Coflore® ATR
Agitated Tube Reactor

Pilot Scale Flow Reactor
Company Overview

Founded in 2000, AM Technology is a chemical engineering company based in Cheshire, England that designs and manufactures the Coflore® range of actively-mixed continuous flow reactors for the chemical manufacturing industry.

Whether for laboratory, pilot or industrial scale chemical production, our range of flow reactors offer a unique scope of capabilities suited towards a wide range of processes, with wide-ranging reaction times and reaction mixture types. We also offer development services in our well-equipped laboratories to carry out feasibility and scale-up studies on client-specific chemical processes.

The Coflore® flow reactor range: the Realistic Alternative to Batch Chemical Manufacturing


Introduction

Coflore® flow reactors are designed for flexibility & scalability, for processes with reaction times ranging from seconds to many hours. The unique method of active mixing enables the processing of a wide and versatile range of reaction mixtures, including liquids, gases and slurries.

The Coflores® ATR is an actively-mixed, multi-stage, tubular reactor (0.35L to 10L reactor volume), achieving efficient mixing with a high degree of plug flow, irrespective of residence time.
Coflore® ATR System

The Coflore® ATR system consists of an Agitating Platform, Reactor Tube Assembly and Acoustic Cabinet.

ATR Reactor Tube Assembly can be configured in multiple arrangements which enables the volume of the reactor to be configured to suit the process requirements. Reactor tubes can be disassembled to allow access for cleaning and testing of all wetted surfaces.

Coflore® ATR Reactor Tube

The Coflore® ATR reactor tube consists of a Reactor Tube with Heat Transfer Jacket, End Caps and an Agitator.

Agitators generate active mixing inside the reactor tube. Active mixing decouples mixing and plug flow from residence time. Agitators are interchangeable with different designs.

Agitators provide horizontal agitation to the reactor tubes to generate mechanical mixing.

Heat Transfer Jacket consists of a spiral wound coil which transfers heating/cooling through the reactor tube wall. The heat transfer jackets are connected to the heat transfer manifold in either counter current or co-current configurations.

End Caps are used for connecting additional process inlets or temperature probes. They can be removed to gain access for cleaning and testing of all wetted surfaces.

ATR Reactor Tubes are available in two sizes 0.35L & 1.25L, these are interchangeable. Vertical reactor tube connections are used for process inlet/outlet or reactor tube interconnections.
**Coflore® ATR Reactor Tube Assembly**

The Coflore® ATR Reactor Tube Assembly consists of a Reactor Tube Bank with Heat Transfer Jacket Manifold mounted on a reactor tube frame.

**ATR Reactor Tube Assembly**

Operating Range: -40 to +150 °C, up to 50 Bar. Reactor tubes are interchangeable.

**Reactor Tubes** can be connected to up to four tubes in a vertical cascade. Two banks of reactor tubes can be mounted meaning up to 8 reactor tubes can be mounted on a reactor tube frame.

**Heat Transfer Manifold** provides heat transfer fluid to the ATR reactor tubes. Valves are used for isolating / regulating the heat transfer fluid flow.

**ATR reactor tubes** can be removed for cleaning or to adjust reactor volume.

**ATR** reactor tubes have short vertical connections at each end enabling the reactor tubes to be close coupled together. This provides minimal unmixed volume for the interstage channels.
**Coflore® ATR Inlet / Outlet Connectors**

**Reactor Tube End Caps** have 1/2” triclover connections with a 9.5mm ID inlet. Custom design end caps with multiple connections are available on request.

**4mm Triclover Adaptors** adapt to a 1/4” BSPP with a 4mm diameter through-hole. Can be used with 1/4” BSP injection plug to maintain deadspace and adapt to a 1/4-28 UNF thread.

**Injection Plugs** can be used to adapt from a 1/4” BSPP to 1/4 - 28 UNF thread.

**9.5mm Triclover Adaptors** adapt from a 1/2” triclover to a 1/4” BSPP with a 9.5mm through-hole.

**Hose Barb Adaptors** adapt from a 1/2” triclover to a hose barb to suit 4.8mm ID tubing.

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**Coflore® ATR Temperature Measurement**

A **Thermowell** sensor is used for temperature measurement within the ATR reactor tube. Thermowells incorporate a T-type thermocouple with miniature plug.

A **Thermowell** can be fitted to the ATR through the ATR reactor tube end cap.

**Thermowells** are recessed to provide accurate temperature measurement without affecting agitator travel.
Coflore® ATR Agitating Platform

The ATR agitating platform is mounted on an anti vibration table. The ATR is available with either Analogue or Digital Control.

- **Anti-Vibration Table** with removable enclosure panels for mounting peripherals
- **Bolt Down Feet** are used to secure the agitating platform and isolate vibration
- **4” OD Fume Extract Connection** for connecting the ATR cabinet to local exhaust
- **Removable Access Panels** with viewing window and 1/4-turn panel key locks. Removable to provide full access to the reactor tube assembly
- **Bulkhead Connection Panels** for mounting process hoses and connections
- **The ATR Cabinet** provides noise insulation and protection from moving parts

Coflore® Analogue ATR Control

Analogue ATR control incorporates the basic controls for operating the platform. Control of the ATR is performed via a Local Control Panel on the anti-vibration table.

- **Start / Stop Agitation** with push button
- **Agitate Rate** Select from 6 agitation frequencies with dial. Frequencies 2,4,5,6,8,9 Hz
- **Temperature Display** with up to 12 thermocouple inputs with one temperature display. Select display temperature with selector switch

Analogue control panel
Coflore® ATR Digital Control

Digital ATR control has a 5.5" interactive touchscreen enabling the user to control the platform and peripherals. Digital ATR control is performed via a Remote Control Panel.

Digital Control Features include:
- Temperature Display with up to 10 thermocouple inputs and 10 temperature displays
- Programmable Alarm for high and low temperature set points
- Ethernet Connection enabling remote control via PC
- Start/Stop Agitation with 8 agitation frequencies: 2,3,4,5,6,7,8,9 Hz
- Remote DCS/PLC Interface for remote agitation control with local and remote emergency stop
- Pump Control for up to 3 pumps via a 4 - 20 mA signal to include: start/stop, set point 0 - 100%, pump flow rate totaliser & automatic pump control
- Actuated Valve Control for up to 2 actuated valves to include: open / close time & flow rate totaliser
- 4 - 20 mA Input Monitoring for up to 4 input signals measuring 4 - 20 mA from 0 - 100%
- Data Logging for process monitoring & data export to MS Excel
- ATEX certification and CFR21 compliance options available on request

Coflore® ATR Catalogue

The Coflore® ATR is a modular and easily customisable platform consisting of an Agitating Platform, Control System, Reactor Tube Assembly, Acoustic Cabinet and Accessories.
Coflore® ATR Agitating Platforms

Available as Analogue or Digital versions. ATEX and CFR21 compliance available on request.

Analogue Agitating Platform (ATR-P100)

<table>
<thead>
<tr>
<th>Controls:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agitation: Start/stop</td>
</tr>
<tr>
<td>Agitate rate selection: 2,4,5,6,8,9</td>
</tr>
<tr>
<td>Temperature: 12 thermocouple input, one display</td>
</tr>
<tr>
<td>Size: 1200mm W, 780mm D, 1800mm H (with cabinet)</td>
</tr>
<tr>
<td>Material: 316 Stainless Steel</td>
</tr>
<tr>
<td>Reactor mass: 270 Kg (total assembly)</td>
</tr>
<tr>
<td>Temp. range: -40 to 150° C</td>
</tr>
<tr>
<td>Power: 1ph + N+E 100-240 VAC 50/60 Hz 2A (2P + E + 16A 3 pin plug)</td>
</tr>
<tr>
<td>Compressed air: 10mm push fit connection</td>
</tr>
<tr>
<td>Air consumption: 13 CFM at 7 Bar (g), oil free clean air</td>
</tr>
<tr>
<td>Heat transfer: 1/2” swagelok tube connection. Single zone heat transfer manifold</td>
</tr>
</tbody>
</table>

Digital Agitating Platform (ATR-P200 / ATR-P200-Ex)

<table>
<thead>
<tr>
<th>Controls:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agitation: Start/stop</td>
</tr>
<tr>
<td>Agitate rate selection: 2,3,4,5,6,7,8,9</td>
</tr>
<tr>
<td>Input/output controls:</td>
</tr>
<tr>
<td>10 x thermocouple input, 10 x temperature display, E-stop circuit, 3 x pump control output, 2 x actuated valve control output, 4 x 4-20 mA input 0-100%, 1 x digital input, remote DCS/PLC interface, programmable alarm, data logging, export data to MS Excel, remote control via ethernet, supplied with 5 metre cable for connecting to ATR agitation platform</td>
</tr>
<tr>
<td>Size: 1200mm W, 780mm D, 1800mm H (with cabinet)</td>
</tr>
<tr>
<td>Material: 316 Stainless Steel</td>
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<td>Heat transfer: 1/2” swagelok tube connection. Single zone heat transfer manifold</td>
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</table>

Coflore® ATR Reactor Tubes

Available in sizes 0.35L or 1.25L and materials Hastelloy C276 or 316 Stainless Steel. Up to 8 reactor tubes per agitating platform.

0.35L Reactor Tube (ATR 0.35L-Ha / ATR 0.35L-SS)

| Size: | 22.2mm ID x 870mm L |
| Volume: | 0.35L |
| Wetted material: | Hastelloy C276 & PTFE (ATR 0.35L-Ha) or 316 Stainless Steel & PTFE (ATR 0.35L-SS) |
| Temp. range: | -40 to 150°C |
| Pressure: | Up to 50 Bar |
| Connections: |
| 2 off 1/2” triclover connection per reactor tube end |
| 1 off connection on end cap |
| 1 off vertical connection per end |
| Additional components include: |
| 1 off perforated tube agitator Ø16mm x 865mm L |

Available in Hastelloy C276 or 316 Stainless Steel

1.25L Reactor Tube (ATR 1.25L-Ha / ATR 1.25L-SS)

| Size: | 42.7mm ID x 870mm L |
| Volume: | 1.25L |
| Wetted material: | Hastelloy C276 & PTFE (ATR 1.25L-Ha) or 316 Stainless Steel & PTFE (ATR 1.25L-SS) |
| Temp. range: | -40 to 150°C |
| Pressure: | Up to 50 Bar |
| Connections: |
| 2 off 1/2” triclover connection per reactor tube end |
| 1 off connection on end cap |
| 1 off vertical connection per end |
| Additional components include: |
| 1 off perforated tube agitator Ø27mm x 865mm L |

Available in Hastelloy C276 or 316 Stainless Steel

Available as Analogue or Digital versions. ATEX and CFR21 compliance available on request.
**Coflore® ATR Accessories**

Accessories are available to meet your process requirements.

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**Acoustic Cabinet (ATR-Cabinet)**

Provides noise insulation and protection from moving parts. With fume extract connection and removable window panels for viewing and accessing the reactor tube assembly.

**Size:** 1200mm W, 780mm D, 1800mm H

**Material:** 304 Stainless Steel

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**Thermowell (ATR-TP-Ha / ATR-TP-SS)**

T-type thermocouple calibrated from -40 to 200 °C

**Connections:** 1/2” triclover

**Wetted material:** Hastelloy C276 (ATR-TP-Ha) or 316 Stainless Steel (ATR-TP-SS)

Thermowells incorporate a T-type Thermocouple with miniature plug

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**Inlet / Outlet Hose (ATR-H-2000)**

**Size:** 9.5mm ID x 2000mm PTFE braided hose

**Operating pressure Range:** up to 50 Bar

**Material:** 316 Stainless Steel (non-wetted) & PTFE

**Connections:** 1/2” triclover

Custom sizes available on request

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**¼” BSP Injection Plug (ATR-PLUG-INJ)**

¼” BSP injection plug
For use with 4mm triclover adaptor
Adapts from ¼” BSP to ¼-28 UNF

**Operating pressure range:** up to 10 Bar

**Material:** PTFE, 316 Stainless Steel (non-wetted)

**Connections:** ¼” BSPP male, ¼-28 UNF female

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**Hose Barb Adaptor (ATR-HB-Ha / ATR-HB-SS)**

Adapts from 1/2” triclover to hose barb

**Material:** Hastelloy C276 (ATR-HB-Ha) or 316 Stainless Steel (ATR-HB-SS)

**Connections:** 1/2” triclover, 4.8mm ID hose barb

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**4mm Triclover Adaptor (ATR-BSP4-Ha / ATR-BSP4-SS)**

Adapts 1/2” triclover to 1/4” BSP thread 4mm through hole. Can be used with 1/4” BSP injection plug

**Material:** Hastelloy C276 (ATR-BSP4-Ha) or 316 Stainless Steel (ATR-BSP4-SS)

**Connections:** 1/2” triclover, 1/4” BSP female, 04mm through hole

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**9.5mm Triclover Adaptor (ATR-BSP9.5-Ha / ATR-BSP9.5-SS)**

Adapts 1/2” triclover to 1/4” BSP thread 9.5mm through hole

**Material:** Hastelloy C276 (ATR-BSP9.5-Ha) or 316 Stainless Steel (ATR-BSP9.5-SS)

**Connections:** 1/2” triclover, 1/4” BSP female, 09.5mm through hole

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**Coflore® ATR Tool Kits & Service Kits**

AM Technology recommends periodic maintenance using **Tool kits and Service Kits** to maintain optimum performance of the **Coflore® ATR**.

**ATR Tool Kit (ATR-Tools)**

**Components include:**
- 1 x tool bag
- 1 x allen key set
- 1 x 17mm ratchet spanner
- 2 x 13mm spanners
- 2 x adjustable spanners
- 1 x pliers

**ATR Service Kits**

**(ATR-Service Kit (non-ATEX), ATR-Service Kit-EX (ATEX Zone IICT4))**

**Service and maintenance kit for the ATR**

**Components include:**
- 1 x Solenoid Valve Assembly
- 4 x Pneumatic Actuator
- 4 x Agitation Springs

Some of the agitating platform components have a limited life cycle. The solenoid valve assembly, pneumatic actuator and agitation springs should be replaced according to the following schedule:

- **Infrequent use (less than 1 day per week):**
  Replace at user’s discretion.
- **Frequent use (2-3 days per week):**
  Replace every 12 months
- **Continuous use (5 days per week):**
  Replace every 6 months
- **Continuous use (7 days per week):**
  Replace every 4 months

In the event of the need to replace solenoids, actuators or agitation springs, please contact AM Technology.

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**Coflore® ATR Gaskets & Tube Fittings**

**Gaskets** are used to ensure a tight liquid and gas seal within the end-cap flange of the ATR tube. Available as **Kits** on request. **Tube fittings** are used as process connections.

**1/2” Triclover Gasket (Gk.BS0050.PE)**

PTFE envelope gasket

**Material:** PTFE, Viton (non-wetted)

**For use with:** ATR end caps, ATR interconnections, ATR PTFE hoses

**1” Triclover Gasket (Gk.BS0100.PE)**

PTFE envelope gasket

**Material:** PTFE, Viton (non-wetted)

**For use with:** 0.35L ATR reactor tube

**1 1/2” Triclover Gasket (Gk.BS10.0150.PE)**

PTFE envelope gasket

**Material:** PTFE, Viton (non-wetted)

**For use with:** 1.25L ATR reactor tube

**Soft Tubing Connector**

Soft tubing connectors for use with peristaltic pump tubing and ¼” BSP injection plug (ATR-PLUG-INJ)

**Material:** ETFE

**Connection:** 1/4”-28 UNF male

<table>
<thead>
<tr>
<th>Master flex tubing size</th>
<th>Tubing ID (mm)</th>
<th>Barb size (mm)</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>L/S 13</td>
<td>0.8</td>
<td>1.6</td>
<td>P-646</td>
</tr>
<tr>
<td>L/S 14</td>
<td>1.6</td>
<td>1.6</td>
<td>P-646</td>
</tr>
<tr>
<td>L/S 16</td>
<td>3.1</td>
<td>3.2</td>
<td>P-647</td>
</tr>
<tr>
<td>L/S 25</td>
<td>4.8</td>
<td>4.8</td>
<td>P-648</td>
</tr>
</tbody>
</table>

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Coflore® ATR Tube Fittings

Tube fittings are used as process connections.

### Omnifit Tube Connectors
Omnifit tube connectors for use with PTFE tubing and ¼” BSP injection plug (ATR-PLUG-INJ)

**Material:** Gripper body: PEEK. Ferrule: PTFE

**Connections:** ¼-28 UNF male

<table>
<thead>
<tr>
<th>Tubing size (OD)</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>⅛”</td>
<td>XP-283</td>
</tr>
<tr>
<td>⅛”</td>
<td>XP-335</td>
</tr>
</tbody>
</table>

### Swagelok Tube Connectors
Swagelok tube connectors for use with PTFE/Stainless Steel tubing. For use with 9.5mm triclover adaptor (ATR-BSP9.5)

**Material:** Fitting: 316 Stainless Steel. Washer: Stainless Steel, viton

**Components include:** Compression fitting, bonded washer

<table>
<thead>
<tr>
<th>Tubing size (OD)</th>
<th>Part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>⅛”</td>
<td>SS-200-1-4RP</td>
</tr>
<tr>
<td>⅛”</td>
<td>SS-400-1-4RP</td>
</tr>
</tbody>
</table>

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Coflore® ATR Technical Details

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum reactor mass</strong></td>
<td>120 Kg</td>
</tr>
<tr>
<td><strong>Agitating platform mass</strong></td>
<td>150 Kg</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>&lt; 70 dBA</td>
</tr>
<tr>
<td><strong>Requirements:</strong></td>
<td></td>
</tr>
<tr>
<td>Compressed air</td>
<td>3-7 Bar (g), 13 CFM oil free clean air</td>
</tr>
<tr>
<td>Maximum air pressure</td>
<td>7 Bar (g)</td>
</tr>
<tr>
<td>Power supply</td>
<td>1ph + N+E 100-240 VAC 50/60 Hz 2A</td>
</tr>
<tr>
<td>Compressed air connection</td>
<td>10mm push fit</td>
</tr>
<tr>
<td>Heat transfer fluid connections</td>
<td>⅛” Swagelok</td>
</tr>
</tbody>
</table>

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![ATR Technical Details Diagram](image-url)
The Coflore® Flow Reactor Range

The range of Coflore® Flow Reactors consists of the Agitated Cell Reactor (ACR), Agitated Tube Reactor (ATR) and the Rotating Tube Reactor (RTR). Facilitates laboratory-scale to full industrial-scale chemical production.

The Coflore® ACR is an actively-mixed ten-stage system for efficient mixing and a high degree of orderly flow, irrespective of residence time. The Coflore® ACR is a low volume reactor (30mL to 100mL), which delivers comparable performance to the larger Coflore® ATR/RTR reactors.

The Coflore® ATR is an actively-mixed, multi-stage, tubular reactor (0.35L to 10L reactor volume), achieving efficient mixing with a high degree of orderly flow, irrespective of residence time.

The Coflore® RTR operates as a ten stage, actively-mixed continuous flow reactor with a 100L capacity that is capable of processing theoretically limitless reactor volumes without interruption.

Contact AM Technology

We welcome enquiries from across the globe. If you require more information about our reactors, or to find out whether our reactors are suitable for any applications you have in mind, we would be very interested in hearing from you.

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