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INNOVATIONS

MEGA LAB

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AmAr®

HIGH PRESSURE REACTORS & SYSTEMS

About AMAR

- Serving Industry Since 1974
- 50000 sqft state-of-the-art manufacturing facility
- Largest exporter of pressure & flow reactors in India
- Expertise in custom designing high pressure & flow systems
- Well equipped flow chemistry process developed lab
- Exports to over 50 countries worldwide
- Over 7500 successful installations worldwide
- More than 2500 delighted customers globally
- Manufacturing on CNC/VMC & automated machines
- Unmatched quality & safety standards
- Prompt & efficient after sales service
- Highly skilled & trained team of more than 200 personnel
- ISO, PED, ASME U, CE, CSA, UL, Ex-Proof, ATEX certification

ISO 9001:2015

TÜVNORD

Certificate

Management system as per

ISO 9001:2015

The Certification Body TÜVNORDCERTGmbH. hereby confirms as a result of the audit, assessment and certification decision according to ISO/IEC17021-1:2015that the organization

AMAR EQUIPMENTSPVT. LTD.
Unit No. 544/8, Valson Textile Mills,
LBS Road, Bhandup (West),
Mumbai - 400 078,
Maharashtra,
India

operates a management system in accordance with the requirements of ISO9001 : 2015 and will be assessed for conformity within the 3 year term of validity of the certificate.

Scope

Design, Manufacture and Sale of High-Pressure Autoclaves, Reactors, Vessels and Systems, Continuous Flow Reactors and Systems, Agitated Nutsche Filter Dryer and Heating Cooling Circulators with Related Accessories.

Certificate Registration No. 44 100 094147
Audit Report No. 2.5-4301/2009

Valid from 25.05.2024
Valid until 24.05.2027
Initial certification 25.05.2009

Visit our database to verify the validity of this certificate.

Mumbai, 19.05.2024

Certification Body at TÜVNORDCERTGmbH

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India
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TÜVNORDGROUP

PED

Certificate

Quality-Assurance System
according to directive 2014/68/EU

Certificate no.:	**01 2627 IN/Q-200001.01**
Name and address of the manufacturer:	**Amar Equipments Pvt.Ltd. Valiram Sons, LBS Marg, Near Tank Road, Opp. ICICI Bank, Bhandup(West), Mumbai-400078, India.**
	Herewith we certify that the above -mentioned manufacturer operates a quality system according to the European Directive 2014/68/EU. The manufacturer has the permission to affix the following CE marking to pressure equipment described and manufactured in accordance to the scope covered by this Quality-Assurance System: **CE 2627**
Tested acc. to Directive 2014/68/EU:	**QS-System (Module H1)** (the QS-Modules E1, E, D1, D, H are covered by Module H1)
Audit report no.:	R_01 2627 IN/Q-200001.01
Area of validity:	Design and manufacturer of High pressure Autoclave/Reactors/Pressure vessels, Tubular Reactors/Micro, Reactors & Pilot Plants with assemblies with related pressure and safety accessories, see annex to certificate
Manufacturing plant:	**Amar Equipments Pvt.Ltd. Valiram Sons, LBS Marg, Near Tank Road, Opp. ICICI Bank, Bhandup (West), Mumbai-400078, India.**
Valid until:	The certificate is valid until 20.05.2025. First certification: 21.05.2019 (Notified Body 0035)

Place, 21.05.2022

Ewa Krajewska

TÜV Rheinland Polska Sp. z o.o.
Notified Body for Pressure Equipment, ID-No. 2627
ul. Wolności 347, 41-800 Zabrze, Poland

T8. MS-0045597en Rev.0

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ASME U

The American Society of Mechanical Engineers

CERTIFICATE OF AUTHORIZATION

The named company is authorized by The American Society of Mechanical Engineers (ASME) for the scope of activity shown below in accordance with the applicable rules of the ASME Boiler and Pressure Vessel Code. The use of the ASME Single Certification Mark and the authority granted by this Certificate of Authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with the ASME Single Certification Mark shall have been built strictly in accordance with the provisions of the ASME Boiler and Pressure Vessel Code.

COMPANY:

AMAR EQUIPMENTS PVT. LTD.
Valiram Sons, LBS Marg
Bhandup West
Mumbai, Maharashtra 400078
India

SCOPE:

Manufacture of pressure vessels at the above location and field sites controlled by the above location (This authorization does not cover impregnated graphite)

AUTHORIZED: **April 26, 2023**
EXPIRES: **April 26, 2026**
CERTIFICATE NUMBER: **54313**

Board Chair, Conformity Assessment

Managing Director, Standards & Engineering Services

Pressure Reactors - Vessel Systems

OUR PRODUCTS

Pressure Reactors - Vessel & Systems

Stirred Pressure Autoclaves
Plant Scale Custom Built Pressure Reactors
Parallel Synthesizer | React-7
Glass Autoclaves
Magnetic Drive Couplings / Stirrers
Pressure Vessels
Acid Digestion Bombs / Vessels
Shaker Hydrogenator
Supercritical Fluid Extraction System
HPHT Corrosion Testing System
Gas Hydrate Formation System
Continuous Stirred Tank Reactor

Custom Built Pilot Plants / Skids
Heating Cooling Circulators
Agitated Nutsche Filter & Dryer
Flow Reactors & Systems

SALIENT FEATURES

- Stirred pressure reactors - vessels & systems.
- 25mL to 1,000L volume.
- Material: SS-316L, Hastelloy B/C, Monel, Inconel, Nickel, Titanium, Tantalum lined, Zirconium etc.
- Max. design pressures upto 700 bar & temperatures upto 650 °C.
- Designs as per ASME codes with PED or U stamp marking optional.
- Highly efficient impellers for various applications.
- High torque maintenance free zero leakage magnetic drive coupling.
- Semi / fully automated pilot plant & skids with automatic temperature, pressure, RPM, liquid & gas flow control, distillation setup with pumps, temperature control units & PLC with touch panels & SCADA software for remote monitoring & control.
- Complete flame / explosion proof / ATEX certified systems suitable for zone 1, 2 & gas group IIA, IIB, IIC.
- CE, UL / CSA certified electricals & controls.

APPLICATIONS

- It is used for high-pressure high-temperature chemical reactions like alkylation, amination, bromination, carboxylation, catalytic reduction, chlorination, dehydrogenation, esterification, ethoxylation, halogenation, hydrogenation, methylation, nitration, oxidation, ozonization, polymerization, sulphonation etc.
  - To synthesize new molecules / chemicals & study reaction parameters
  - For synthesis of chemicals in small / pilot / large quantities
  - For quality control & process improvements
  - For high throughput screening
- For supercritical CO_2 extraction / textile dying / particle formation
- For static, dynamic, loop & electrochemical HPHT corrosion testing
- Gas hydrate formation studies
- For hydrogen disbonding test
- Soaking of diamonds / precious stones
- For high pressure storage & transfer of gas / liquid / slurries
- For acid digestion

In R&D centers, pilot plants & manufacturing facilities of fine & speciality chemicals, bulk drug (API) pharmaceuticals, dyes, intermediates, paints, oils, agrochemical, petrochemicals, oil & gas etc. Industries & in chemical engineering colleges / research institutes / defence organisations where high pressure reactions / testing is carried out.

AmAr FLOW LABORATORY

Flow Chemistry Process Development Lab

INDEX

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- Hastelloy is registered trademark of Haynes International

Abbreviations used in the catalogue

- QRC: Quick release coupling
- Temp.: Temperature
- Ø: Phase
- NRV: Non-return valve
- FLP: Flame proof / Explosion proof
- NA: Not applicable / not available
- MOC: Material of construction
- Pr.: Pressure
- L: Litre

All volumes mentioned are net filling unless specified.
As development is a continuous process, the specifications in the catalogue can change without prior notice.
Accessories shown in the images may not be part of standard supply.
Customization of volume, material, pressure, temperature etc. may be possible on request.

Autoclaves | 100mL & 250mL

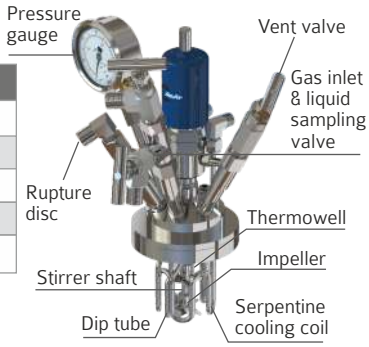
100mL assembly

250mL assembly

100mL
table top autoclave

250mL trolley autoclave

Nozzle orientation & internal fittings



STANDARD MODELS FOR 100mL VOLUME

Model	A1313	A1315	A1323	A1325
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	40			
Vessel Internal Height (mm)	83			
Min. Stirrable Volume (mL)	20			

STANDARD MODELS FOR 250mL VOLUME

Model	A1413	A1415	A1423	A1425	A1433	A1435
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	65				62	
Vessel Internal Height (mm)	80				80	
Min. Stirrable Volume (mL)	50				50	

TECHNICAL SPECIFICATIONS FOR 100mL & 250mL STANDARD MODELS

Description	Specification
Material of Construction	SS 316L wetted parts
Head Mounting Style	Removable head and vessel design
Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C
Motor	¼ hp AC motor / ¼ hp ex-proof gas group IIB motor (zone 1) with 100-1450 RPM
Shaft Sealing	Zero leakage magnetic drive coupling M8 with 0.8 Nm torque
Stirrer	4 bladed turbine stirrer
Standard Nozzles, Valves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve on common dip tube, vent needle valve, solenoid valve at inlet of cooling coil (All needle valves ¼" NPTM) **Internal Fittings:** Single tube-in & tube-out coil (for 100mL), serpentine cooling coil (for 250mL), dip tube, thermowell with RTD PT100 temperature sensor
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C
Closure Type	Split clamp with clamp bolts
Control Panel	With programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control, motor RPM, power & current indication
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz

Mounting & Dimensions (W x D x H) mm	Table Top		Trolley	Trolley model shall include water pump & 10L tank to cool the magnetic drive
	Reactor	Control panel		
	275 x 275 x 800	275 x 300 x 250	1010 x 410 x 1300	

Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.

Refer page no. 16 to 21 for options of standard models & page no. 49 to 53 for optional accessories

Autoclaves | 500mL, 750mL & 1000mL

500mL assembly

750mL assembly

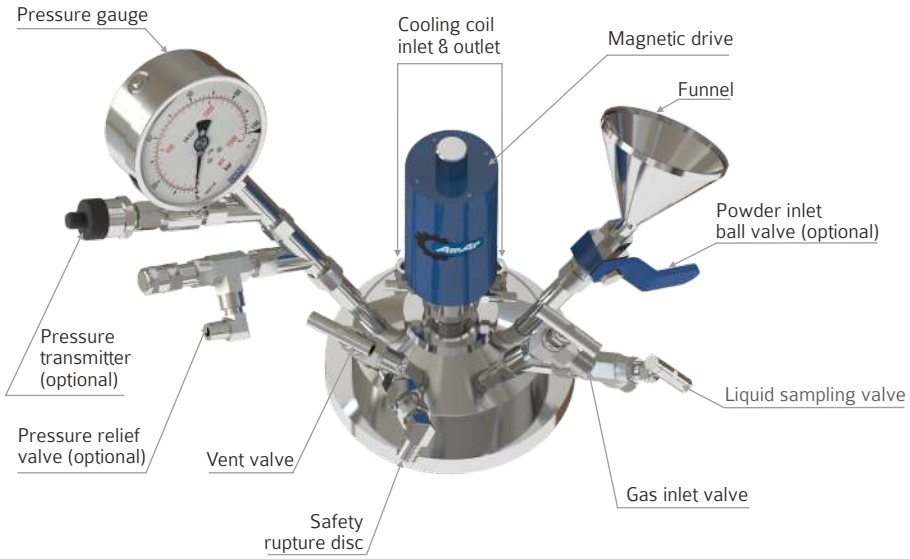
1,000mL assembly

500mL table top autoclave

750mL table top autoclave

1000mL trolley autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS



Autoclaves | 500mL, 750mL & 1000mL

STANDARD MODELS FOR 500mL AUTOCLAVE

Model	A2113	A2115	A2123	A2125
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	75			
Vessel Internal Height (mm)	118			
Min. Stirrable Volume (mL)	85			

STANDARD MODELS FOR 750mL AUTOCLAVE

Model	A2213	A2215	A2223	A2225	A2233	A2235
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	75				74	
Vessel Internal Height (mm)	193				193	
Min. Stirrable Volume (mL)	85				85	

STANDARD MODELS FOR 1000mL AUTOCLAVE

Model	A2313	A2315
Design Pressure	100 bar	
Design Temperature	300°C	500°C
Vessel I/D (mm)	101.6	
Vessel Internal Height (mm)	163	
Min. Stirrable Volume (mL)	130	

TECHNICAL SPECIFICATIONS FOR 500mL, 750mL & 1000mL STANDARD MODELS

Description	Specification		
Material of Construction	SS 316L wetted parts		
Head Mounting Style	Removable head and vessel design		
Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C		
Motor	¼ hp AC motor / ¼ hp ex-proof gas group IIB motor (zone 1) with 100-1450 RPM		
Shaft Sealing	Zero leakage magnetic drive coupling M40 with 4 Nm torque		
Stirrer	2 stage 6 bladed turbine stirrer		
Standard Nozzles, Valves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve on common dip tube, vent needle valve (all needle valves are ¼" NPTM) **Internal Fittings:** Helical cooling coil, dip tube, thermowell with RTD PT 100 temperature sensor		
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C		
Closure Type	Split clamp with clamp bolts		
Auto-cooling System[1]	With water pump for forced cooling, SS tank & hose pipes for temperature control		
Water Pump & 10L Tank[1]	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.		
Control Panel	With programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control, motor RPM, power & current indication		
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz		
Mounting & Dimensions (W x D x H) mm	Table top		Trolley
	Reactor	Panel	
	400 x 400 x 925	275 x 300 x 250	1010 x 410 x 1350

[1] Only for trolley model

Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.

Refer page no. 16 to 21 for options of standard models & page no. 49 to 53 for optional accessories

Autoclaves | 2L & 5L

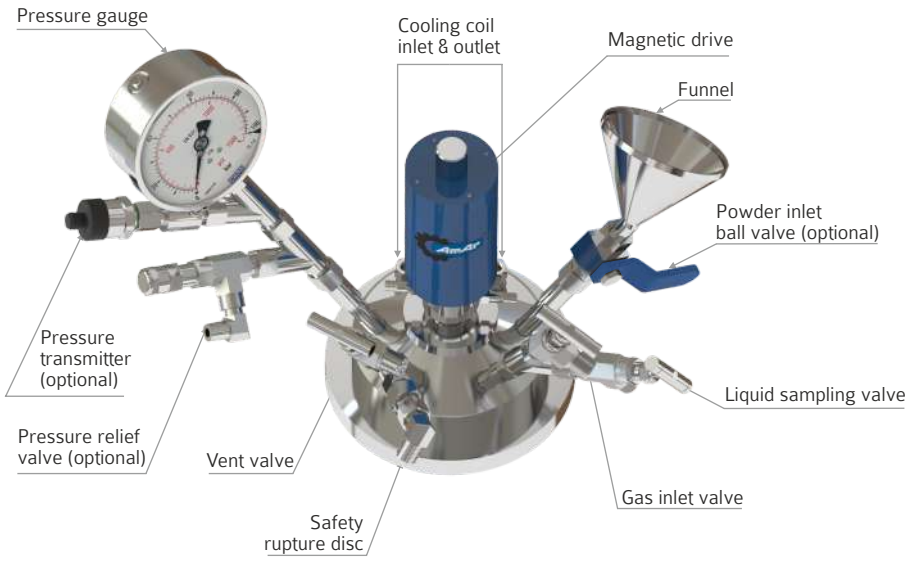
2L trolley autoclave

2L assembly

5L assembly

5L trolley autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS



Autoclaves | 2L & 5L

STANDARD MODELS FOR 2L AUTOCLAVE

Model	A2413	A2415	A2423	A2425	A2433	A2435
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	101.6		94		90	
Vessel Internal Height (mm)	303		303		315	
Min. Stirrable Volume (mL)	130		110		155	

STANDARD MODELS FOR 5L AUTOCLAVE

Model	A2513	A2515	A2523	A2525	A2533	A2535
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	149		134		134	
Vessel Internal Height (mm)	310		360		360	
Min. Stirrable Volume (mL)	360					

TECHNICAL SPECIFICATIONS FOR 2L & 5L STANDARD MODELS

Description	Specification
Material of Construction	SS 316L wetted parts
Head Mounting Style	Removable head and vessel design
Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C
Motor	¼ hp AC motor / ¼ hp ex-proof gas group IIB motor (zone 1) with 100-1450 RPM
Shaft Sealing	Zero leakage magnetic drive coupling M40 with 4 Nm torque
Stirrer	2 stage 6 bladed turbine stirrer
Standard Nozzles, Valves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve on common dip tube, vent needle valve (all needle valves are ¼" NPTM), 10 mm flush bottom valve (for 5 ltr autoclave) **Internal Fittings:** Helical cooling coil*, dip tube, thermowell with RTD PT 100 temperature sensor
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C
Closure Type	Split clamp with clamp bolts
Auto-cooling System	With water pump for forced cooling, SS tank & hose pipes for temperature control.
Water Pump & 10L Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.
Control Panel	With programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control, motor RPM, power & current indication
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz
Mounting & Dimensions (W x D x H) mm	Reactor volume: 2L — Trolley: 1040 x 410 x 1350 Reactor volume: 5L — Trolley: 1100 x 410 x 1350

* Serpentine cooling coil for 2L 200 & 350 bar model

Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.

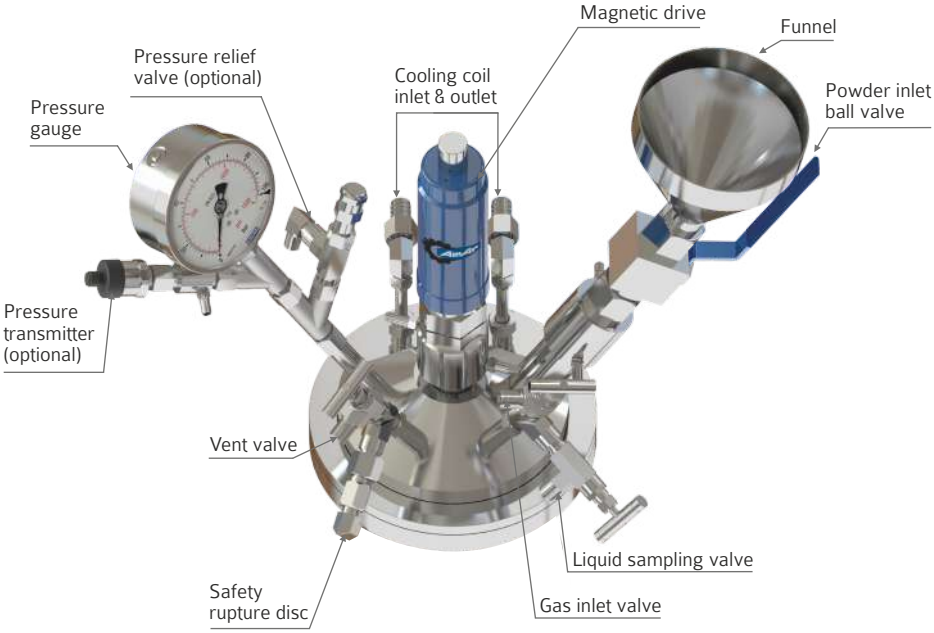
Refer page no. 16 to 21 for options of standard models & page no. 49 to 53 for optional accessories

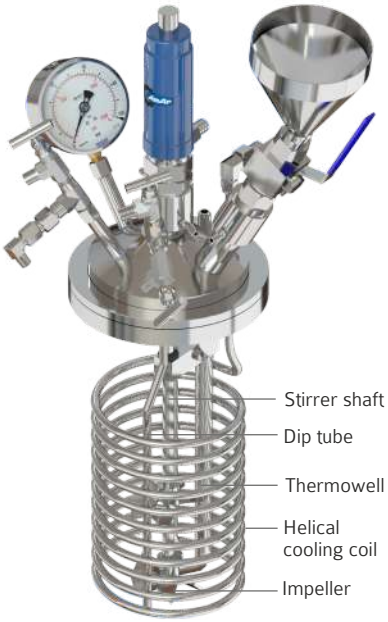
Autoclaves | 10L & 25L

10L autoclave

25L autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS





Autoclaves | 10L & 25L

STANDARD MODELS FOR 10L VOLUME

Model	A3113	A3115	A3123	A3125	A3133	A3135
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	185					
Vessel Internal Height (mm)	420					
Min. Stirrable Volume (L)	1					

STANDARD MODELS FOR 25L VOLUME

Model	A3313	A3315	A3323	A3325
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	243			
Vessel Internal Height (mm)	595			
Min. Stirrable Volume (L)	2.6			

TECHNICAL SPECIFICATIONS FOR 10L & 25L STANDARD MODELS

Description	Specification
Material of Construction	SS 316L wetted parts
Head Mounting Style	Removable head and vessel design
Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C
Motor	½ hp AC motor / ½ hp ex-proof gas group IIB motor (zone 1) locked to 750 RPM
Shaft Sealing	Zero leakage magnetic drive coupling M80 with 8 Nm torque
Stirrer	2 stage 6 bladed turbine stirrer
Standard Nozzles, Valves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve on common dip tube, vent needle valve, ball valve for powder/ liquid inlet with funnel, flush bottom valve
	Needle valve: ¼" NPTM; Ball Valve: ¾" NPTM; Flush Bottom Valve: 15 mm
	Internal Fittings: Helical cooling coil, dip tube, thermowell with RTD PT100 temperature sensor, baffles
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C
Closure Type	Split clamp with clamp bolts
Auto-cooling System	With water pump for forced cooling, SS tank & hose pipes for temperature control.
Water Pump & 10L Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.
Lifting Arrangement	Mechanical chain pulley arrangement for lifting the head, vessel etc.
Control Panel	With programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control, motor RPM, power & current indication
Power Supply	3 Ø, 440 V AC, 25 Amp, 50 / 60 Hz
Mounting & Dimensions (W x D x H) mm	Reactor Volume: 10L — Trolley: 1310 x 760 x 2300; Reactor Volume: 25L — Trolley: 1310 x 760 x 2550

Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.

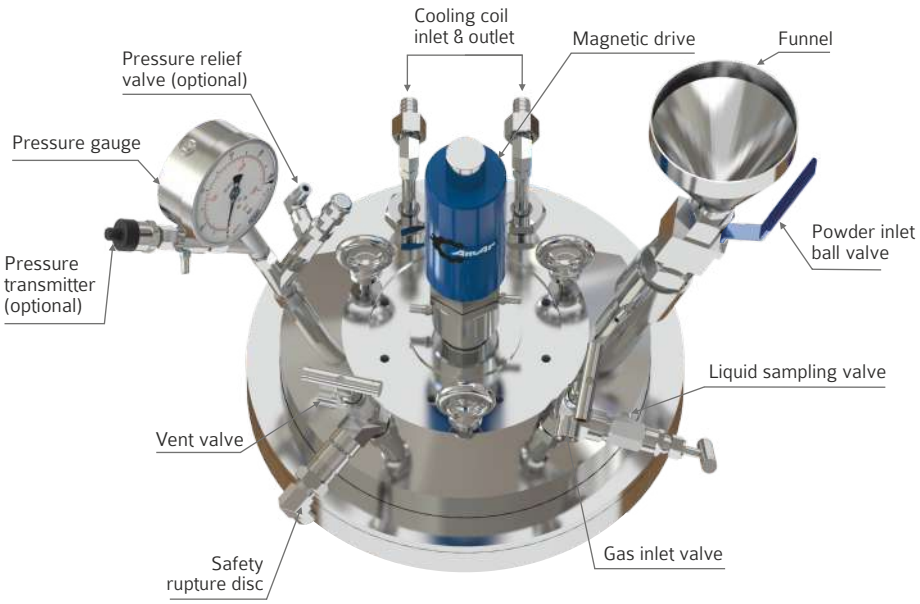
Refer page no. 16 to 21 for options of standard models & page no. 49 to 53 for optional accessories

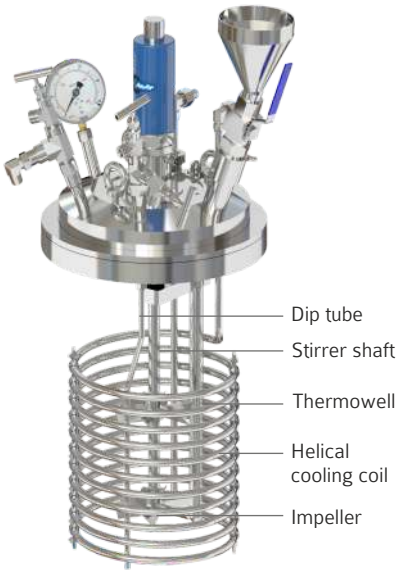
Autoclaves | 50L & 100L

50L autoclave

100L autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS





Autoclaves | 50L & 100L

STANDARD MODELS FOR 50L VOLUME

Model	A3403	A3405	A3413	A3415
Design Pressure	50 bar		100 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	355		343	
Vessel Internal Height (mm)	558		600	
Min. Stirrable Volume (L)	6			

STANDARD MODELS FOR 100L VOLUME

Model	A3503	A3505	A3513	A3515
Design Pressure	50 bar		100 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	456		440	
Vessel Internal Height (mm)	699		735	
Min. Stirrable Volume (L)	12			

TECHNICAL SPECIFICATIONS FOR 50L & 100L STANDARD MODELS

Description	Specification
Material of Construction	SS 316L wetted parts
Head Mounting Style	Removable head and vessel design
Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C
Motor	1 hp AC motor / 1 hp ex-proof gas group IIB motor (zone 1) with gear box up to 440 RPM
Shaft Sealing	Zero leakage magnetic drive coupling M120 with 12 Nm torque
Stirrer	2 stage 6 bladed turbine stirrer
Standard Nozzles, alves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve on common dip tube, vent needle valve, ball valve for powder/ liquid inlet with funnel, flush bottom valve
	Needle valve: ½" NPTM; Ball Valve: 1" NPTM; Flush Bottom Valve: 25 mm
	Internal Fittings: Helical cooling coil, dip tube, thermowell with RTD PT100 temperature sensor, baffles
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C
Closure Type	Split clamp with clamp bolts
Auto-cooling System	With water pump for forced cooling, SS tank & hose pipes for temperature control.
Water Pump & 10L Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.
Lifting Arrangement	Mechanical chain pulley arrangement for lifting the head, vessel etc.
Control Panel	With programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control, motor RPM, power & current indication
Power Supply	3 Ø, 440 V AC, 25 Amp, 50 / 60 Hz
Mounting & Dimensions (W x D x H) mm	Reactor Volume: 50L — Trolley: 1500 x 850 x 3200; Reactor Volume: 100L — Trolley: 1500 x 955 x 3400

Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.

Refer page no. 16 to 21 for options of standard models & page no. 49 to 53 for optional accessories

Parallel Synthesizer

For high throughput screening with automation

SALIENT FEATURES

- 4 or 6 nos. of 100mL to 2L parallel overhead stirred autoclaves.
- Common mounting & control panel with remote monitoring & control.
- Pressures up to 350 bar & temperatures up to 500°C.
- Simultaneous reactions can be carried out in each reactor with different parameters, comparative studies can be done from the data received. It saves lot of space & helps in advanced & faster research i.e. high throughput screening.
- Touch panel, PLC & SCADA software for recipe management, remote set points, control & recording of temperature, pressure, speed control, H_2 gas flow rates, total H_2 consumed, liquid flow rates with batch reports & online / history graphs.
- Optional accessories can be common or separate for all autoclaves.

MODELS

VOLUME	100 bar		200 bar		350 bar	
	300 °C	500 °C	300 °C	500 °C	300 °C	500 °C
100mL	A1313	A1315	A1323	A1325	-	-
250mL	A1413	A1415	A1423	A1425	A1433	A1435
500mL	A2113	A2115	A2123	A2125	-	-
750mL	A2213	A2215	A2223	A2225	A2233	A2235
1L	A2313	A2315	-	-	-	-
2L	A2413	A2415	A2423	A2425	A2433	A2435

Note: Prefix the above model nos. with M4 or M6 for 4 nos. or 6 nos. reactors

Refer page 5 to 9 for each autoclave specifications.

REACT-7

SALIENT FEATURES

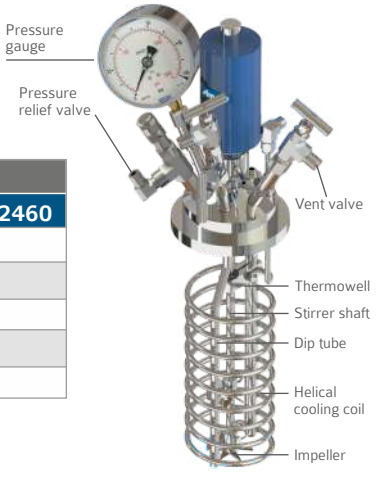
- 7 parallel reactors of 25mL volume each with common bottom stirring, heating & independent lid, valve & pressures.
- Design pressure of 100 bar at 200°C
- Maximum stirring speed 1000 RPM
- Material: SS 316, Hastelloy C & glass.
- Very compact & economical system
- Ideal for high throughput screening
- Mounting: Table top
- Dimensions: 350 mm (W) x 350 mm (D) x 500 mm (H)

Glass Autoclaves

500mL bottom heated glass autoclave

2L Jacketed glass autoclave with temperature control unit

Nozzle orientation & internal fittings



STANDARD MODELS FOR GLASS AUTOCLAVES

Volume	500mL	1L		2L
Model *	G2160 / GJ2160	G2360 / GJ2360	GJ2370	G2460 / GJ2460
Design Pressure	6 bar	6 bar	10 bar	6 bar
Design Temperature	150°C with bottom heating & 200°C in Jacketed vessel			
Vessel I/D (mm)	75		101.6	
Vessel Internal Height (mm)	118	163		303
Min. Stirrable Volume (mL)	60		130	

*Suffix J stands for Jacket model.

Internal wetted parts of SS 316, Hastelloy C, Inconel, etc.

Options for Standard Models

Inquiry guide for customised models

Inquiry code structure is **A-B-C-D-E-F-G-H-I-J-K** where A, B, C, D, E, F, G, H, I, J, K can be selected from the below tables. For example 500mL, 100 bar, 300 °C, Hastelloy C276, manual fixed head & electrical ex-proof heater, motor & panel will read as **A2113-H6-K-EA-XC-F2C**.

A. STANDARD MODELS

VOLUME	50 bar		100 bar		200 bar		350 bar	
	300 °C	500 °C	300 °C	500 °C	300 °C	500 °C	300 °C	500 °C
100mL	-	-	A1313	A1315	A1323	A1325	-	-
250mL	-	-	A1413	A1415	A1423	A1425	A1433	A1435
500mL	-	-	A2113	A2115	A2123	A2125	-	-
750mL	-	-	A2213	A2215	A2223	A2225	A2233	A2235
1L	-	-	A2313	A2315	-	-	-	-
2L	-	-	A2413	A2415	A2423	A2425	A2433	A2435
5L	-	-	A2513	A2515	A2523	A2525	A2533	A2535
10L	-	-	A3113	A3115	A3123	A3125	A3133	A3135
25L	-	-	A3313	A3315	A3323	A3325	-	-
50L	A3403	A3405	A3413	A3415	A3423	-	-	-
100L	A3503	A3505	A3513	A3515	A3523	-	-	-

B. MATERIAL OF CONSTRUCTION

Reactor vessels of material SS316L, up to 5L are machined from rolled / forged bar stock & reactors above 5L are normally fabricated from plates. SS316L autoclaves up to 100L have lids made from rolled / forged bar stock. All wetted parts are made from SS-316L as standard.

Note: Amar tries to offer all the internal & optionally external wetted parts in the same material of construction as that of body & head to give fully corrosion resistant autoclaves.

Other Material options	Hastelloy C276	Hastelloy C22	Hastelloy B	Monel 400	Inconel 600	Inconel 625	Nickel 200	Titanium Gr.2	Zirconium 702	Tantalum lined
Code	H6	H2	HB	M4	I0	I6	N2	T2	Zi	TN
100mL to 100L	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

General corrosion properties of some metals & alloys:

RATINGS

0. Unsuitable 1. Poor to fair 2. Fair 3. Fair to good 4. Good 5. Good to excellent 6. Normally excellent

Small variations in service condition may appreciably affect corrosion. Therefore whenever possible, material choice is guided by a combination of experience and laboratory site tests.

Materials	Non-oxidizing or reducing media				Liquids			Gases				Max. design temp. in °C
	Acid solutions, excluding hydrochloric, Phosphoric, sulfuric, (most condition many organics)	Neutral solutions, e.g. many Non-oxidizing salt solutions, chlorides, sulfates	Alkaline solutions e.g. Caustic and mild alkalies, excluding ammonium hydroxide	Alkaline solutions e.g. Ammonium hydroxide and amines	Oxidizing Media: Acid solutions, e.g. nitirc	Oxidizing Media: Neutral or alkaline solutions e.g. per sulfates, peroxides, chromates	Oxidizing Media: Pitting media, acid ferric chloride solutions	Halogen and derivatives: Halogen: Moist, e.g., chlorine below dew point	Halogen and derivatives: Halogen: Dry, e.g. fluorine above dew point	Halogen and derivatives: Halide acids, moist, e.g. hydrochloric hydrolysis products of organic halides	Halogen and derivatives: Hydrogen halides, dry, e.g., dry, Hydrogen chloride	
Stainless Steel, (SS 316)	4	5	5	6	5	6	1	0	3	2	4<220°C 3<400°C	600
Hastelloy C 276	5	6	5	6	4	6	5	5	4	4	4<400°C 3<480°C	600
Hastelloy B	6	5	4	4	0	3	0	1	3	5	4<400°C 3<480°C	427
Inconel 600 / 625	3	6	6	6	3	6	1	2	5	3	5<220°C 4<480°C	475 / 600
Monel 400	5	6	6	1	0	5	1	2	6	3	6<220°C 3<400°C 2<480°C	450
Nickel 200-commercial	4	5	6	1	0	5	0	2	6	2	6<220°C 5<400°C 4<480°C	316
Titanium	3	6	2	6	6	6	6	6	0	1	0	316
Zirconium 702	3	6	2	6	6	6	2	6	1	6	0	371

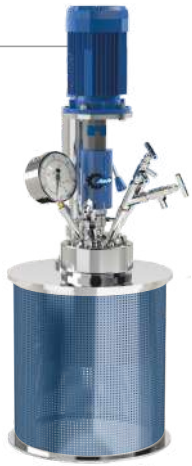
- The above table is just for reference. Customers are advised to carry out their own tests with sample coupons under desired working conditions.
- From perry, chemical engineer's handbook

Options for Standard Models

C. HEAD MOUNTING STYLE

Removable head design

This is the most commonly used option & available for all sizes of autoclaves. Here the body rests on the stand / trolley & the head is lifted for charging, discharging & cleaning. The vessel can be removed for charging / discharging / cleaning. This option is more common as the head & vessel can be taken out easily for pressure testing, fitting accessories, servicing etc. The head can be lifted & lowered by chain pulley arrangement for autoclaves above 5L volume.



1L autoclave with removable head design

Optional:

a) Fixed head design with raising & lowering

In this system, the head of the autoclave is fixed with motor stand & the vessel & heater are raised & lowered manually by scissor lift for 100mL to 750mL, pneumatically for 1L to 25L & hydraulically for 50L & 100L. This system is useful when head of the autoclave has many fittings & accessories, making it difficult to lift the head & detach all the fittings after every batch. Further, removing the heater for faster cooling & ease of lifting or lowering the vessel is advantageous.

100mL with manual vessel raising lowering

10L with pneumatic vessel raising lowering

50L with hydraulic vessel raising lowering

b) Fixed head design with raising, lowering & tilting

In this system, head of the autoclave is fixed while a pneumatic or hydraulic lift allows the vessel (with heater) to be raised & lowered. When lowered, the vessel can be tilted. This system is very useful where a vessel needs cleaning after every batch & for highly viscous material to discharge them easily just by tilting.

2L autoclave with raising lowering & tilting

Type	Fixed head with manual vessel lifting	Fixed head with pneumatic vessel lifting	Fixed head with pneumatic vessel lifting & tilting	Fixed head with hydraulic vessel lifting	Fixed head with hydraulic vessel lifting & tilting
Code	**K**	**P**	**PT**	**H**	**HT**
100mL	✓	-	-	-	-
250mL	✓	-	-	-	-
500mL	✓	-	-	-	-
750mL	✓	-	-	-	-
1L	-	✓	✓	-	-
2L	-	✓	✓	-	-
5L	-	✓	✓	-	-
10L	-	✓	✓	-	-
25L	-	✓	✓	-	-
50L	-	-	-	✓	✓
100L	-	-	-	✓	✓

Options for Standard Models

D. HEATING TYPES

Electrical ceramic band heater with ceramic wool insulation & cladding.

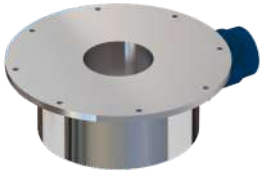
Optional:

a) Flameproof (FLP) / explosion proof IIB + H_2 certified, aluminium cast Heater (temperature up to 200 °C) for H_2 gas with totally enclosed heating element inside metal tube. Heating rates are lower in FLP heaters in comparison to ceramic band heaters

b) SS-304 jacket for oil / steam heating with insulation & cladding .

Note: Optionally external heater temperature thermocouple is provided with the cascade temperature control to ensure safety of heater, vessel & accurate temperature control. It is a standard feature in aluminum cast heaters.

Type	Ex-proof electrical heater	SS304 Jacket with insulation
Code	EA	JS
100mL	✓	✓
250mL	✓	✓
500mL	✓	✓
750mL	✓	✓
1L	✓	✓
2L	✓	✓
5L	✓	✓
10L	✓	✓
25L	✓	✓
50L	-	✓
100L	-	✓



(a)

(b)

E. MOTOR & DRIVE

Top mounted AC motor

Non flameproof CE marked or Flameproof (FLP) / Explosion proof AC motor (for Group IIA/ IIB gases) suitable in hazardous area for all flammable liquids / gases except hydrogen & acetylene with variable frequency drive & stirrer RPM indication is provided as standard. The motor is coupled to the magnetic drive directly by specially designed coupling ensuring quick engagement & disengagement of motor from autoclave head. The direct coupling eliminates pulleys, belts & minimizes transmission losses, noise, vibrations & maintenance. The frequency drive can indicate motor current & power (on selection). This is useful to monitor the change in viscosity of the liquid under stirring. The frequency drive is mounted on a common control panel. It has the facility to trip the motor on any overload, over voltage or over current.

RPM Range: 100 - 1450

Motor options:

- Flameproof AC motor for gas group IIC, ideal for H_2 gas
- Ex-proof CE ATEX* zone 1 / CSA* certified
- Motors with gear box can be offered for stirring highly viscous material at low rpm (50 - 440 RPM)
- Motors with 2900 RPM for stirring at high speeds

IIC FLP motor / ATEX motor

AC motor

Motor with gear box

IIA, IIB FLP motor

Compact inline motor drive

Compact inline brushless DC motor & magnetic drive & speed controller with indicator for 300-1200 RPM for 100mL to 750mL autoclaves. Very compact, economical & light weight. No external rotating part.

D1. Motor type options

Type	Compact inline motor	Ex-proof gas group IIC (zone 1)	Ex-proof CE ATEX certified*	Ex-proof CSA certified**
Code	BD	XC	AZ	CD
100mL	✓	✓	✓	✓
250mL	✓	✓	✓	✓
500mL	✓	✓	✓	✓
750mL	✓	✓	✓	✓
1L	-	✓	✓	✓
2L	-	✓	✓	✓
5L	-	✓	✓	✓
10L	-	✓	✓	✓
25L	-	✓	✓	✓
50L	-	✓	✓	✓
100L	-	✓	✓	✓

*ATEX II 2G Ex de IIC T4

**CSA class 1 DIV 2 group A, B, C, D

Options for Standard Models

D2. Motor RPM options

Type	Upto 2900 RPM	Gear box for 440 RPM
Code	**RT**	**R4**
100mL	✓	-
250mL	✓	-
500mL	✓	✓
750mL	✓	✓
1L	✓	✓
2L	✓	✓
5L	✓	✓
10L	-	✓
25L	-	✓
50L	-	✓*
100L	-	✓*

✓* Standard fitting

Autoclave with inline motor

F. VALVES & FITTINGS

Pressure gauge, vent needle valve, safety rupture disc (rated to rupture at MAWP), internal cooling coil, thermowell (with RTD-PT-100 temperature sensor), gas inlet & liquid sampling needle valves with a common dip tube (sparger) upto the bottom.

Optional:

a) Ball valve with funnel for powder / slurry / liquid inlet. These valves are 1/4"- 2" size & depending on autoclave volume they can be used to charge solids or liquid slurry at atmospheric pressure or higher, provided a high pressure liquid charging pot is also ordered.

b) Flush bottom valve with almost zero dead volume (optionally additional ball valve at the outlet of flush bottom valve can be provided).

c) Serpentine cooling coil instead of helical for easy cleaning (500mL to 100L)

d) Removable internal baffles for better stirring (cooling coil has to be removed up to 5L autoclave)

e) Pressure safety valve

(a)

(b)

(c)

(d)

(e)

Type	Serpentine cooling coil	Ball valve with funnel for powder inlet	Flush bottom valve	Baffles	Pressure safety valve
Code	**SCC**	**BVP**	**FBV**	**BFL**	**PSV**
100mL	-	-	-	-	✓
250mL	✓*	-	-	-	✓
500mL	✓	✓	✓	✓	✓
750mL	✓	✓	✓	✓	✓
1L	✓	✓	✓	✓	✓
2L	✓	✓	✓	✓	✓
5L	✓	✓	✓*	✓	✓
10L	✓	✓*	✓*	✓*	✓
25L	✓	✓*	✓*	✓*	✓
50L	✓	✓*	✓*	✓*	✓
100L	✓	✓*	✓*	✓*	✓

✓* Standard fitting

All options specified above are addons & multiple / all of them can be availed at the same time.

Options for Standard Models

G. STIRRER OPTIONS

Single or two stage, 4/6 bladed pitch blade turbine type impeller

Optional:

a) Hollow shaft for high mass transfer for any gas-liquid reaction.

b) Anchor / gate anchor for viscous liquids up to 60 RPM.

c) Helix / double helix for highly viscous material for inside-outside & upside-down mixing up to 60 rpm.

Note: 1) Gear box has to be provided & cooling coil has to be removed & plugged for (b) & (c).

2) Higher hp motor & high torque magnetic drive could be recommended for (b) & (c)

(a)

(b)

(c)

Type	Hollow shaft with gas induction impeller	Anchor impeller	Helix / double helix impeller
Code	**SH**	**SA**	**SS / DS**
100mL	✓	-	-
250mL	✓	-	-
500mL	✓	✓	✓
750mL	✓	✓	✓
1L	✓	✓	✓
2L	✓	✓	✓
5L	✓	✓	✓
10L	✓	✓	✓
25L	✓	✓	✓
50L	✓	✓	✓
100L	✓	✓	✓

H. CONTROL PANEL

Compact control panel with programmable PID temperature controller cum indicator, high temperature alarm, safety alarm & heater trip system for malfunctioning of controller / sensor / temperature rise beyond set limit. The motor speed drive is mounted on the same panel for stirred autoclaves. Motor, heater, cooling / solenoid valve / pump / sensors etc. utilities are connected to panel by simple plug & socket arrangement. The panel is very easy to open & all internal components are plug socket type, making replacement easy. Digital pressure indicator / controller, flow indicator, flow totaliser, motor current / power indicator, heater temperature cascade controller etc. indicators are provided additionally on same common control panel depending on the optional accessories selected.

Touch panel

Optional:

a) Complete ex-proof - flame proof (FLP) Group IIA/IIB or IIC, zone 1 certified control panels mounted on trolley.

Note: FLP panels should be opted only if the heater & motors are FLP and area is totally ex-proof as FLP panels are too bulky & inconvenient for operation & maintenance.

b) 7"/10" high resolution touch screen panel with SCADA software for single or multiple autoclaves.

c) PLC based control panel with touch panel HMI or remote SCADA software & PC control.

d) Panels with RS 485 port for remote PC communication through SCADA software with local display.

e) CE, UL / CSA marked control panels can be supplied on request.

f) Customised power supply can be offered on request.

Ex-proof group IIC certified (available for autoclaves up to 100L)	F2C
Touch screen panel (available for autoclaves up to 100L)	TSP

1Ø panel

3Ø panel

FLP panel

PLC panel

Options for Standard Models

I. MOUNTING ARRANGEMENT

Trolley & table top

Complete autoclave with motor drive assembly is mounted on easily movable SS-304 trolley with 4 nos. lockable wheels & the trolley top is big enough to mount the optional accessories & the control panel. Table / bench top model is for keeping the autoclave on platform. Table top mounting is offered for sizes from 100mL to 1L only. In table top model the panel & accessories have to be mounted separately.

Table top (for autoclaves up to 1000mL)	TT
Trolley (for autoclaves of all sizes)	TL

500mL table top autoclave

2L trolley autoclave

J. CERTIFICATIONS

PED 2014 / 68 / EU for pressure vessels or ASME U stamp for pressure vessels	PED ASU
CE marked panel & electrical parts or UL / CSA marked panel & electrical parts	ECE USC
ATEX certified electricals	ATP
ATEX certified system as per 2014 / 34 / EU	ATM

Country specific certifications like CRN for Canada, AS1210 for Australia & DOSH for Malaysia can be offered on request.

Magnetic Drive Coupling & Mixers

SALIENT FEATURES

- Suitable for full vacuum up to 700 bar pressure & 500 °C temperature
- Magnetic drive couplings, mixers & agitators available for 100mL - 10,000L reactors
- High torque magnetic drive from 0.8 to 1000 Nm
- Materials of SS316, Hastelloy C, inconel for resistance to various chemicals
- Compact inline motor & magnetic couplings MM series with speed controller
- Very useful for long or round the clock reactions as in gland/mechanical sealing if there is any leakage midway, the whole batch may go waste
- Zero leakage implies zero breakdown & zero maintenance, hence large saving in maintenance costs for years
- Safe while using toxic & hazardous chemicals as its leakage is totally prevented

M-Series

TECHNICAL SPECIFICATIONS

Model No.*	Static torque capacity		For reactor volume	
	Kg-cm.	N-m.	Standard	Optional
M08 / MM08	8	0.8	100mL - 250mL	–
M20 / MM20	20	2	-	500mL - 1L
M40	40	4	500mL - 5L	-
M80	80	8	10 - 25L	500mL - 5L
M120	120	12	50 - 100L	10L - 25L
M200	200	20	100L - 10,000L up to 30 hp motor & 300 RPM	
M400	400	40		
M600	600	60		
M1200	1200	120		
M2400	2400	240		
M4800	4800	480		
M6000	6000	600		
M9600	9600	960		

MM-Series

Note:
a) The number after the series indicates the static torque capacity in kg-cm
b) Pressure ratings of the magnetic drives are equal to or higher than reactor pressure ratings
c) Magnetic drives of higher torque capacity for reactors of any make can be designed on request. Drives with torque higher / lower than recommended can be used for particular reactor size depending on motor hp / viscosities / stirrer design etc.
***M-series:** Magnetic drive for metal autoclaves / reactors
***MM-series:** Inline motor & magnetic drive for metal autoclaves / reactors

Plant Scale Pressure Reactors

250L 100 bar reactor
with automated valves

1000L gas induction reactor

500L reactor

SALIENT FEATURES

- 100L to 1,000L (working) volumes
- Materials SS-316L, Hastelloy B/C, Monel, Inconel, Nickel, Titanium, Zirconium etc.
- Design pressures upto 100 bar (1450 psi)
- Maximum working temperatures upto 350 °C
- High torque zero leakage magnetic drive coupling
- High mass transfer hollow shaft with gas induction impeller (ideal for hydrogenation, oxidation, ammination, chlorination, bromination & other gas-liquid reactions) pitch blade turbine, anchor etc. for other applications
- Custom built skid mounted pilot plant with accessories & automation
- All designs as per ASME codes
- 'U' stamp coded, PED certified reactors can be offered on request
- CE-ATEX / UL / CSA certified systems offered
- Jacketed or single / double limpet coil with insulation & cladding
- Upto 440 rpm infinite variable speed with suitable gear box
- Body flanges with bolts & gaskets or monoblock design without body flange, offered depending on pressures & volume
- Internal cooling coil, vent, liquid / powder charging, dip tube, thermowell, safety rupture disc, pressure safety valve, flush bottom outlet, baffles, light & sight glass, handhole / manhole etc. nozzles, manual / automated valves, fittings, ex-proof control panel & accessories offered based on requirement
- Suitable catalyst filtration & recycling system offered for hydrogenation (refer page 52)
- Suitable catch pot & flame arrester to collect the vent (refer page 53)
- Lugs or floor stand skid mounted structure in MS or SS

For other optional accessories refer page 49 to 53.

400L Hastelloy reactor with
continuous recirculation system

Custom Built Pressure Reactors

300L reactor with
hydraulic lifting arrangement

150L high pressure reactor system

100L jacketed reactor with
hydraulic lifting arrangement, condenser & receiver pot

1,000L high pressure reactor
with mechanical seal & limpet

Non-stirred Pressure Vessels




SALIENT FEATURES

- 25mL to 100L net filling volume standard models & 150L to 1,000L customized designs
- Pressures upto 700 bar & temperatures upto 600°C
- Available in different Materials of Construction (MOC) like SS-316L, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Tantalum lined, Zirconium etc.
- Ex-proof / ATEX / CE / PED / ASME U / CRN certified systems on request
- Fully automated PC controlled high pressure system / pilot plant to continuously monitor, control & record various parameters

APPLICATIONS

- For gas / liquid storage / charging under pressure
- For gas / liquid separation & collection
- For static, loop, electrochemical, corrosion studies
- For study of gas hydrate formation
- For supercritical fluid extraction
- For hydrogen induced disbonding tests
- For soaking of diamonds / precious stones

STANDARD MODELS | 25mL TO 250mL

Volume	25mL					
Model	**P1113**	**P1115**	**P1123**	**P1125**	**P1133**	**P1135**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	30					
Vessel Internal Height (mm)	40					

Volume	50mL					
Model	**P1213**	**P1215**	**P1223**	**P1225**	**P1233**	**P1235**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	40					
Vessel Internal Height (mm)	63					

Volume	100mL			
Model	**P1313**	**P1315**	**P1323**	**P1325**
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	40			
Vessel Internal Height (mm)	83			

Volume	250mL					
Model	**P1413**	**P1415**	**P1423**	**P1425**	**P1433**	**P1435**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	65				62	
Vessel Internal Height (mm)	80				80	

Non-stirred Pressure Vessels

STANDARD MODELS | 500mL TO 5L

Volume	500mL			
Model	**P2113**	**P2115**	**P2123**	**P2125**
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	75			
Vessel Internal Height (mm)	118			

Volume	750mL					
Model	**P2213**	**P2215**	**P2223**	**P2225**	**P2233**	**P2235**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	75				74	
Vessel Internal Height (mm)	193				193	

Volume	1L	
Model	**P2313**	**P2315**
Design Pressure	100 bar	
Design Temperature	300°C	500°C
Vessel I/D (mm)	101.6	
Vessel Internal Height (mm)	163	

Volume	2L					
Model	**P2413**	**P2415**	**P2423**	**P2425**	**P2433**	**P2435**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	101.6		94		90	
Vessel Internal Height (mm)	303		303		315	

Volume	5L					
Model	**P2513**	**P2515**	**P2523**	**P2525**	**P2533**	**P2535**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	149		134			
Vessel Internal Height (mm)	310		360			

STANDARD MODELS 10L TO 100L

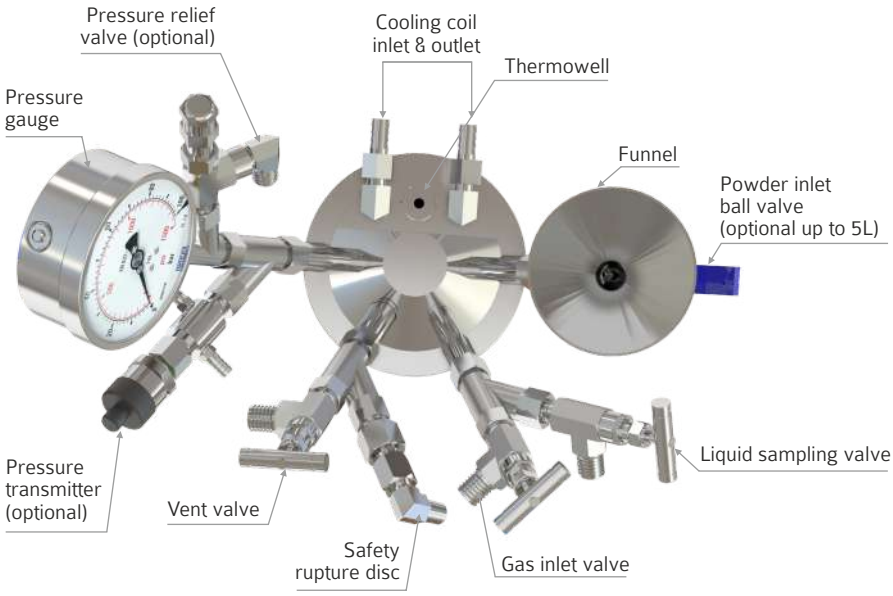
Volume	10L					
Model	**P3113**	**P3115**	**P3123**	**P3125**	**P3133**	**P3135**
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	185					
Vessel Internal Height (mm)	400					

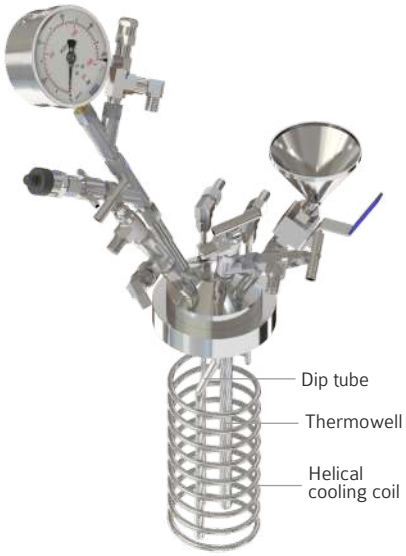
Volume	25L			
Model	**P3313**	**P3315**	**P3323**	**P3325**
Design Pressure	100 bar		200 bar	
Design Temperature	300°C	500°C	300°C	500°C
Vessel I/D (mm)	243			
Vessel Internal Height (mm)	595			

Volume	50L				100L			
Model	**P3403**	**P3405**	**P3413**	**P3515**	**P3503**	**P3505**	**P3513**	**P3515**
Design Pressure	50 bar		100 bar		50 bar		100 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	355		343		456		440	
Vessel Internal Height (mm)	558		600		699		739	

Non-stirred Pressure Vessels

NOZZLE ORIENTATION & INTERNALS





VALVE DETAILS

Vessel volume	Needle Valve	Ball Valve	Flush Bottom Valve
50mL - 250mL	¼" NPT	—	—
500mL - 5L	¼" NPT	¼" NPT (optional)	10 mm (optional)
10L - 25L	¼" NPT	¾" NPT	15 mm
50L - 100L	½" NPT	1" NPT	25 mm

TECHNICAL SPECIFICATIONS FOR NON-STIRRED PRESSURE VESSEL STANDARD MODELS

Description	Specification		
Material of Construction	SS 316L wetted parts		
Head Mounting Style	Removable head and vessel design		
Standard Nozzles, Valves & Fittings	**External Valves & Fittings:** Pressure gauge, safety rupture disc, gas inlet and liquid sampling needle valve with common dip tube, vent needle valve, ball valve for powder / liquid inlet (for10L to 100L), flush bottom valve (5L to 100L) **Internal Fittings:** Single tube-in & tube-out coil (for100mL), serpentine cooling coil (for 250mL), Helical cooling coil (for 500mL to 100L), dip tube, thermowell with RTD PT 100 temperature sensor		
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C		
Closure Type	Split clamp with clamp bolts		
Heating Type*	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C		
Auto-cooling System*	With water pump for forced cooling, SS tank & hose pipes for temperature control.		
Water Pump & 10L Tank*	With tubing to cool the pressure sensor etc. by water re-circulation.		
Control Panel*	With programmable PID temperature controller & high temperature alarm		
Mounting & Dimensions (W x D x H) mm	**Mounting**	**Vessel Volume**	**Dimensions**
	Table Top	25mL, 50mL, 100mL, 250mL	140 x 140 x 500
		500mL & 750mL	160 x 160 x 630
		1L	200 x 200 x 710
	Trolley Model	2L	1040 x 410 x 1140
		5L	1100 x 410 x 1140
		10L	1310 x 585 x 1750
		25L	1310 x 600 x 1800
		50L	1500 x 675 x 1850
		100L	1550 x 780 x 1900

*Optional

Non-stirred Pressure Vessels

Inquiry guide for non-stirred pressure vessel customized models

Inquiry code structure is **Standard Model-B-C-D-F-H-I-J-K** where B, C, D, F, H, I, J & K options can be selected from below tables. The below options will be in place of standard supply. For example 500 ml, 100 bar, 300°C, Hastelloy C, fixed head autoclave with electrical ex-proof heater & panel will read as **P 2113-H6-K-EA-F2C**

OPTIONS

B Material of Construction

Hastelloy C 276	H6	Inconel 625	I6
Hastelloy C 22	H2	Nickel 200	N2
Hastelloy B	HB	Titanium Gr. 2	T2
Monel 400	M4	Zirconium 702	ZI
Inconel 600	I0	Tantalum lined	TN

Refer page no. 16 for more details

C Head Mounting Style

Fixed head with manual vessel raising lowering (50mL to 750mL)	K
Fixed head with pneumatic vessel raising lowering (1L to 25L)	P
Fixed head with pneumatic vessel raising lowering & tilting (1L to 25L)	PT
Fixed head with hydraulic vessel raising lowering (50L & 100L)	H
Fixed head with hydraulic vessel raising lowering & tilting (50L & 100L)	HT

Refer page no. 17 for more details

D Heating Types

Electric ceramic band heater (For table top models)	EC
Electrical ex-proof IIB + H2 certified (up to 200°C)	EA
Welded SS 304 jacket with insulation	JS

Refer page no. 18 for more details

F Valves & Fittings*

Ball valve powder inlet (500 ml - 5 ltr)	BVP
Flush bottom valve (500 ml - 5 ltr)	FBV
Serpentine cooling coil	SCC
Pressure safety valve	PSV

Refer page no. 19 for more details

H Control Panel

Control panel with programmable PID temperature controller & high temperature alarm (For table top models)	STD
Ex-proof group IIC zone 1 certified	F2C
Touch screen	TSP

Refer page no. 20 for more details

I Mounting & Overall Dimensions (approx)

Mounting	Volume Reactor	Reactor with control panel (W x D x H) mm	Code
SS Trolley	25mL, 50mL, 100mL, 250mL	1010 x 410 x 850	TL
	500mL	1010 x 410 x 880	
	750mL		
	1L	1040 x 410 x 890	

Refer page no. 21 for more details

J Certifications**

PED 2014 / 68 / EU for pressure vessels or ASME U stamp for pressure vessels	PED / ASU
CE marked panel & electrical parts or UL / CSA marked panel & electrical parts	ECE / USC
ATEX certified electricals	ATP
ATEX certified system as per 2014 / 34 / EU	ATM

Note: 1) Customers are advised to select best suited options for most optimized price & delivery.
2) For other optional accessories please refer page 49 to 53.
3) All above options may not be available / possible with all models.
4) Customization of volume, material, pressure, temperature etc. may be possible on request.
5) Customised power supply can be offered on request.
6) Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.
*All options specified in F are addons & multiple / all of them can be availed at the same time.
**Country specific certifications like CRN for Canada, AS1210 for Australia & DOSH for Malaysia can be offered on request.

Acid Digestion Bombs

100mL

250mL

500mL

SALIENT FEATURES

- 50mL to 750mL net filling volume
- Design pressures up to 200 bar and temperatures up to 250°C
- Acid digestion vessels made from SS-316 with PTFE liner & PTFE cap
- Non-metallic microwaveable acid digestion bombs

APPLICATIONS

- Used for dissolving or digesting inorganic or organic samples in strong acids or alkalis

50mL 100mL

STANDARD MODELS FOR ACID DIGESTION BOMBS

Volume	50mL	100mL	250mL	500mL	750mL
Model	**D1212**	**D1312**	**D1412**	**D2112**	**D2212**
Design Pressure	100 bar				
Design Temperature	200°C (optional 250 °C with carbon filled PTFE)*				
Vessel I/D (mm)	35	44	45	60	60
Vessel Internal Height (mm)	55	70	160	180	270

STANDARD MODELS FOR MICROWAVEABLE ACID DIGESTION BOMBS

Volume	50mL	100mL
Model	**DM1202**	**DM1302**
Design Pressure	50 bar	
Design Temperature	200°C	
Vessel I/D (mm)	30	30
Vessel Internal Height (mm)	73	146

TECHNICAL SPECIFICATIONS FOR ACID DIGESTION BOMBS

Description	Specification
Material of Construction	PTFE liner & cap inside SS 304 / high temperature resistant polymer for microwaveable models
Standard Fittings	Safety rupture disc.
Closure	Split clamp with clamp bolts for metal models & threaded for polymer models
Mounting	Vessel fixture & Suitable spanner

Note: Customization of volume, material, pressure, temperature etc. may be possible on request.

*Suffix the standard models of acid digestion bombs with 'C' for 250°C option.

Shaker Hydrogenator

APPLICATIONS

- Used for synthesizing or modifying organic compounds by catalytic hydrogenation
- Used to study catalyst activity
- Economical considering the interchangeability of different capacity & different material vessels in one unit

STANDARD MODELS FOR SHAKER HYDROGENATOR

Volume	500mL		1L		2L	
Model	**SM2082**	**SG2060**	**SM2282**	**SG2260**	**SM2382**	**SG2360**
Design Pressure	20 bar	3 bar	20 bar	3 bar	20 bar	3 bar
Design Temperature	200°C	150°C	200°C	150°C	200°C	150°C

TECHNICAL SPECIFICATION FOR SHAKER HYDROGENATOR STANDARD MODELS

Description	Specification		
Material of Construction	SS 316L vessel for SM series* / Glass vessel for SG series		
Drive	½ hp, ex-proof IIA / IIB AC motor with variable speed drive panel for 20 - 200 oscillations / minute rocking		
Gas Cylinder	4L cap. gas cylinder of SS-304 with inlet, outlet valves, pressure safety valve, pressure gauge & flexible hose pipe with NRV to feed gas into the vessel while in motion		
Standard Fittings	Vent valve, dip tube with sampling valve, 2" opening on top for powder / liquid inlet & cleaning, (for metal vessel only) thermowell, pressure safety valve		
Power Supply	1Ø, 220 V AC, 50 / 60 Hz		
Mounting & Dimensions (W x D x H) mm	**Mounting**	**Dimensions**	
	Table Top	850 x 700 x 700	
Safety Shield	SS wire grid (for glass vessel only)		

*SM series comes with electric ceramic band heater

Inquiry guide for customized models

Inquiry code structure is **Standard Model-A-B-C-D-E-F-G** where **A, B, C, D, E, F & G** options can be selected from below tables. The below options will be in place of standard supply. For example 500 ml, 20 bar, 200°C, Hastelloy C with ex-proof gas group IIC (zone1) certified motor & panel will read as **SM2182-H6-XC-F2C**. For interchangeable vessels add the vessel code & its material code if Hastelloy C for as many vessels required.

OPTIONS

A Material of Construction (wetted parts)

Hastelloy C 276	H6

B Motor Type

Ex-proof gas group IIC (Zone 1)	XC
Ex-proof CE ATEX certified II 2G Ex de IIC T4	AZ
Ex-proof CSA certified Class 1 Div 2 group A, B, C, D	CD

C Control Panel

SS control panel PID temperature controller	STD
Ex-proof group IIC zone 1 certified	F2C
Touch screen	TSP

D Mounting & Dimension (mm) (approx)

Floor Stand	850 x 700 x 1300 (W x D x H)	FS

E Certifications

CE marked panel & electrical parts	ECE
UL/CSA marked panel & electrical parts	USC

F Interchangeable Metal Vessels*

Interchangeable metal vessels 500mL	M21
Interchangeable metal vessels 1L	M23
Interchangeable metal vessels 2L	M24

G Interchangeable Glass Vessels*

Interchangeable glass vessels 500mL	G21
Interchangeable glass vessels 1L	G23
Interchangeable glass vessels 2L	G24

Note: 1) Customer is advised to select best suited options for most optimized price & delivery.
2) For other optional accessories please refer page 49 to 53.
3) All above options may not be available / possible with all models.
4) Customised power supply can be offered on request.
5) Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.
*Multiple options can be selected for one unit with heaters.

Supercritical Fluid Extraction System

SALIENT FEATURES

- 100mL lab scale to 1,000L commercial plants offered
- Pressures upto 700 bar for lab scale units & upto 450 bar for commercial plants
- Semi or fully automated PLC based plants with CO_2 recycling
- PED, U stamp, CE, CSA, UL certification optional
- Customizable designs as per client requirements

SCFE plant - 1L

WORLD-CLASS TECHNOLOGY FOR NATURAL PRODUCTS

- There is a tremendous demand for high purity & residual solvent free extracts of natural products. Also there is increasing requirement of eco-friendly manufacturing processes for the extraction of natural products.
- Supercritical fluid extraction technology provides an economical solution to providing a safe & eco-friendly way for extraction of natural products. Its superiority over the conventional technologies of extraction, especially for natural products in the food and pharmaceutical industry is well recognized.
- Supercritical CO_2 textile dyeing is an emerging innovative waterless technology for dyeing of textile fabrics that will revive the textile industries.

SCFE plant - 50L

COMMERCIAL APPLICATIONS

- Extraction of natural products such as spice oil & oleoresins, flavors, fragrances, colors
- Decaffeination of tea & coffee
- Production of uniform &ultra fine particles
- Supercritical CO_2 (SCO_2) textile dyeing of fabrics
- Supercritical CO_2 (SCO_2) cleaning of high precision metal components
- Supercritical CO_2 (SCO_2) drying of aerogels

ADVANTAGES OF SCFE

- Extract with delicacy & freshness close to natural
- High potency of active components
- Longer shelf life extracts
- Eco-friendly & green technology with no residual solvent & effluents
- High flexibility of process conditions
- Simultaneous fractionation of extracts
- High yields compared to solvent extracted products
- Low batch times for extraction
- Recycling of CO_2
- Low operating cost

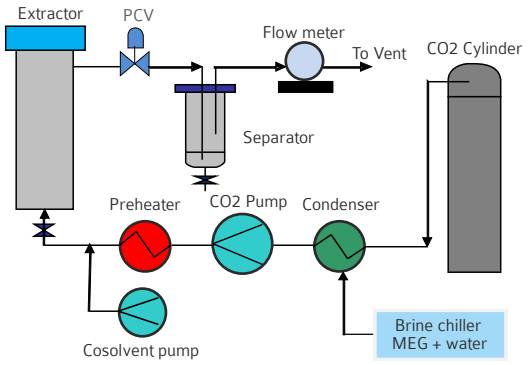
ADVANTAGE OF CO_2 AS A SOLVENT

- Carbon dioxide is generally regarded as safe (GRAS) for food products.
- Inexpensive & easily available.
- Non-toxic, non-flammable and inert to most materials.

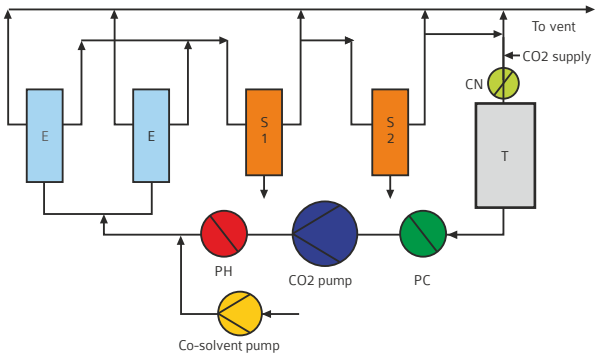
PROCESS DESCRIPTION FOR LAB-SCALE

The Carbon dioxide gas from the cylinder is first liquefied & then pressurized above the critical pressure of CO_2 (73.8 bar) to the required pressure necessary for extraction. This high pressure liquid CO_2 is then heated above the critical temperature of CO_2 (31°C) to the required temperature. CO_2 which is now in supercritical phase ($SCCO_2$) enters the extractor where the raw material is fed in powder form & the extraction is achieved on the basis of solubility. The compounds dissolved in $SCCO_2$ finally come to the separator at atmospheric pressure & get precipitated. CO_2 leaving the separator is then measured by passing it through a CO_2 gas flow meter.

Supercritical Fluid Extraction System



SCFE flow diagram for lab scale model



PFD for commercial scale SCFE plant with CO_2 recycling

E Extractor
S1 Separator 1
S2 Separator 2
PC Pre-cooler
PH Pre-heater
CN Condenser
T CO2 tank

PROCESS DESCRIPTION FOR COMMERCIAL SCALE PLANT

The raw material in powder form is fed to the extractor. The liquid carbon dioxide from the CO_2 tank is precooled by passing it through the precooler. This precooled liquid carbon dioxide is then pressurized by means of a positive displacement plunger pump to a pressure above the critical pressure of CO_2 (i.e. 73.8 bar). High pressure liquid CO_2 is then heated above the critical temperature of CO_2 (i.e 31 °C) by passing it through preheater. CO_2 which is now in the supercritical state enters the extractor in which the raw material is loaded. The $SCCO_2$ dissolves substances on the basis of solubility, depending on operating conditions. The $SCCO_2$ with soluble extracts enters the separators where the pressure & temperature are reduced sequentially so that solubility decreases & extract precipitates in the separators. Finally the clean CO_2 without any traces is recycled back to the CO_2 tank via condenser.

$SCCO_2$ system for very high temperature (400°C) application

SPECIFICATIONS

MOC SS316

Volume (L)	Design pressure (bar)		Design temp. (°C)	
	Standard	Optional	Standard	Optional
0.1 to 2	350	500, 700	100	200
5 to 25	350	450	100	200
50 to 100	350	450	100	150
200 to 1000	350	450	100	150

SCFE plant - 250mL

SCFE STANDARD MODELS

Model	Working volume (L)	Feed cap.* (kg/day)
E1331	0.1	0.24
E1431	0.25	0.6
E2131	0.5	1.2
E2331	1	2.4
E2431	2	4.8
E2531	5	12
E3131	10	24
E3331	25	60
E3431	50	120
E3531	100	240
E3631	200	480
E3731	400	1000
E3831	1000	2400

* The feed capacity is assuming bulk density of 0.4 kg/L of feed & maximum 6 batches / day.

- 5L & above systems are offered with CO_2 recycling & PLC controls.

AEPL has trial facility of lab scale SCFE plant with extractor volume of 2.5L having design temperature of 200°C & design pressure of 550 bar with CO_2 & co-solvent pumps along with CO_2 recycling facility.

1L extraction vessels in series & parallel for 700 bar pressure with CO2 pump for extraction of natural products

Autoclaves for HPHT Corrosion Testing

SALIENT FEATURES

- For high pressure high temperature static, dynamic, loop & electrochemical corrosion studies
- Volumes from 100mL to 100L
- Design pressures up to 350 bar & temperatures up to 600°C.
- Available in different materials of construction – SS 316, Hastelloy C, Inconel, Titanium etc.
- Stirred / non-stirred autoclave systems
- Completely customizable system

2L autoclave with separate head for weight loss method & electrochemical corrosion studies

METHODS OF TESTING CORROSION USING AUTOCLAVES

- Weight loss method with corrosion coupons
- Electrical resistance probe
- Electrochemical probe
- Electrochemical noise in current or potential

APPLICATIONS

- Autoclaves for corrosion application are mainly used in aggressive environments like H_2S & supercritical water in oil refineries & defence industries.
- Electro - chemical corrosion measurements in HPHT media-water and other solutions
- Coating and materials evaluation in high pressure simulated deep sea condition (submarine paint etc) using impedance measurements
- Autoclave for cement curing under deep sea applications as per API standard.
- Polymer testing /curing/processing under HPHT conditions
- Slow strain rate tests for stress corrosion cracking under HPHT conditions

10L autoclave for HPHT corrosion testing

5L autoclave for corrosion testing by weight loss method, electrochemical & recirculation loop

Autoclaves for HPHT Corrosion Testing

STATIC & STIRRED AUTOCLAVE

- Normally corrosion test coupons are suspended in static (non-stirred) or stirred autoclave systems & corrosion is measured in terms of weight loss. In stirred autoclave system, sometimes the coupon holders are attached to the shaft & rotated during testing.
- Autoclaves are then fed with the corrosive media & designed temperature & pressure are reached & maintained in the autoclaves. Optionally suitable electrodes like pH or ORP (MOC: SS316 / Hast-C) are provided to measure pH & redox potential under pressure.
- Autoclaves with working, counters / reference & auxillary electrodes can also be offered with potential measurement system for electrochemical corrosion testing.
- For standard model selection refer page 16 for stirred autoclave & page 24-25 for non-stirred pressure vessels

Rotating coupon holder assembly

1L & 5L autoclaves for corrosion testing

High pressure electrochemical probes

Potentiostat

RE-CIRCULATING LOOP AUTOCLAVES FOR CORROSION TESTING

In this system, the autoclave is connected with a special high pressure pump which can recirculate water/liquid continuously at very high velocity through the test spool & the autoclave connected in line with each other.

Autoclaves to Study Gas Hydrates

SALIENT FEATURES

- 100mL to 100L net filling volume
- Pressures upto 350 bar & temperatures upto 100°C
- For examination / study of gas hydrate formation
- Analysis of effectiveness & efficiency of thermo dynamic and kinetic gas hydrate inhibitors
- MOC: SS316 / Hastelloy C etc.
- Glass window with camera for visual observation of gas hydrate formation
- Long term experiments of upto 30 days can be performed

AUTOCLAVES FOR OBSERVATION OF GAS HYDRATE FORMATION

Gas hydrates are inclusion compounds of gases in a lattice of water molecules. Huge amounts of methane are stored around the world under the sea floor in the form of solid methane hydrates. Methane hydrates, represent a new and completely untapped reservoir of fossil fuel, because they contain, immense amounts of methane, which is the main component of natural gas. Methane hydrates belong to a group of substances called Clathrates - substances in which one molecule type forms a crystal-like cage structure and encloses another type of molecule. If the cage-forming molecule is water, it is called a hydrate. If the molecule trapped in the water cage is a gas, it is a gas hydrate, like methane hydrate. Methane hydrate also poses problems during transportation of natural gas. Temperature and pressure conditions in pipelines especially in cold areas allow the formation of hydrates. These hydrates form agglomerates and tend to clog valves, pumps, pipelines and other parts. It is desirable to avoid the formation of hydrates rather than removal of existing hydrate due to economical and safety reasons. The production as well as study of artificial gas hydrates are done in special autoclaves like the gas hydrate autoclave System, under specific pressure and temperature conditions. At room temperature and normal atmospheric pressure, methane hydrate is unstable dissociating into water and gas. Pipeline conditions can be simulated in the gas hydrate autoclaves to check the effectiveness & optimization of hydrate-inhibitors. Pressure-resistant borosilicate / quartz / sapphire-glass windows in the gas hydrate autoclaves allows the use of one or multiple boroscope-cameras for observing or recording the processes of gas hydrate formation inside the autoclave. The autoclaves can also be provided with magnetic stirrer to simulate turbulent mixing conditions. Overhead stirrer can be connected to a torque sensor to perform torque measurements to study viscosity changes. For standard autoclave models refer page 16.

High Pressure System for Hydrogen Induced Disbonding Tests

Amar manufactures & supplies systems for Hydrogen Induced Disbonding (HID) tests as per ASTM G146. These tests are used to simulate & study the effects of hydrogen environment under very high pressures from 150 - 250 bar & temperatures from 400 - 500°C on bimetallic plates that are to be used under similar conditions in refineries. The results indicate the resistance of bimetallic steels & its alloy to hydrogen induced disbonding. Such tests can be used to decide the material metallurgy, its heat treatment, manufacturing & fabrication technology for use in refineries in similar environments. The system can be manually operated or completely automated.

Initially the test samples are put inside the vessel, pressurized with hydrogen to very high pressure upto 150 - 200 bar & then heated to desired temperature of around 400 - 500°C for a period of around 48 hrs. After the test is over, the vessel is cooled at a pre-defined rate of around 150°C/hr till the temperature reaches 200°C. The vessel pressure is then released completely & cooled further to remove the test samples.

Pressure Vessels for Gas-Liquid Storage

SALIENT FEATURES

- 150L to 1,000L custom designed pressure vessels
- Design pressures up to 350 bar & design temperature up to 500 °C
- Available in different Materials of Construction (MOC) like SS-316L, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Tantalum lined, Zirconium etc.
- PED / ASME U stamp certified vessels can be provided on request
- It can be used as a gas - liquid storage vessel at high pressure.

Note: For standard non-stirred pressure vessel models refer page 24 & 25.

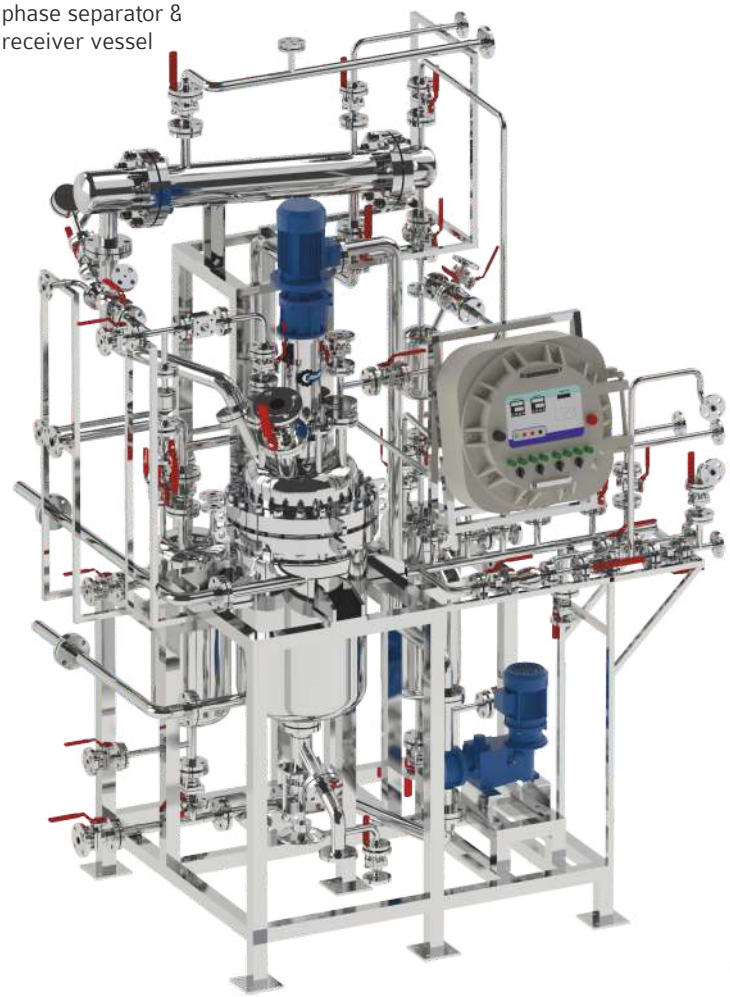
Custom Built Skids & Pilot Plants

SALIENT FEATURES

- **Custom-built skids & pilot plant** are designed with suitable arrangements for liquid & gas charging, intermediate charging, discharge collection, dosing & vacuum pumps, temperature controlling unit, reactor, distillation, condensor, receiver, solvent recovery system, catalyst filtration system, inter-connecting piping, valves and instruments etc. complete turnkey solution within a common SS304 / MS painted / aluminum skid along with partial or fully automated PLC with touch panel & SCADA software with recording & control of all the parameters remotely can be offered for different applications.
- **Volume:** Reactor volume can be in the range of 1L to 1,000L
- **Pressure:** Can be customised from atmospheric to 350 bar.
- **Temperature range:** Can be customised from 100°C to 500°C.
- **Material:** SS-316L, Hastelloy, Monel, Nickel, Inconel, Titanium, Zirconium
- **Standards & certifications:** PED / ASME U stamp certified vessels, ex-proof, CE certified / CSA certified electricals (optional)

20L high temperature pilot plant

300L Ex-proof pilot plant with pump, condenser, phase separator & receiver vessel



100L ex-proof hydrogenation pilot plant with catalyst charging, catalyst filter with recycle, auto cooling system, vacuum pump & catch pot

Custom Built Skids & Pilot Plants

Bottom driven autoclave

Reactor with reflux return or take off

Ex-proof autoclave with load cell arrangement

100L polymerization reactor for (2 million cP) viscous polymer with hydraulic vessel raising lowering & tilting mechanism

10L pilot plant for ethoxylation

Custom Built Skids & Pilot Plants

Continuous emulsion polymerization pilot plant

500mL high pressure vessel
with ultrasonicator probe system

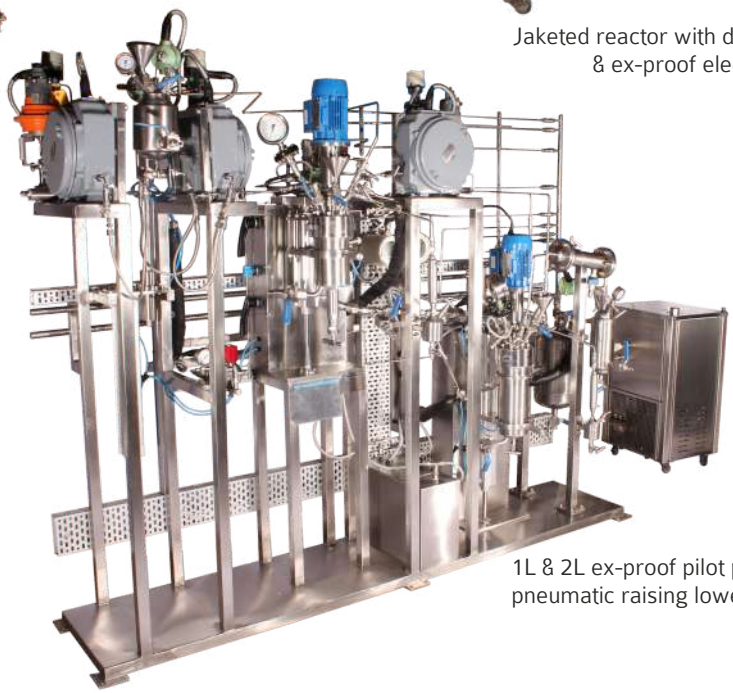
High pressure fischer tropsch reactor with
gas booster, mass flow controller etc.
accessories & SCADA software

25L reactor with dean stark arrangement

Custom Built Skids & Pilot Plants

10L high pressure ex-proof system with catalyst filtration & recycling

Jaketed reactor with distillation setup & ex-proof electricals



1L & 2L ex-proof pilot plant with pneumatic raising lowering arrangement

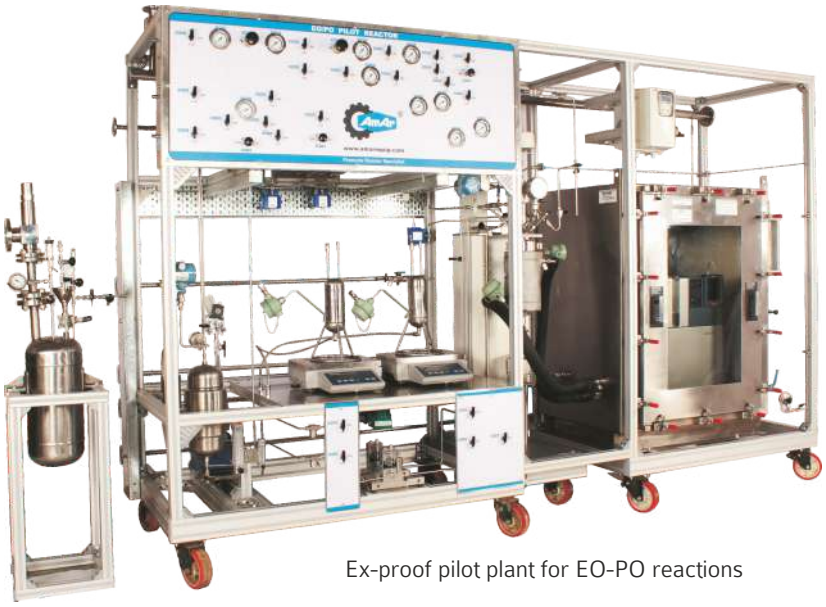
Multipurpose pressure reactor with column distillation assembly

EO-PO pilot plant with ex-proof fittings

Custom Built Skids & Pilot Plants

500L hydrogenation pilot plant
with catalyst filter & recycle

Pilot Plant for
Styrene Butadiene
Emulsion Polymerisation



Ex-proof pilot plant for EO-PO reactions

Fully automated & semi continuous pilot plant
for styrene butadiene emulsion polymerisation
with pneumatic vessel rasing, lowering & tilting

Custom Built Skids & Pilot Plants

10L fully automated ex-proof alkoxylation pilot plant

100L pilot plant with distillation setup

25L reactor with pneumatic raising lowering & tilting

5L high pressure ex-proof distillation skid

Custom Built Skids & Pilot Plants

100L reactor with hydraulic lifting arrangement & solvent recovery setup

25L titanium high vacuum reactor lid with homogenizer & anchor with PTFE wiper blades

High pressure polytest reactor system

50L pitch impregnation equipment for processing high temperature carbon-fiber, composites using pitch monomer / coal demoralization

Continuous Stirred Tank Reactor

SALIENT FEATURES

- Product is developed / produced on continuous basis for better productivity
- Stirred tank reactors of 100mL to 1,000L
- Single or multiple reactors connected in series
- SS-316, Hastelloy C, Inconel etc. materials
- Pressures up to 350 bar @ 500°C
- Ex-proof system for hazardous area
- Fully automated PC controlled systems to continuously monitor, record & control various parameters like temperature pressure, motor speed, gas / liquid flow etc.
- Gas mass flow controller, metering pumps, level controller, catalyst filtration system with SCADA software etc. are provided for a typical hydrogenation application.

5L, 4 nos. & 1 no. 25 ltr CSTR in series

1L, 4 nos. CSTR in series

High pressure CSTR
for hydrogenation

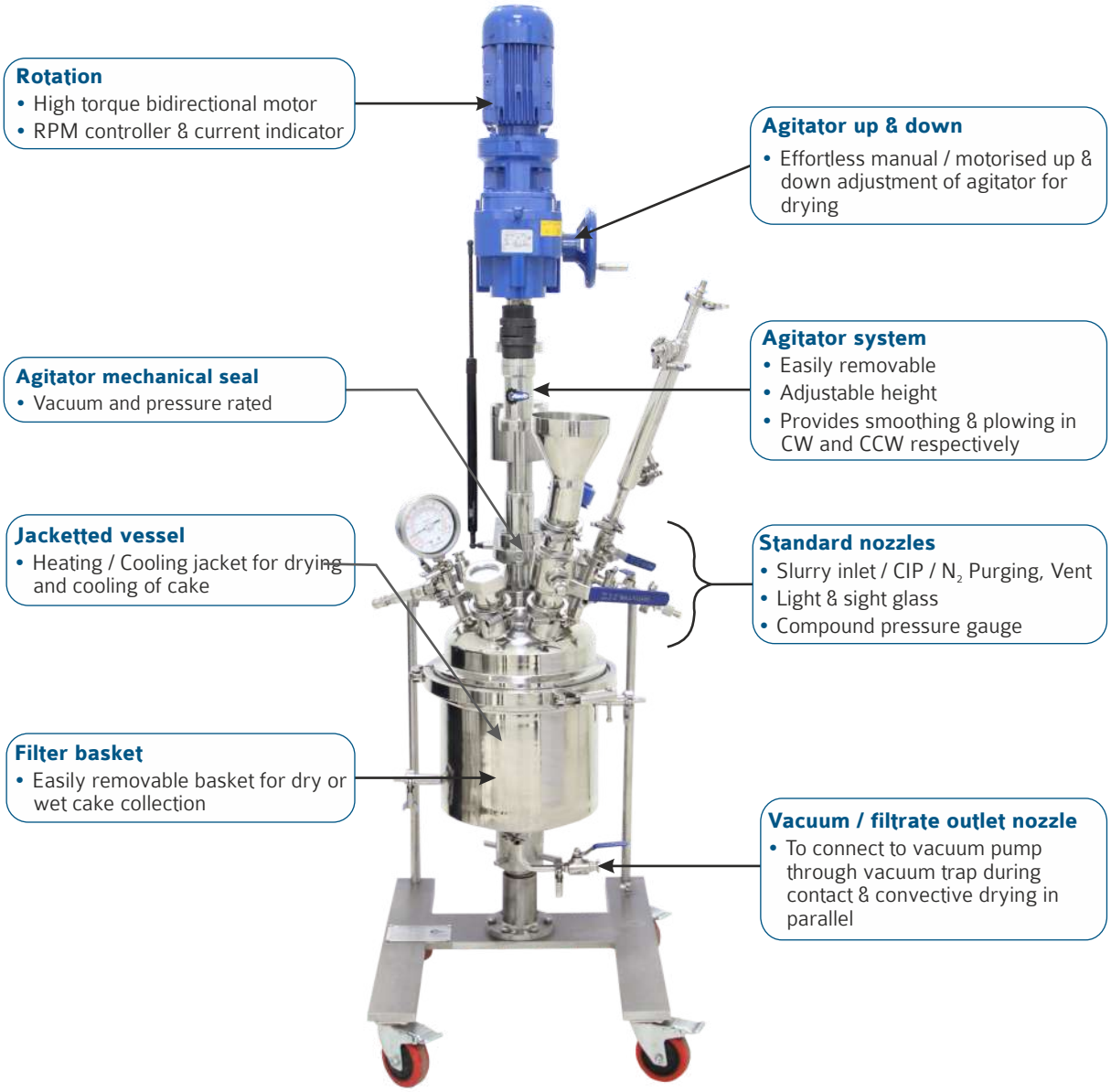
CSTR for hydro-cracking
of heavy hydrocarbon oils

Agitated Nutsche Filter Dryer

Lab to pilot scale GMP models with motorized raising lowering

- Volume: 1 L to 100 L slurry volume
- Filtration Area: 0.005 m² to 0.2 m²
- Design Pressure: -1 to 4 bar
- Design Temperature: -20°C to 150°C
- Materials: SS316, Hastelloy C, Inconel, Titanium, etc.
- Certifications: PED / ASME U-Stamp, CE / CSA, Ex-proof / ATEX

Agitated Nutsche Filter Dryer



STANDARD SPECIFICATIONS

Model*	Filter area	Slurry volume	Cake volume
ANFD-1	0.005 m^2	1L	500mL
ANFD-2	0.008 m^2	2L	800mL
ANFD-5	0.02 m^2	5L	2L
ANFD-10	0.05 m^2	10L	5L
ANFD-25	0.07 m^2	25L	8L
ANFD-50	0.13 m^2	50L	18L
ANFD-100	0.20 m^2	100L	32L

*Numeric value indicates slurry volume

APPLICATIONS

- Pharmaceutical Intermediates
- Food, flavors & fragrance industry
- Edible oil deodorization & deacidification
- Hazardous materials filtration
- Moisture removal & solvent recovery
- Precious metal & other catalyst recovery
- Fine & speciality chemicals
- Polymer devolatilization
- Microsphere separation & purification

OPTIONAL ACCESSORIES

- Mother liquor tank
- Condenser
- Thermostats
- Digital pressure indicator
- Gas pressure regulator

Heating Cooling Circulators

Thermostats for 10mL to 3,000L reactors

- Single fluid closed loop circulators: -90 °C to 250 °C.
- Heating cooling circulators: -70 °C to 175 °C.
- High temperature circulators: Ambient to 350 °C.
- Chillers: Up to -15 °C.
- CE marked units & NATURAL refrigerant optional
- With accurate programmable temperature controller & touch panel

Heating Cooling Circulators

Model	Temperature range C	Heating power in Kw	Cooling power in Kw @					*Pump flow lpm	Maximum pressure bar	HTF end connection	Dimensions mm	Supply voltage	Maximum current	Machine version	Cooling water flow and pressure
			0°C	-20°C	-30°C	-40°C	-60°C								
isoTHERM series (-90 to 250°C) closed loop heating cooling circulators															
CLM-1	-30...+200	1.5	0.6	0.3	0.1	—	—	18~20	0.3	M-24	475x400x800	1-ph 230 VAC	10A	Air cooled	—
CLM-2	-40...+250	2.5	0.8	0.5	0.25	—	—	30~35	0.4	M-24	420x520x875	3-ph 420 VAC	10A	Air cooled	—
CLM-3	-40...+250	3.6	1.2	0.7	0.3	—	—	30~35	0.4	M-24	450x600x900	3-ph 420 VAC	12A	Air cooled	—
CLM-4W	-45...+250	4.5	2.5	1.3	0.6	—	—	40~45	0.7	M-42	540x650x1250	3-ph 420 VAC	15A	Air cooled	250 LPH/3 bar
CLL-1	-75...+200	1.5	0.6	0.6	0.6	0.6	0.3	30~35	0.4	M-24	600x650x1400	3-ph 420 VAC	15A	Air cooled	—
CLL-2	-75...+200	3	1.5	1.5	1.5	1.4	1.2	30~35	0.4	M-24	600x650x1400	3-ph 420 VAC	18A	Air cooled	—
CLL-3W	-75...+200	4.5	2.2	2.2	2.1	2	1.4	40~45	0.7	M-42	700x750x1500	3-ph 420 VAC	20A	Water cooled	250 LPH/3 bar
CLL-4W	-90...+200	4.5	2.2	2.2	2.1	2	1.4	40~45	0.7	M-42	700x750x1501	3-ph 420 VAC	20A	Water cooled	250 LPH/3 bar
CPM-1W	-45...+250	6	4	2.2	1.3	—	—	50~55	1	M-42	560x650x1300	3-ph 420 VAC	15A	Water cooled	400 LPH/3 bar
CPM-2W	-45...+250	9	7	3.5	1.8	—	—	50~55	1	M-42	600x690x1300	3-ph 420 VAC	35A	Water cooled	700 LPH/3 bar
CPM-3W	-45...+250	12	12	6	3	—	—	80~90	1.5	M-42	700x750x1500	3-ph 420 VAC	50A	Water cooled	1200 LPH/3 bar
CPM-4W	-45...+250	18	15	7	3.5	—	—	80~90	1.5	M-42	750x790x1500	3-ph 420 VAC	50A	Water cooled	1500 LPH/3 bar
CPL-1W	-60...+250	6	6.5	6.5	6.5	3.2	1	50~55	1	M-42	750x790x1500	3-ph 420 VAC	40A	Water cooled	650 LPH/3 bar
CPL-2W	-60...+250	9	12	12	12	6	1.5	80~90	1.5	M-42	750x790x1500	3-ph 420 VAC	50A	Water cooled	1200 LPH/3 bar
CIM-1W	-45...+200	21	25	11	8	—	—	100	1.5	M-42	1200x950x1600	3-ph 420 VAC	65A	Water cooled	2500 LPH/3 bar
CIM-2W	-45...+200	33	45	21	12	—	—	120	2	M-42	1400x950x1800	3-ph 420 VAC	75A	Water cooled	4500 LPH/3 bar
CIM-3W	-45...+200	45	70	30	17	—	—	120	2	M-42	1800x1000x1600	3-ph 420 VAC	95A	Water cooled	7000 LPH/3 bar
CIM-4W	-45...+200	66	90	45	24	—	—	120	2	M-42	2000x1200x2000	3-ph 420 VAC	110A	Water cooled	9000 LPH/3 bar
uniTHERM series (-70 to 175°C) heating cooling bath circulators															
HCB-1	-25...+175	1	0.4	0.2	0.05	—	—	14~16	0.4	M-16	300x500x650	1-ph 230 VAC	8A	Water cooled	—
HCB-2	-25...+175	2	1.1	0.7	0.3	—	—	14~16	0.4	M-16	420x560x1000	1-ph 230 VAC	12A	Air cooled	—
HCB-3	-25...+175	3	1.5	1	0.45	—	—	30~35	0.7	M-24	510x620x1050	3-ph 420 VAC	8A	Air cooled	—
HCL-1	-70...+100	1	—	0.4	—	0.3	0.2	14~16	0.4	M-16	610x700x1150	1-ph 230 VAC	15A	Air cooled	—
HCL-2	-70...+100	2	—	1.1	—	0.8	0.4	14~16	0.4	M-16	610x700x1150	1-ph 230 VAC	20A	Air cooled	—
HCL-3	-70...+100	3	—	1.5	—	1.4	0.6	30~35	0.7	M-24	700x700x1300	3-ph 420 VAC	15A	Air cooled	—
hiTHERM series (ambient to 350°C) high temperature circulators															
HTC-1	Amb...+350	3	Through internal cooling coil					30~35	0.7	M-24	410x410x700	1-ph 230 VAC	18A	—	—
HTC-2	Amb...+350	6	Through internal cooling coil					30~35	0.7	M-24	600x600x900	3-ph 420 VAC	12A	—	—
HTC-3	Amb...+350	12	Through internal cooling coil					50~55	1	M-42	900x900x1100	3-ph 420 VAC	22A	—	—
Penguin series (ambient to -15°C) chillers															
			0°C	-10°C											
CHL-1	Amb...-15	—	0.35	0.15	—	—	—	12~14	0.3	M-24	330x370x550	1-ph 230 VAC	6A	Air cooled	—
CHL-2	Amb...-15	—	0.7	0.3	—	—	—	12~14	0.3	M-24	360x460x600	1-ph 230 VAC	8A	Air cooled	—
CHL-3	Amb...-15	—	1.2	0.6	—	—	—	25~30	0.5	M-24	550x650x700	1-ph 230 VAC	12A	Air cooled	—
CHL-4	Amb...-15	—	2.4	1.5	—	—	—	30~35	0.6	M-24	450x650x1150	3-ph 420 VAC	6A	Air cooled	—
CHL-5	Amb...-15	—	4.5	2.5	—	—	—	30~35	0.6	M-24	700x700x1200	3-ph 420 VAC	8A	Air cooled	—
CHL-6	Amb...-15	—	10	6	—	—	—	55~60	1	M-24	1300x800x1600	3-ph 420 VAC	25A	Air cooled	—
CHL-7	Amb...-15	—	15	8	—	—	—	55~60	1	M-24	1500x950x1700	3-ph 420 VAC	32A	Air cooled	—
CHL-8	Amb...-15	—	20	12	—	—	—	80~90	1.5	M-24	1650x1100x1600	3-ph 420 VAC	45A	Air cooled	—

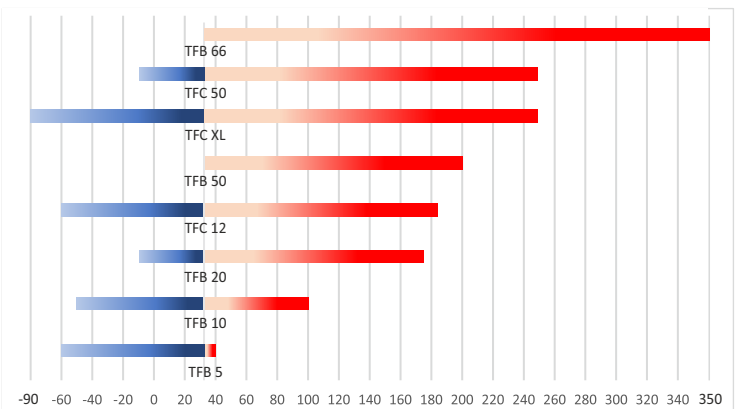
Note:

- Suffix "W" in model is for water cooled machine
- The given cooling power is at 35°C ambient temperature
- The temperature range mentioned above is at outlet of the machine
- Custom built models on request, as per process requirement
- In hiTHERM series, machines with higher heating capacity & ex-proof version on request
- *Pump flow rates are at atmospheric pressure

ACCESSORIES

- Insulated hose pipes
- Thermic fluid
- SCADA software & remote control
- Pressure booster pump
- Purge panel for ex-proof zone

Thermic fluid temperature chart



PascalFLO™ Pump

The patented PascalFlo's innovation lies in its ability to control the flow of the liquid /slurry without a flow meter on the liquid line

FEATURES

- Controlled dosing/pumping of any type of liquid or slurry, independent of temperature, rheology, composition of the fluid
- Accurate flow control without controllers on the liquid lines
- No need for recalibration of the system upon changing the liquid
- Practically pulseless pumping
- Operated by controlled gas flow

SPECIFICATIONS

- Flow rates: Range from 1mL/min up to 100LPH
- Pressure: Up to 100 bar
- Temperature: Up to 350°C
- Material: SS316, Hastealloy C

Optional Accessories

Optional accessories are offered to increase the versatility of the equipment, to add value & feature to the standard product & to provide complete range of instrument/ equipment required for a particular application. Most of the optional accessories are common for stirred, non-stirred, glass, shaker & fabricated reactors unless specified. The standard optional accessories can be enquired by simply mentioning their code & required specifications.

Complete mounting of all the accessories shall be done on autoclave stand / trolley.

All the indicators / controllers are mounted on a common SS panel.

GAS PRESSURE REGULATOR

To manually charge different gases at desired pressures upto 140 bar / 2000 psi or higher into the reactor from gas cylinder. Nitrogen, Oxygen & Hydrogen can be charged through same regulator (with special adaptor). The regulator is made from SS316 & comes with inlet - outlet pressure gauges & flexible SS braided PTFE high pressure hose pipe (4m long) with non return valve.

Optional:
- Regulators upto 350 bar, automated regulator
- Regulator for other gases like NH_3, CO_2 etc. & MOC of Hastelloy C
- Pressure reducing station with auto changeover

GAS BOOSTER

Gas boosters are useful when the cylinder pressures are much lower than the autoclave rated pressures. In such case the booster takes gas at lower pressure from cylinder & compresses the same to deliver at higher pressures. They are generally pneumatically operated. Special gas booster pumps are available for liquid CO_2 used in supercritical fluid extraction system. The booster systems are supplied with air filter regulator, pressure relief valves, inlet-outlet pressure gauges, valves & flexible hose pipe.

Optional: Boosters up to 700 bar pressure

Gas Booster

SS mounting with all fittings & valves

THERMAL GAS MASS FLOW METER / CONTROLLER (MFM / MFC)

MFM can be used to measure accurate mass flow rate of gas (in gm/hr or LPH) & totalized quantity of mass / volume (in gms/ltr) charged in the autoclave at any point. Mass flow controller (MFC) is used to charge the set flow rate of gas into the autoclave at high pressures up to 100 bar or it can be used in pressure control mode to indicate the gas flow & total gas uptake to maintain desired set pressure inside the autoclave (ideal for hydrogenation). The same MFM / MFC can be used for multiple gases by just entering the conversion factor for different gas densities provided the gases are inert to each other. The MFM/MFC comes with high pressure flexible hose, inlet filter with digital gas flow indicator cum totalizer & additional pressure PID controller with pressure sensor if the MFC is used in pressure control mode. User has to specify the maximum flow rate range, pressure, gas & mode (flow control or pressure control) for ordering MFM/MFC.

Optional:
- Ex-proof MFM / MFC can be offered on request.
- MFM/MFC upto 300 bar pressure

MFC

Flow Indicator & Totaliser

Ex-proof MFC

Ex-proof enclosure for MFC

CORIOLIS GAS - LIQUID MASS FLOW METER / CONTROLLER

These are used for higher & accurate gas or liquid flow rate indication or control in cases where thermal mass flow meters are not suitable. A common meter can be used for different gases & liquids for a particular range of flow.

Optional: Ex-proof CFM/CFC can be offered on request

Coriolis Mass Flow Meter

Coriolis Mass Flow Controller

DIGITAL PRESSURE INDICATOR / CONTROLLER

It consists of SS316 pressure sensor (transmitter) & digital pressure indicator/ controller (mounted on common control panel) with pressure alarm & optionally heater cut off for safety. Digital pressure indicator has pressure reading in bar & psi, where as controller reads any one of the units. The controller is normally used with mass flow controllers (MFCs) or solenoid/flow control valves to maintain constant pressure inside the autoclave. With MFC, gas flow indicator & totalizer are also provided on the same panel. The pressure sensor has temperature limitation upto 100°C & hence the same is provided with water cooling jacket.

Optional:
- Intrinsically safe pressure sensor.
- Pressure sensors with Hastelloy C / Inconel wetted parts can be offered on request.

Solenoid Valve

Pressure Sensor

Optional Accessories

LIQUID / SLURRY / GAS CHARGING HIGH PRESSURE POT

It is used to transfer liquids, slurries or gases in to the autoclave under pressure. It consists of high pressure SS-316 pot designed for working pressure 100 bar or higher with port for nitrogen gas (N_2), liquid / slurry inlet with valve & funnel, outlet valve, pressure gauge, pressure safety valve, high pressure hose & NRV. The liquid to be charged is fed into the pot from top funnel & pressurized with N_2 gas until its pressure is higher than the autoclave pressure & then under pressure the liquid is charged into the autoclave. The quantity & rate of flow of liquid charged is not known precisely in this system. However a level indicator or sight glass or weighing balance or flow meter can be provided optionally to measure the liquid charged or its flow rate. Pots of different pressure, material & sizes can be offered.

These pots can also be used for storage of gases when gas cylinders are located at a far away place. With this option approximate quantity or flow of gas consumed can also be determined by measuring the pressure drop.

Volume: ½L, 1L, 2L, 5L, 10L, 25L, 50L

Optional:
- Forward pressure regulators can be provided at the outlet of the charging pot if they are used as gas charging.
- Pots up to 200 bar / 350 bar
- Pots in Hastelloy C, Inconel, Monel, Titanium

ETHYLENE EO / POLYPROPYLENE PO OXIDE POT

It consists of SS 316 (EO/PO) horizontal pot with inlet, outlet valves, gas inlet with dip tube, thermowell, pressure gauge & high pressure hose pipe for 10 bar working pressure.

It is used for ethoxylation / propoxylation.

Volume: 1L, 2L & 5L

Optional: Ex-proof weighing balance to measure the quantity of EO/PO charged.

LIQUID METERING PUMP SYSTEM

(a)

(b)

This system is used to charge liquid at a desired rate from as low as 1mL/hr to 100L/hr, when the autoclave is under pressurized condition. The system comes with a metering pump, flow indicator, controller, liquid sump, pressure gauge, strainer, high pressure hose & check valve.

Pressure safety valve, flow totalizer can be offered on request. Types of pumps offered are:

a) Diaphragm metering pumps for pressures up to 100 bar & minimum flow range of 60-600mL/hr to maximum 10-100L/hr. The flow rates are varied by varying the motor speed with variable frequency drive. Materials: SS316, option: Hastelloy C, Titanium, PTFE

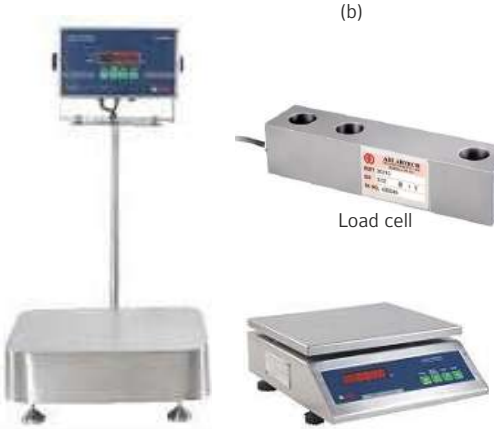
b) High pressure more accurate HPLC type low flow metering pumps for high pressures upto 350 bar & flow range from 0.01 up to 100mL/min.

These pumps can be used along with precision weighing scales to measure the total liquid charged at any point of time. Materials: SS316, option: Hastelloy C, Titanium

In line flow meters can be connected to measure & control the flow of the liquids.

LOAD CELLS & WEIGHING SCALE

Load cell



Weighing scale

- 3 or 4 nos. load cells to measure quantity of the reaction mass inside the reactor.
- Weighing scale are often used for EO / PO etc. liquid charging pots and for charging vessels of metering pump to know the quantity of material charged / dosed.
- Ex-proof load cells & weighing scales are available

Optional Accessories

REFLUX CONDENSER

It is a jacketed single tube SS-316 heat exchanger with packing material inside used to reflux the condensate back into the reactor & vent off the uncondensed vapours. It is connected directly on the autoclave lid & works under full autoclave pressure. A receiver pot can be connected at the bottom of the reflux condenser with valve for reflux take off. It is available in 0.01, 0.02 or 0.05 m^2 area.

Optional: Reflux condensers can be offered in different materials & area.

CONDENSER

It is a SS-316 shell & tube reverse flow heat exchanger for distillation/condensing vent vapours from the autoclave up to 10 bar pressure. It is offered in different surface areas such as 0.1, 0.2, 0.5, 1 & 2 m^2. The condensate can be collected separately in a receiver or optionally refluxed back into the reactor.

Optional:
- Higher area & pressures up to 100 bar
- Different materials
- Corrugated tubes heat exchangers for better efficiency / compact size.

RECEIVER POT

SS 316 receiver pot can be connected at the outlet of the shell & tube or reflux condenser to collect the condensate separately. It is also provided with a port to apply vacuum & offered in 250mL, 500mL, 1L, 2L & 5L volumes. Higher volumes & other materials can be offered on special request. It can be optionally provided with level indication.

FLOW CONTROL VALVES

(a) (b)

These valves can be connected at jacket inlet for controlling flow of steam/ hot oil/ water for temperature control from PID or at the inlet or outlet of the autoclaves for control of pressure.

Two options are available:

a) On/off pneumatic ball valve actuated by 230V output from panel to solenoid valve inline of air supply

b) Pneumatic proportionate flow control valves with I to P convertor (for accurate temperature / pressure control).

BACK PRESSURE REGULATOR (BPR)

(a)

(b)

It is SS 316 regulator mounted on the vent line of the autoclave & is used for maintaining constant pressure inside the autoclave up to 350 bar. The pressure is maintained by releasing the excess pressure into the atmosphere or through a hose to safe area. The pressure can be set initially on the gauge, by manually varying the knob until the gas comes out. Once the set pressure is exceeded the excess pressure is released until the autoclave pressure becomes equal to or below the set pressure. The pressure release is slow & gradual & the set pressure can be varied at any point.

Optional:
a) Electronic actuated digital pneumatic back pressure regulator, where the pressure is set digitally & can be released at preset rate of pressure release (6 bar air supply is required).

b) Pneumatically actuated pilot operated back pressure regulator (air / N_2 gas supply for rated pressure is required to activate the same)

c) Electronic control unit & forward pressure regulator with 4m hose for activating (b) above.

d) Materials: Hastelloy C, PTFE etc.

Optional Accessories

SCADA SOFTWARE FOR REMOTE OPERATION & RECORDING

SCADA is a supervisory control & data acquisition software with all controllers / indicators having RS 485 modbus communication port or PLC & HMI / touch panel, for online display, set point changes & data logging of various parameters like pressure, temperature, motor RPM, motor current / torque, liquid / gas flow rate with totaliser, heater temperature, level, pH, ORP, turbidity, IR etc. remotely from PC as well as locally from panel. It gives continuous online data logging at predefined (variable) time interval, online graphical representation as well as historical data & graphs on PC for single or multiple autoclaves. RS 485-232 convertor & cable up to 50m or higher is also supplied.

Optional: Wireless data communication from PC to panel or mobile alerts can be supplied on request.

LINERS

PTFE Metal

Removable PTFE / metal liner can be offered for autoclaves from 100mL - 5L. These liners can be used for reactions that are corrosive, to prevent the autoclave body from corrosion. PTFE liner can be used up to 200°C & metal up to 500°C. The heat transfer is poor with PTFE liner. Hence, Amar recommends the use of completely corrosion resistant metal autoclaves made from special alloys like Hastelloy, Inconel, Titanium etc. over PTFE liners. Liners should be used only if cost is the constraint or corrosive chemicals are to be used sparingly. Metal liners can be offered in Hastelloy C , Inconel , Monel , Titanium etc.

CATALYST FILTERS

These are small 7 microns SS 316 sintered cup filters which are threaded to bottom of the sampling dip tube so that the catalyst does not come out while sampling liquid. It is very useful when the catalyst is expensive or pyrophoric. These filters may reduce the rate/ flow of the sampling liquid due to the resistance offered by the fine mesh, hence they need regular cleaning to prevent choking. Filters are available for 500mL - 1,000L autoclaves.

Optional: Materials: Hastelloy C

CATALYST FILTRATION & RECYCLING SYSTEM

For small autoclaves

It consists of vertical SS sintered filter cartridges in a SS housing. After the batch is over the reactor liquid is transferred to the catalyst filter under reactor/nitrogen pressure. After filtration is over, catalyst is taken back in to the reactor by back washing, thus recycling the same & making it available for the next batch. Thus catalyst is never exposed to atmosphere & is reused. Generally this system is suitable & available for 2L to 1,000L reactor volume. These filters are available with zero hold-up volume.

CATALYST SLURRY CHARGING SYSTEM

It is a pressure reactor with magnetic drive stirring, inlet & outlet valves, pressure gauge & nitrogen/vent. Solvent & catalyst are charged in the vessel & the slurry formed by mixing is transferred under nitrogen pressure into the reactor. The pressure rating & volume of this system is designed depending on the quantity of catalyst, pressure & temperature rating of the autoclave. Specially designed control system developed by Amar can be offered to charge the catalyst slurry in continuous mode at a pre-defined flow rate under pressure. This is very useful for CSTR, where no suitable pumps are available for slurry. This system is available for any reactor volume, pressures up to 350 bar & for a wide range of materials.

Optional Accessories

CATCH POT

It is used to collect the vent vapours / gases from the autoclave vent / rupture disc / safety valve port, when the vapour / gas is highly hazardous & cannot be released directly into the atmosphere. It is a pressure vessel, designed depending on volume of autoclave & its design pressure. It is provided with inlet, outlet, vent, dip tubes, pressure gauge, safety valve & optionally a flame / flash back arrester. It is normally filled with water. The gases / vapours collected are safely released through the flame / flash back arrester to avoid any hazard. It is suitable & available for any autoclave volume.

VACUUM PUMP

Suitable rotary vane or diaphragm oil fee vacuum pumps can be supplied for vacuum from 100 mbar up to 0.001 mbar in the reactor. It is used either before starting the batch or for high vacuum distillation. Suitable analogue or digital vacuum indicator with controller can be offered on request. The reactor fittings would change for very high vacuum & this may limit its pressure rating

VIEW WINDOWS / LIGHT & SIGHT GLASS

These are quartz / sapphire view glass windows / light & sight glass of small diameter or along the length of the vessel with special cameras & software for continuous online viewing / recording in jacketed vessels to see the reaction. Suitable for high pressures up to 200 bar & any autoclave / reactor volume.

Multiple view windows | Round view window | Sight glass along the vessel length

OTHER ACCESSORIES / OPTIONS

a) Level transmitter (LT) / switch (LS) with indicator to measure or maintain level inside the reactor under high pressure. Used mainly in CSTR.
b) Sampling pot with condenser for cooling / condensing & collecting the sample taken at high pressure & temperature.
c) Torque sensor for accurate measurement of the motor torque, where change in torque indicates change in viscosity of the reaction.
d) High pressure ultrasound transducer for high frequency mixing.
e) Ex-proof certified gas purge panels for electrical accessories / utilities like heating cooling circulators etc.

(a)

(b)

(c)

(d)

(e)

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