250



The **ACR Ultimate Package** is a top of the range flow system package, with an inbuilt industrial PC and data logging capability. The system is CFR21 compatible and can be easily integrated into your existing DCS.

- 1x Coflore ACR Agitation Platform with in-built industrial SCADA PC
- 1x Ultimate control system software
- 1x ACR Reactor Cell Block
- 1x ACR Insulation Jacket
- 10x ACR 10% "Spring" Agitators
- 10x ACR 30% Agitators
- 10x ACR 50% Agitators
- 10x ACR 70% Agitators
- 10x Catalyst Basket Agitators
- 10x ACR Injection Plugs
- 10x ACR Window Nozzle Assemblies
- 8x ACR T-Type Thermocouple Assemblies
- 2x ACR Seal Kits
- 1x ACR Tool Kit

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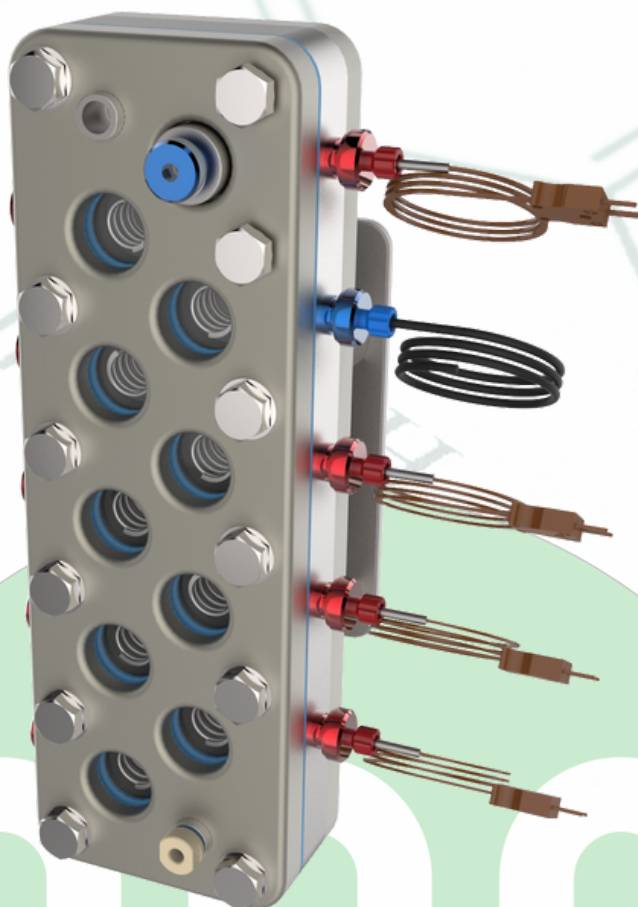
# ACR Accessories

A range of adapters and accessories for the ACR reactor cell block are available such as:

- Side Port Injection Plugs
- Side Port Thermocouple Assemblies
- Master Inlet/Outlet Adapters
- Window Port Injection Plugs

In addition, AM Technology can assist with peripheral equipment such as Huber temperature control units, and can offer various reagent pump options such as syringe pumps and peristaltic pumps.

**Contact AM Technology to discuss your requirements!**



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# Notes

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Engineering Chemistry

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# Contact

AM Technology is based in the United Kingdom. A list of distribution partners can be found at: <https://www.amt.uk/distributors>

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## Engineering Chemistry

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