



HIGH PRESSURE REACTORS & SYSTEMS

About AMAR

Serving Industry Since 1974

New 50000 sqft state-of-the-art manufacturing facility

Largest exporter of pressure & flow reactors in India

Expertise in custom designing high pressure & flow systems

Inline with government's MAKE IN INDIA campaign

Exports to over 50 countries worldwide

Over 6000 successful installations worldwide

More than 2000 delighted customers globally

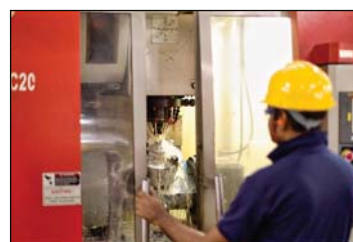
Manufacturing on CNC/VMC & automated machines

Unmatched quality & safety standards

ISO, CE-PED, ASME U, CSA, UL, Ex-Proof, ATEX certification

Prompt & efficient after sales service

Highly skilled & trained team of more than 200 personnel



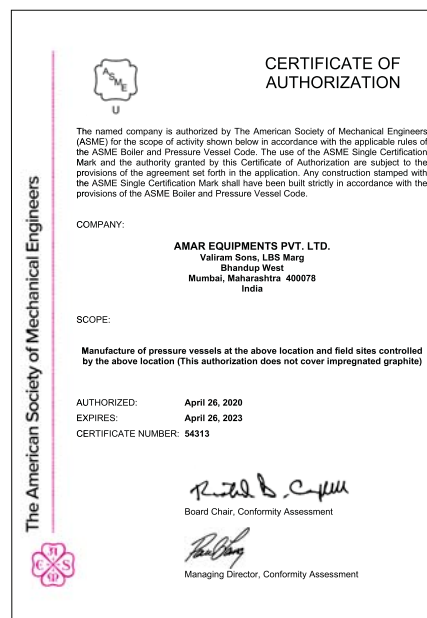
ISO 9001:2015



CE-PED



ASME U



PRESSURE REACTORS – VESSELS & SYSTEMS



OUR PRODUCTS

Stirred Pressure Autoclaves
Plant Scale Pressure Reactors
Parallel Synthesizer
Eco Catalyst Screening
Glass Autoclaves
Magnetic Drive Couplings / Stirrers
Pressure Vessels
Acid Digestion Bomb
Shaker Hydrogenator
Super Critical Fluid Extraction System
HPHT Corrosion Testing System
Gas Hydrate Formation System
Custom Built Pilot Plants / Skids
Continuous Stirred Tank Reactor



SALIENT FEATURES

- Stirred pressure reactors - vessels & systems.
- 25 ml to 10,000 ltr 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.
- 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 invent new molecules / chemicals & study reaction parameters
 - For synthesis of chemicals in small / pilot / large quantities
 - For quality control & process improvements
 - For high throughput catalyst screening
- For supercritical CO₂ solvent extraction / reaction / drying / evaporation system
- For static, dynamic, loop & electrochemical HPHT corrosion testing
- Gas hydrate formation
- 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.



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Abbreviations used in the catalogue

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

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 – 100 ml & 250 ml



100 ml assembly



250 ml assembly



100 ml
table top autoclave

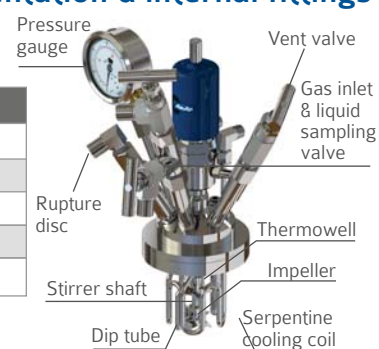


250 ml trolley autoclave

Nozzle orientation & internal fittings

STANDARD MODELS FOR 100 ml VOLUME

Model No.	A 1313	A 1315	A 1323	A 1325
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 250 ml VOLUME

Model No.	A 1413	A 1415	A 1423	A 1425	A 1433	A 1435
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 100 ml & 250 ml 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 100 ml), serpentine cooling coil (for 250 ml), 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	SS control panel with programmable PID temperature controller with high temperature alarm and variable frequency drive for motor speed control
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz
Mounting & Dimensions	SS Table Top
	(W x D x H) mm
	275 x 275 x 800
Mounting & Dimensions	SS Trolley
	Reactor
	275 x 300 x 250
Mounting & Dimensions	Control panel
	1010 x 410 x 1300
	Trolley model shall include water pump & 10 ltr tank to cool the magnetic drive

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. 43 to 49 for optional accessories



AUTOCLAVES – 500 ml, 750 ml & 1000 ml



500 ml assembly



750 ml assembly



1000 ml assembly



500 ml table top autoclave

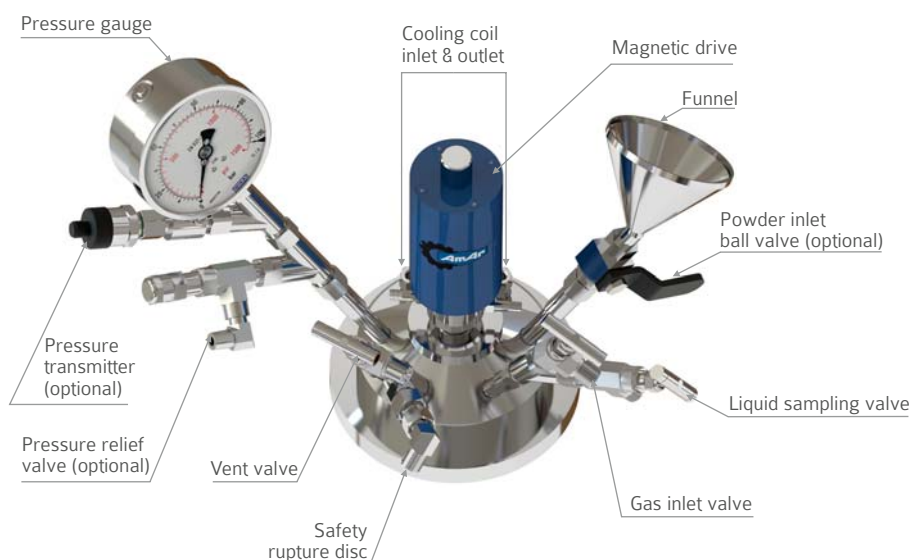


750 ml table top autoclave



1000 ml trolley autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS



AUTOCLAVES – 500 ml, 750 ml & 1000 ml



STANDARD MODELS FOR 500 ml AUTOCLAVE

Model No.	A 2113	A 2115	A 2123	A 2125
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 750 ml AUTOCLAVE

Model No.	A 2213	A 2215	A 2223	A 2225	A 2233	A 2235
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 1000 ml AUTOCLAVE

Model No.	A 2313	A 2315
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 500 ml, 750 ml & 1000 ml 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 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 & 10ltr Tank ¹	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.			
Control Panel	SS control panel with programmable PID temperature controller with high temperature alarm and variable frequency drive for motor speed control			
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz			
Mounting (W x D x H) mm		SS table top		Trolley
	Reactor volume	Reactor	Panel	
	500 ml & 750 ml	400 x 400 x 900	275 x 300 x 250	1010 x 410 x 1340
	1000 ml	400 x 400 x 925	275 x 300 x 250	1040 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. 43 to 49 for optional accessories



AUTOCLAVES – 2 ltr & 5 ltr



2 ltr trolley autoclave



2 ltr assembly

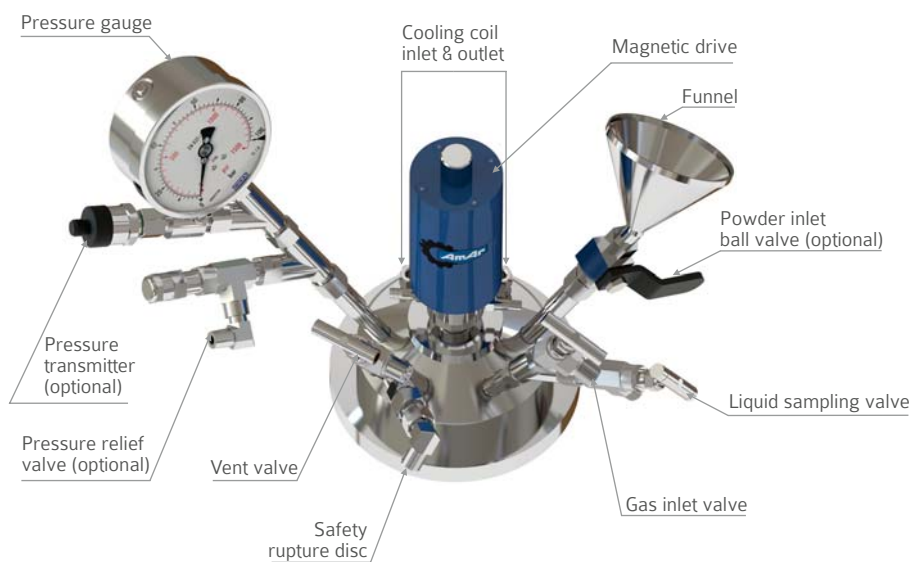


5 ltr assembly



5 ltr trolley autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS



AUTOCLAVES – 2 ltr & 5 ltr



STANDARD MODELS FOR 2 ltr AUTOCLAVE

Model No.	A 2413	A 2415	A 2423	A 2425	A 2433	A 2435
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 5 ltr AUTOCLAVE

Model No.	A 2513	A 2515	A 2523	A 2525	A 2533	A 2535
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)	152		134		134	
Vessel Internal Height (mm)	310		360		360	
Min. Stirrable Volume (ml)	360					

TECHNICAL SPECIFICATIONS FOR 2 ltr & 5 ltr 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 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 & 10ltr Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.		
Control Panel	SS control panel with programmable PID temperature controller with high temperature alarm and variable frequency drive for motor speed control		
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz		
Mounting (W x D x H) mm	Reactor volume	SS Trolley	
	2 ltr	1040 x 410 x 1350	
	5 ltr	1100 x 410 x 1350	

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

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

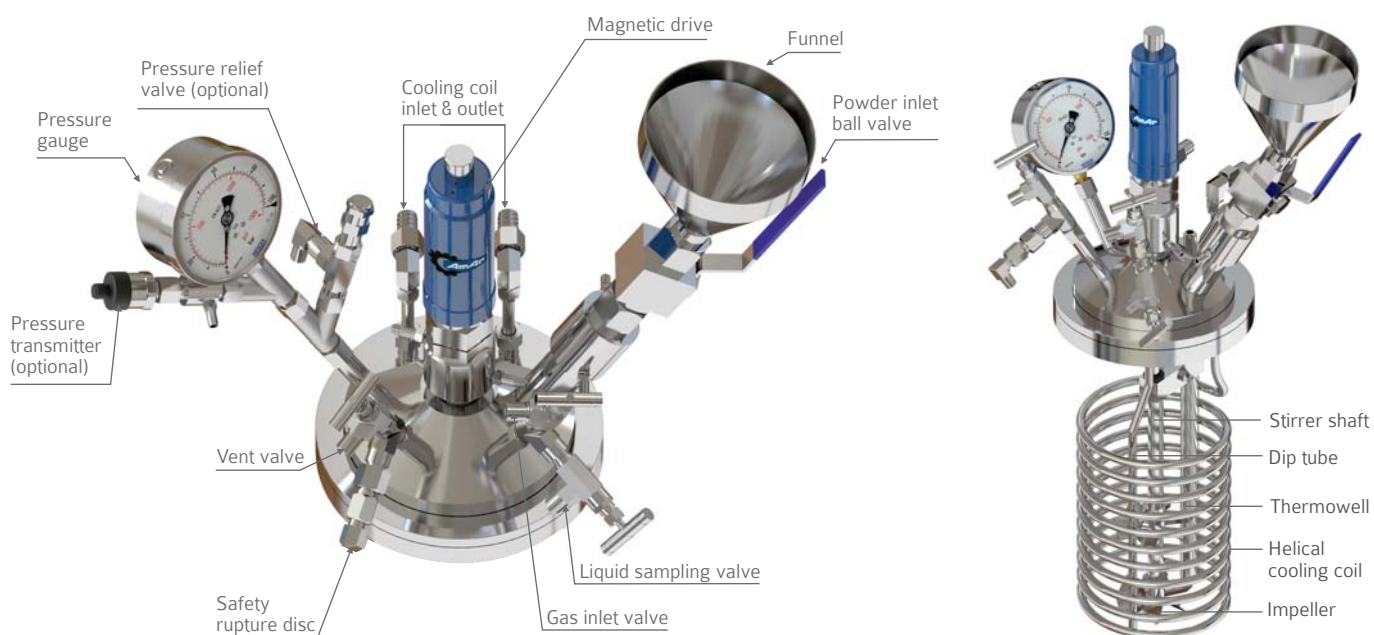
Refer page no. 16 to 21 for options of standard models & page no. 43 to 49 for optional accessories



AUTOCLAVES – 10 ltr & 25 ltr



NOZZLE ORIENTATION & INTERNAL FITTINGS



AUTOCLAVES – 10 ltr & 25 ltr



STANDARD MODELS FOR 10 ltr VOLUME

Model No.	A 3113	A 3115	A 3123	A 3125	A 3133	A 3135
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 (ltr)	1					

STANDARD MODELS FOR 25 ltr VOLUME

Model No.	A 3313	A 3315	A 3323	A 3325
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 (ltr)	2.6			

TECHNICAL SPECIFICATIONS FOR 10 ltr & 25 ltr 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	Ball Valve	FBV
	¼" NPTM	¾" NPTM	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 & 10ltr Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.		
Lifting Arrangement	Mechanical chainpulley arrangement for lifting the head, vessel etc.		
Control Panel	SS control panel with programmable PID temperature controller with high temperature alarm and variable frequency drive for motor speed control		
Power Supply	3 Ø, 440 V AC, 25 Amp, 50 / 60 Hz		
Mounting & Dimensions (W x D x H) mm	Reactor Volume	SS Trolley	
	10 ltr	1310 x 585 x 1550	
	25 ltr	1310 x 585 x 1800	

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. 43 to 49 for optional accessories



AUTOCLAVES – 50 ltr & 100 ltr

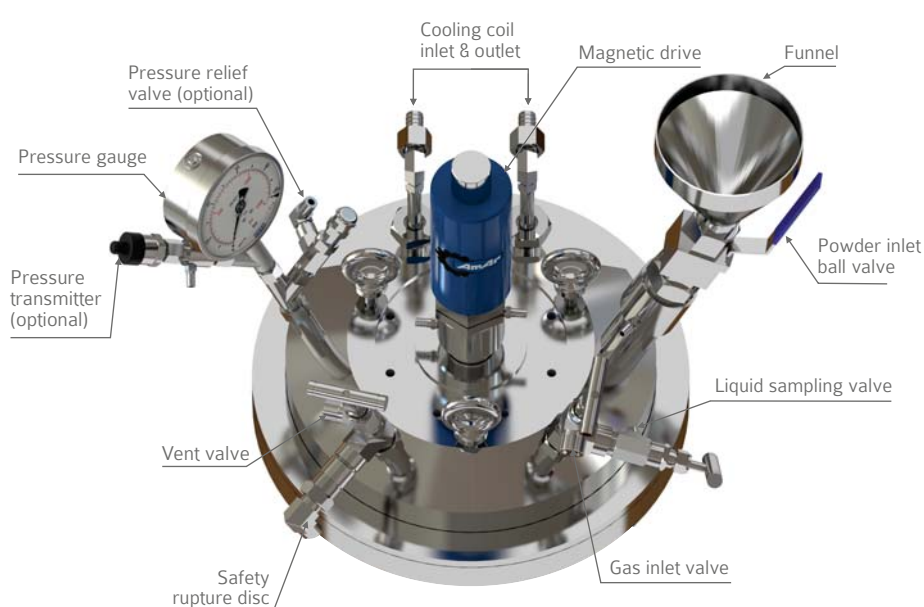


50 ltr autoclave



100 ltr autoclave

NOZZLE ORIENTATION & INTERNAL FITTINGS



AUTOCLAVES – 50 ltr & 100 ltr



STANDARD MODELS FOR 50 ltr VOLUME

Model No.	A 3403	A 3405	A 3413	A 3415
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 (ltr)	6			

STANDARD MODELS FOR 100 ltr VOLUME

Model No.	A 3503	A 3505	A 3513	A 3515
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 (ltr)	12			

TECHNICAL SPECIFICATIONS FOR 50 ltr & 100 ltr 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, 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	Ball Valve	FBV
	½" NPTM	1" NPTM	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 & 10ltr Tank	With tubing to cool the magnetic drive, pressure sensor etc. by water re-circulation.		
Lifting Arrangement	Mechanical chainpulley arrangement for lifting the head, vessel etc.		
Control Panel	SS control panel with programmable PID temperature controller with high temperature alarm and variable frequency drive for motor speed control		
Power Supply	3 Ø, 440 V AC, 25 Amp, 50 / 60 Hz		
Mounting & Dimensions (W x D x H) mm	Reactor Volume	SS Trolley	
	50 ltr	1500 x 675 x 2350	
	100 ltr	1500 x 780 x 2350	

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. 43 to 49 for optional accessories



PARALLEL SYNTHESIZER



SALIENT FEATURES

- 4 or 6 nos. of 100 ml to 2 ltr parallel overhead stirred autoclave.
- Common mounting & control panel with remote monitoring & control.
- Pressure upto 350 bar & temperatures upto 500°C.
- Simultaneous reaction 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 testing.
- SCADA software with suitable laptop for remote set points, control & recording of temperature, pressure, speed control, H₂ gas flow rates, total H₂ consumed with batch reports & online / history graphs
- The optional accessories can be common or separate for all autoclaves.

Note: Prefix M4 or M6 before autoclave models. Refer page no. 5 to 9 for autoclave models & technical specifications



ECO CATALYST SCREENING

SALIENT FEATURES

- **Eco-cat 7:** 7 parallel reactors of 25 ml 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 etc.
- Very compact & economical system
- Ideal for high through-put catalyst screening
- Mounting: Table top
- Dimensions: 350 mm (W) x 350 mm (D) x 500 mm (H)



GLASS AUTOCLAVES



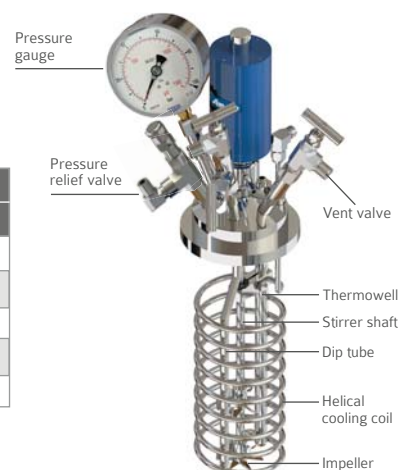
500 ml bottom heated glass autoclave



2 Ltr Jacketed glass autoclave with temperature control unit



Nozzle orientation & internal fittings



STANDARD MODELS FOR GLASS AUTOCLAVES

Volume	500 ml	1 Ltr		2 Ltr
Model No. *	G 2160	G 2360	GJ 2370	G 2460
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 for 6 bar Jacketed vessel

TECHNICAL SPECIFICATION FOR GLASS AUTOCLAVES STANDARD MODELS

Description	Specification			
Material of Construction	Borosilicate glass cylinder with other wetted parts of SS 316L			
Head Mounting Style	Removable head and vessel design			
Heating Type	Electrical plate heater from bottom (jacket optional)			
Motor	¼ hp AC / 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, pressure safety valve, gas inlet and liquid sampling needle valve with common dip tube, vent needle valve Internal Fittings: Helical cooling coil, dip tube, thermowell with RTD PT 100 sensor			
Gasket	PTFE			
Control Panel	SS control panel with programmable PID temperature controller & high temperature alarm (for electrically heated model) and variable frequency drive for motor speed control			
Power Supply	1 Ø, 220 V AC, 16 Amp, 50 / 60 Hz			
Mounting & Dimensions (W x D x H) mm	Reactor Volume	SS Table Top	Control Panel	
	500 ml	320 x 300 x 700	275 x 300 x 250	
	1 ltr	380 x 310 x 910		
	2 ltr	380 x 310 x 1050		
Guard	Polycarbonate guard will be provided around glass body			

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. 43 to 49 for optional accessories



OPTIONS FOR STANDARD MODELS

Enquiry guide for customised models

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

B. MATERIAL OF CONSTRUCTION

Reactor vessels of material SS316L, upto 5 ltr are machined from rolled / forged bar stock & reactors above 5 ltr are normally fabricated from plates. SS316L autoclaves upto 100 ltr 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
100 ml to 100 ltr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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.		Oxidizing Media			Halogen and derivatives				
			Caustic and mild alkalis, excluding ammonium hydroxide	Ammonium hydroxide and amines	Acid solutions, e.g. nitric	Neutral or alkaline solutions e.g. per sulfates, peroxides, chromates	Pitting media, acid ferric chloride solutions	Halogen		Halide acids, moist, e.g. hydrochloric hydrolysis products of organic halides	Hydrogen halides, dry, e.g., dry, Hydrogen chloride	
								Moist, e.g., chlorine below dew point	Dry, e.g. fluorine above dew point			
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 or hydraulic arrangement on special request for autoclaves above 5 ltr volume.

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 100 ml to 750 ml, pneumatically for 1 ltr to 25 ltr & hydraulically for 50 ltr & 100 ltr. This system is useful when head of the autoclave has lot of 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.



1 ltr autoclave with removable head design



100 ml with manual vessel raising lowering



10 ltr with pneumatic vessel raising lowering



50 ltr with hydraulic vessel raising lowering



2 ltr autoclave with raising lowering & tilting

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.

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
100 ml	✓	-	-	-	-
250 ml	✓	-	-	-	-
500 ml	✓	-	-	-	-
750 ml	✓	-	-	-	-
1 ltr.	-	✓	✓	-	-
2 ltr.	-	✓	✓	-	-
5 ltr.	-	✓	✓	-	-
10 ltr.	-	✓	✓	-	-
25 ltr.	-	✓	✓	-	-
50 ltr.	-	-	-	✓	✓
100 ltr.	-	-	-	✓	✓

D. HEATING TYPES

Electrical ceramic band heater with ceramic wool insulation & cladding.

Optional:

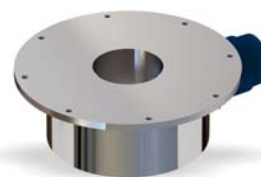
a) Flameproof / explosion proof IIB + H₂ certified, aluminium cast Heater (temperature up to 200 °C) for H₂ gas with totally enclosed heating element inside metal tube. Heating rates are lower in FLP heaters in comparison to ceramic band heaters

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

Note: 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
100 ml	✓	✓
250 ml	✓	✓
500 ml	✓	✓
750 ml	✓	✓
1 ltr.	✓	✓
2 ltr.	✓	✓
5 ltr.	✓	✓
10 ltr.	✓	✓
25 ltr.	✓	✓
50 ltr.	-	✓
100 ltr.	-	✓



(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 / torque % (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 group IIC, ideal for H₂ 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

Compact inline motor drive

Compact inline brushless DC motor & magnetic drive & speed controller with indicator for 300-1200 rpm for 100 ml to 1 ltr autoclaves. Very compact, economical & light weight. No external rotating part.



IIC FLP motor / ATEX motor



AC motor



Motor with gear box



IIA, IIB FLP motor

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
100 ml	✓	✓	✓	✓
250 ml	✓	✓	✓	✓
500 ml	✓	✓	✓	✓
750 ml	✓	✓	✓	✓
1 ltr.	✓	✓	✓	✓
2 ltr.	-	✓	✓	✓
5 ltr.	-	✓	✓	✓
10 ltr.	-	✓	✓	✓
25 ltr.	-	✓	✓	✓
50 ltr.	-	✓	✓	✓
100 ltr.	-	✓	✓	✓

*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
100 ml	✓	-
250 ml	✓	-
500 ml	✓	✓
750 ml	✓	✓
1 ltr.	✓	✓
2 ltr.	✓	✓
5 ltr.	✓	✓
10 ltr.	-	✓
25 ltr.	-	✓
50 ltr.	-	✓*
100 ltr.	-	✓*

✓* Standard fitting



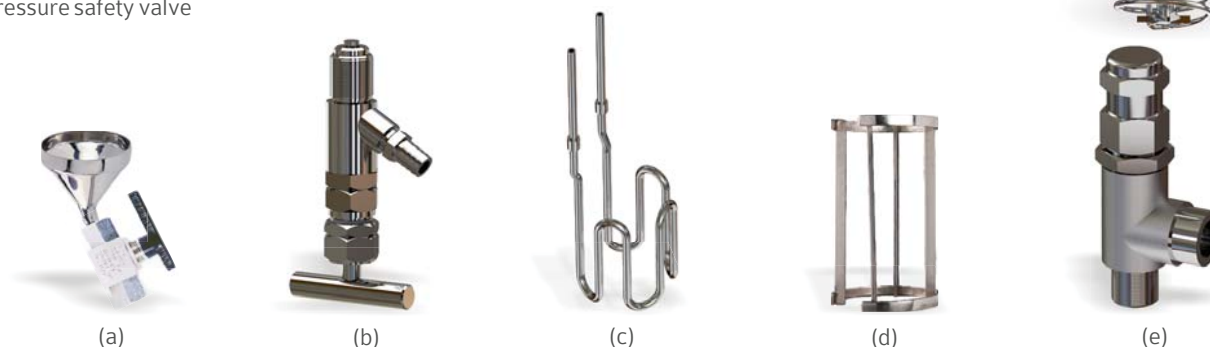
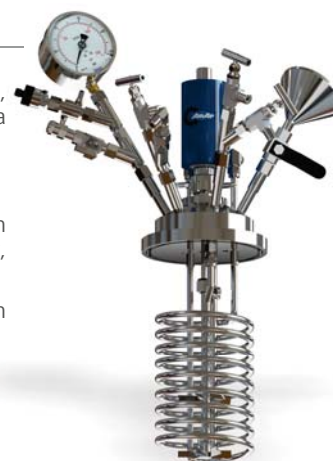
Autoclave with inline motor

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:

- 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.
- Flush bottom valve with almost zero dead volume (optionally additional ball valve at the outlet of flush bottom valve can be provided).
- Serpentine cooling coil instead of helical for easy cleaning (500 ml to 100 ltr)
- Removable internal baffles for better stirring (cooling coil has to be removed up to 5 ltr autoclave)
- Pressure safety valve



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

✓* Standard fitting

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

G. STIRRER OPTIONS

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

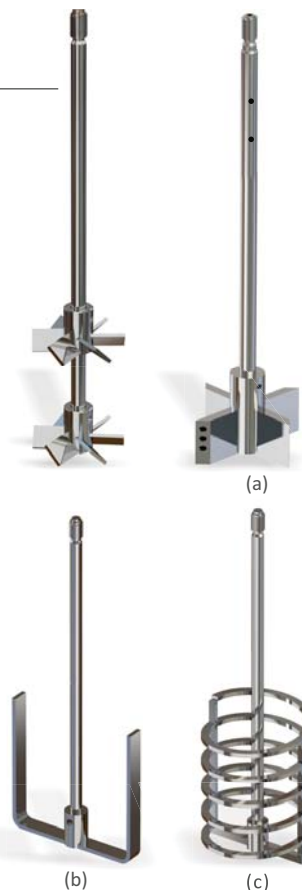
Optional:

- 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)

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



H. BODY & HEAD SEALING

Split clamp bolt design:

Split clamp type quick opening system with clamp bolts & tongue & groove sealing with PTFE head gasket for temperatures upto 300°C & grafoil head gasket for temperatures upto 500°C.

Optional

Threaded sealing:

For 100 ml & 250 ml vessels there is alternative 'O' ring seal design with threaded clamp & threaded vessel for ease of opening & tightening by hand. This design can be offered for pressures upto 100 bar & temperature upto 200°C for Viton & 250°C for Kalrez 'O' ring.

Threaded cap with FKM (Viton) 'O'ring up to 200°C	CV
Threaded cap with FFKM (Kalrez) 'O'ring up to 250°C	CK



Split clamp & bolt design



Threaded sealing

OPTIONS FOR STANDARD MODELS



I. CONTROL PANEL

Compact SS-304 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. 3 phase panels are provided with phase current indicators. This helps in identifying if any of the 3 heaters or phases have failed. 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 torque / current indicator, heater temperature cascade controller etc. indicators are provided additionally on same common control panel depending on the optional accessories selected.

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) 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 100 ltr)	F2C
Touch screen panel (available for autoclaves up to 100 ltr)	TSP



1Ø panel



Touch panel



PLC panel



3Ø panel



1Ø panel



FLP panel

J. 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 100 ml to 1 ltr only. In table top model the panel & accessories have to be mounted separately.

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



500 ml table top autoclave



2 ltr trolley autoclave

K. CERTIFICATIONS

CE-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



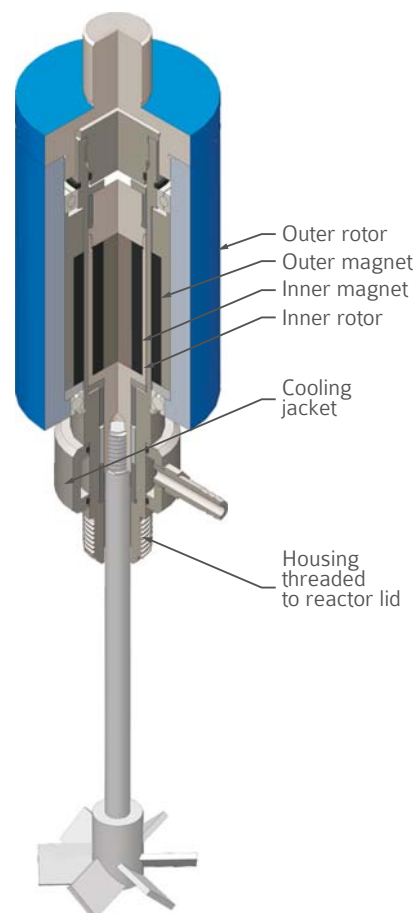
Country specific certifications like CRN for Canada, AS1210 for Australia & DOSH for Malaysia can be offered on request.



MAGNETIC DRIVE COUPLING & MIXERS

SALIENT FEATURE

- Suitable for full vacuum to 700 bar pressure & 500 °C temperature
- Magnetic drive couplings, mixers & agitators available for 100 ml - 10,000 ltr reactors
- High torque magnetic drive from 0.8 to 1000 Nm
- Materials of SS316, Hastelloy C, inconel, titanium, zirconium, for resistance to various chemicals
- Compact inline motor & magnetic couplings MM series with speed controller
- The gland/mechanical sealing need replacement after every 200-1000 hrs of working depending on application & have limitation of maximum pressure where as magnetic drive can run virtually life long without leakage & can be designed for pressures upto 700 bar
- 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
- No wastage of expensive liquids through leakage
- Almost no losses since these are friction free in synchronous operations
- Minimum vibration transmission & hence smooth running
- The coupling is flexible & hence any over load results in coupling slippage, thus preventing any damage to coupling, shaft or motor



Cross-sectional view of magnetic drive coupling for high pressure application (M series)

TECHNICAL SPECIFICATIONS

Model No.*	Static torque capacity		For reactor volume	
	Kg-cm.	N-m.	Standard	Optional
M08 / MM08	8	0.78	100 ml - 250 ml	—
M20 / MM20	20	1.96	-	500 ml - 1 ltr
M40	40	3.92	500 ml - 5 ltr	-
M80	80	7.85	10 - 25 ltr	-
M120	120	11.7	50 - 100 ltr	-
M200	200	19.6	100 - 10,000 ltr up to 30 hp motor & 300 rpm	
M400	400	39.2		
M600	600	58.8		
M1200	1200	117.6		
M2400	2400	235.2		
M4800	4800	470.4		
M6000	6000	588		
M9600	9600	936		

Note:

- a) The number after the series indicates the static torque capacity in kg-cm
b) 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



M-Series



MM-Series

PLANT SCALE PRESSURE REACTORS



250 ltr 100 bar reactor
with automated valves



1000 ltr gas induction reactor



500 ltr reactor

SALIENT FEATURES

- 100 to 10,000 ltr (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
- Zero leakage magnetic drive coupling from 20-1000 Nm torque capacity
- High mass transfer hollow shaft with gas induction impeller (ideal for hydrogenation, oxidation, amination, chlorination, bromination & other gas-liquid reactions) pitch blade turbine, anchor etc. for other applications
- Skid mounted complete 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 48)
- Suitable catch pot & flame arrester to collect the vent (refer page 49)
- Lugs or floor stand skid mounted structure in MS or SS

For other optional accessories refer page 43 to 49.



400 ltr Hastelloy reactor with
continuous recirculation system



NON-STIRRED PRESSURE VESSELS



SALIENT FEATURES

- 25 ml to 100 ltr net filling volume standard models & 150 ltr to 10000 ltr 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 FOR 25 ML TO 250 ML

Volume	25 ml					
Model No.	P 1113	P 1115	P 1123	P 1125	P 1133	P 1135
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	50 ml					
Model No.	P 1213	P 1215	P 1223	P 1225	P 1233	P 1235
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	100 ml			
Model No.	P 1313	P 1315	P 1323	P 1325
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	250 ml					
Model No.	P 1413	P 1415	P 1423	P 1425	P 1433	P 1435
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 500 ML TO 5 LTR

Volume	500 ml			
Model No.	P 2113	P 2115	P 2123	P 2125
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	750 ml					
Model No.	P 2213	P 2215	P 2223	P 2225	P 2233	P 2235
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	1 ltr	
Model No.	P 2313	P 2315
Design Pressure	100 bar	
Design Temperature	300°C	500°C
Vessel I/D (mm)	101.6	
Vessel Internal Height (mm)	163	

Volume	2 ltr					
Model No.	P 2413	P 2415	P 2423	P 2425	P 2433	P 2435
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	5 ltr					
Model No.	P 2513	P 2515	P 2523	P 2525	P 2533	P 2535
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 10 LTR TO 100 LTR

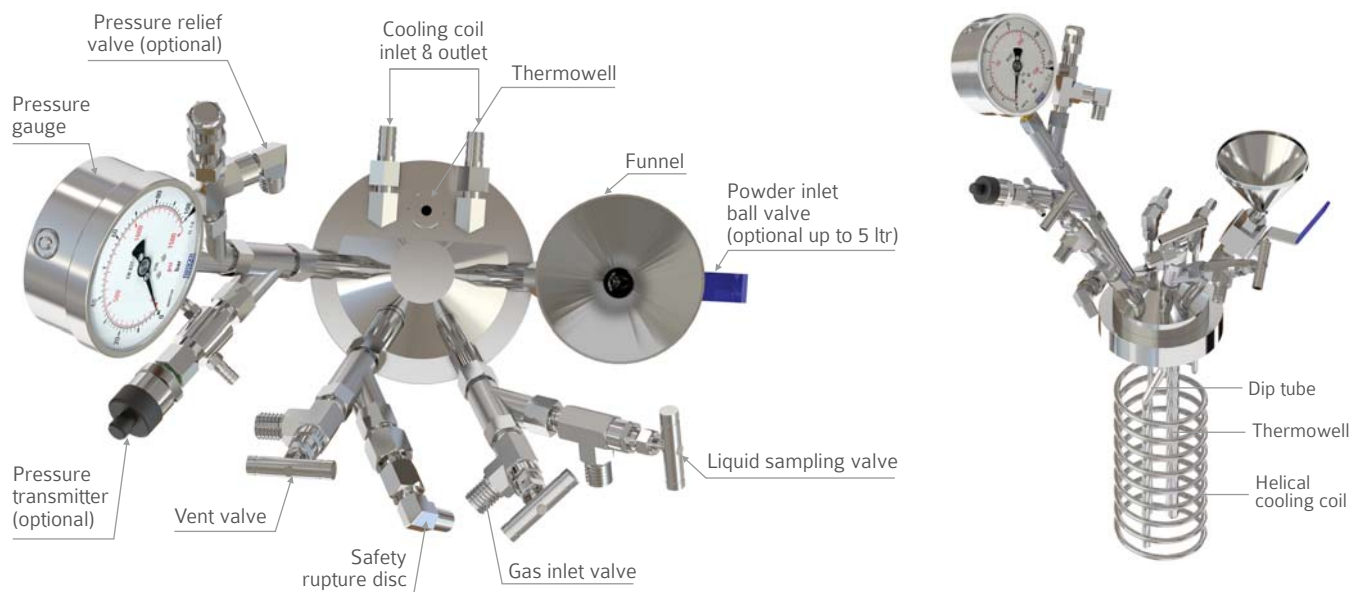
Volume	10 ltr					
Model No.	P 3113	P 3115	P 3123	P 3125	P 3133	P 3135
Design Pressure	100 bar		200 bar		350 bar	
Design Temperature	300°C	500°C	300°C	500°C	300°C	500°C
Vessel I/D (mm)	185					
Vessel Internal Height (mm)	400					

Volume	25 ltr			
Model No.	P 3313	P 3315	P 3323	P 3325
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	50 ltr				100 ltr			
Model No.	P 3403	P 3405	P 3413	P 3515	P 3503	P 3505	P 3513	P 3515
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
50 ml - 250 ml	1/4"	—	—
500 ml - 5 ltr	1/4"	1/4" (optional)	10 mm (optional)
10 ltr - 25 ltr	1/4"	3/4"	15 mm
50 ltr - 100 ltr	1/2"	1"	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 (for 10 ltr to 100 ltr), flush bottom valve (5 ltr to 100 ltr) Internal Fittings: Single tube-in & tube-out coil (for 100 ml), serpentine cooling coil (for 250 ml), Helical cooling coil (for 500 ml to 100 ltr), dip tube, thermowell with RTD PT 100 sensor		
Gasket	PTFE up to 300°C and grafoil gasket up to 500°C		
Closure Type	Split clamp with clamp bolts		
Heating Type ¹	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C		
Auto-cooling System ¹	With water pump for forced cooling, SS tank & hose pipes for temperature control.		
Water Pump & 10 ltr Tank ¹	With tubing to cool the pressure sensor etc. by water re-circulation.		
Control Panel ¹	SS control panel with programmable PID temperature controller with high temperature alarm		
Mounting & Dimensions (W x D x H) mm	Mounting	Vessel Volume	Dimensions
	SS Table Top	25 ml, 50 ml, 100ml, 250 ml	140 x 140 x 500
		500 ml & 750 ml	160 x 160 x 630
		1 ltr	200 x 200 x 710
	Trolley Model	2 ltr	1040 x 410 x 1140
		5 ltr	1100 x 410 x 1140
		10 ltr	1310 x 585 x 1750
		25 ltr	1310 x 600 x 1800
		50 ltr	1500 x 675 x 1850
		100 ltr	1550 x 780 x 1900

¹Only for trolley model
For optional accessories refer page no. 43 to 49.

NON-STIRRED PRESSURE VESSELS



Enquiry guide for non-stirred pressure vessel customized models

Enquiry code structure is **Standard Model no. 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 (50 ml to 750 ml)	K
Fixed head with pneumatic vessel raising lowering (1 ltr to 25 ltr)	P
Fixed head with pneumatic vessel raising lowering & tilting (1 ltr to 25 ltr)	PT
Fixed head with hydraulic vessel raising lowering (50 ltr & 100 ltr)	H
Fixed head with hydraulic vessel raising lowering & tilting (50 ltr & 100 ltr)	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 Body & Head Sealing

Split clamp bolt design	CS
Threaded sealing (for 25 ml to 250 ml)	CT

Refer page no. 20 for more details

I Control Panel

SS 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. 21 for more details

J Mounting & Overall Dimensions (approx)

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

Refer page no. 21 for more details

K Certifications**

CE-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) Customer is advised to select best suited options for most optimized price & delivery.

2) For other optional accessories please refer page 43 to 49.

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



100 ml



250 ml



500 ml

SALIENT FEATURES

- 50 ml to 750 ml net filling volume
- Design pressures upto 200 bar and temperatures upto 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



50 ml

100 ml

STANDARD MODELS FOR ACID DIGESTION BOMBS

Volume	50 ml	100 ml	250 ml	500 ml	750 ml
Model No.	D 1212	D 1312	D 1412	D 2112	D 2212
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	50 ml	100 ml
Model No.	DM 1202	DM 1302
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	500 ml		1 ltr		2 ltr	
Model No.	SM 2082	SG 2060	SM 2282	SG 2260	SM 2382	SG 2360
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	4 ltr 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

Enquiry guide for customized models

Enquiry code structure is **Standard Model no-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 **SM 2182-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 500 ml	M21
Interchangeable metal vessels 1 ltr	M23
Interchangeable metal vessels 2 ltr	M24

G Interchangeable Glass Vessels*

Interchangeable glass vessels 500 ml	G21
Interchangeable glass vessels 1 ltr	G23
Interchangeable glass vessels 2 ltr	G24

Note:

- 1) Customer is advised to select best suited options for most optimized price & delivery.
- 2) For other optional accessories please refer page 43 to 49.
- 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

- 100 ml lab scale to 1000 ltr 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 CO₂ recycling
- PED, U stamp, CE, CSA, UL certification optional
- Customizable designs as per client requirements

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 CO₂ textile dyeing is an emerging innovative waterless technology for dyeing of textile fabrics that will revive the textile industries.



SCFE plant - 1 ltr



SCFE plant - 50 ltr

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 CO₂ (SCO₂) textile dyeing of fabrics
- Supercritical CO₂ (SCO₂) cleaning of high precision metal components
- Supercritical CO₂ (SCO₂) 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 CO₂
- Low operating cost

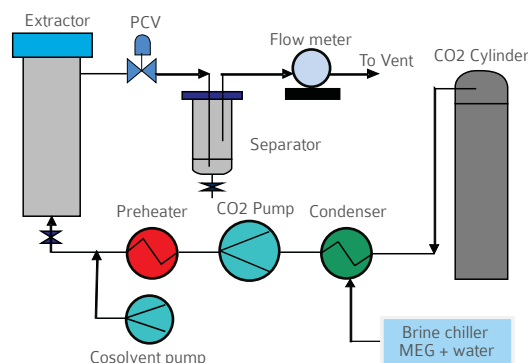
ADVANTAGE OF CO₂ AS A SOLVENT

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

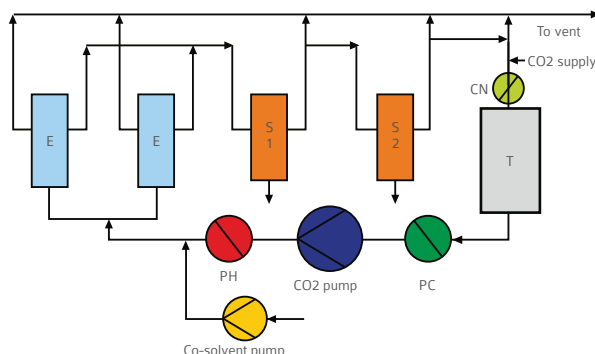
PROCESS DESCRIPTION FOR LAB-SCALE

The Carbon dioxide gas from the cylinder is first liquefied & then pressurized above the critical pressure of CO₂ (73.8 bar) to the required pressure necessary for extraction. This high pressure liquid CO₂ is then heated above the critical temperature of CO₂ (31 °C) to the required temperature. CO₂ which is now in supercritical phase (SCCO₂) 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 SCCO₂ finally come to the separator at atmospheric pressure & get precipitated. CO₂ leaving the separator is then measured by passing it through a CO₂ gas flow meter.

SUPERCritical FLUID EXTRACTION SYSTEM



SCFE flow diagram for lab scale model



PFD for commercial scale SCFE plant with CO₂ 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 CO₂ tank is pre-cooled by passing it through the pre-cooler. This pre-cooled liquid carbon dioxide is then pressurized by means of a positive displacement plunger pump to a pressure above the critical pressure of CO₂ (i.e. 73.8 bar). High pressure liquid CO₂ is then heated above the critical temperature of CO₂ (i.e 31 °C) by passing it through preheater. CO₂ which is now in the supercritical state enters the extractor in which the raw material is loaded. The SCCO₂ dissolves substances on the basis of solubility, depending on operating conditions. The SCCO₂ 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 CO₂ without any traces is recycled back to the CO₂ tank via condenser.



SCCO₂ system for very high temperature (400°C) application

SPECIFICATIONS

MOC SS316

Volume (ltr)	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 STANDARD MODELS

Model no.	Working volume (ltr)	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/ltr of feed & maximum 6 batches / day.

- 5 ltr & above systems are offered with CO₂ recycling & PLC controls.
- **AEPL has trial facility of lab scale SCFE plant with extractor volume of 2.5 ltr having design temperature of 200°C & design pressure of 550 bar with CO₂ & co-solvent pumps along with CO₂ recycling facility.**



SCFE plant - 250 ml



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



AUTOCLAVES FOR CORROSION TESTING

SALIENT FEATURES

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

METHODS OF TESTING CORROSION USING AUTOCLAVE

- 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 waters 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



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



10 ltr autoclave for HPHT corrosion testing



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

AUTOCLAVES FOR 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 & auxiliary 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



1 ltr & 5 ltr autoclaves for corrosion testing



Rotating coupon holder assembly



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

- 100 ml to 100 ltr 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 VESSEL FOR GAS - LIQUID STORAGE

SALIENT FEATURES

- 150 ltr to 10000 ltr custom designed pressure vessels
- Design pressure up to 700 bar & design temperature up to 600 °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.



SALIENT FEATURES

- **Custom-built skids & pilot plant** are designed with suitable arrangements for raw material 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 HMI & 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 2 ltr to 1000 ltr.
- **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
- **Sealing:** Mechanical seal / high torque zero leakage magnetic drive coupling.
- **Standards & certifications:** PED / ASME U stamp certified vessels, ex-proof, CE certified / CSA certified electricals, can be quoted on request.



10 ltr fully automated ex-proof alkoxylation pilot plant



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



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

CUSTOM BUILT SKIDS & PILOT PLANTS



500 Ltr 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 raising, lowering & tilting



CUSTOM BUILT SKIDS & PILOT PLANTS



Continuous emulsion polymerization pilot plant



500 ml high pressure vessel with ultrasonicator probe system



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



5 ltr reactor with charging & condensation arrangement

CUSTOM BUILT SKIDS & PILOT PLANTS



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



Jacketed reactor with distillation setup & ex-proof electricals



1 ltr & 2 ltr 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



20 ltr high temperature pilot plant



Di-nitration & mononitration setup



High pressure polytest reactor system



5 ltr high pressure ex-proof distillation skid



100 ltr pilot plant with distillation setup

CUSTOM BUILT SKIDS & PILOT PLANTS



Ex-proof autoclave
with load cell arrangement



Bottom driven autoclave



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



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



50 ltr high pressure system



Batch reactor
for visbreaking process

OTHER SPECIAL HIGH PRESSURE APPLICATIONS

- Hydrothermal synthesis of zeolites, synthetic clays
- For bauxite digestion
- For alkaline / sulphuric acid leaching of ores
- For napthenic acid corrosion studies
- For crystallization
- For solubility studies of oxides
- For carrying out pulping & pulp bleaching experiment
- Polymer mini reactor for synthesis



2 ltr interchangeable SS & glass
autoclave for ethoxylation



Reactor with reflux return
or take off



CONTINUOUS STIRRED TANK REACTORS

SALIENT FEATURES

- Product is developed / produced on continuous basis for better productivity
- Stirred tank reactors of 100 ml to 10000 ltr
- Single or multiple reactors connected in series
- SS-316, Hastelloy C, inconel etc. materials
- Pressures upto 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.



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



1 ltr, 4 nos. CSTR in series



High pressure CSTR
for hydrogenation



CSTR for hydro-cracking
of heavy hydrocarbon oils

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 Teflon 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 upto 700 bar pressure



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



COROLIS 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



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.



TEMPERATURE CONTROL UNIT



CLM-1



CPM-1W



CLL-1

CLM series (-90°C to +200°C): For lab applications

Model	Temperature Range °C	Heating kW	Cooling power kW			Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
			0°C	-20°C	-30°C				
CLM-1	-30 to +200	1.5	0.6	0.3	0.1	18~20	0.4	475 x 400 x 800	M.24 Male
CLM-2	-35 to +200	2.5	0.8	0.5	0.25	30~35	0.4	420 x 520 x 875	M.24 Male
CLM-3	-35 to +200	3.6	1.2	0.7	0.3	30~35	0.4	450 x 600 x 900	M.24 Male
CLM-4W	-35 to +200	4.5	2.5	1.3	0.6	40~45	0.7	540 x 650 x 1250	M.42 Male
			0°C	-40°C	-60°C				
CLL-1	-75 to +180	1.5	0.6	0.6	0.3	30~35	0.4	600 x 650 x 1400	M.24 Male
CLL-2	-75 to +180	3	1.5	1.4	1.2	30~35	0.4	600 x 650 x 1400	M.24 Male
CLL-3W	-75 to +180	4.5	2.2	2.0	1.4	40~45	0.7	700 x 750 x 1500	M.42 Male
CLL-4W	-90 to +180	4.5	2.2	2.0	1.4	40~45	0.7	700 x 750 x 1500	M.42 Male

CPM series (-60°C to +200°C): For pilot applications

Model	Temperature Range °C	Heating kW	Cooling power kW			Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
			0°C	-20°C	-30°C				
CPM-1W	-35 to +200	6	4	2.2	1.3	50~55	1.0	560 x 650 x 1300	M.42 Male
CPM-2W	-35 to +200	9	7	3.5	1.8	50~55	1.0	600 x 690 x 1300	M.42 Male
CPM-3W	-30 to +200	12	12	6	3	80~90	1.5	700 x 750 x 1500	M.42 Male
CPM-4W	-30 to +200	18	15	7	3.5	80~90	1.5	750 x 790 x 1500	M.42 Male
			0°C	-40°C	-60°C				
CPL-1W	-60 to +200	6	6.5	3.2	1	50~55	1.0	750 x 790 x 1500	M.42 Male
CPL-2W	-60 to +200	9	12	6	1.5	80~90	1.5	750 x 790 x 1500	M.42 Male

CIM series (-30°C to +170°C): For industrial applications

Model	Temperature Range °C	Heating KW	Cooling power kW			Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
			0°C	-20°C	-30°C				
CIM-1W	-30 to +170	21	25	11	8	100	1.5	1200x950x1600	M.42 Male
CIM-2W	-30 to +170	33	45	21	12	120	2	1400x950x1800	M.42 Male
CIM-3W	-30 to +170	45	70	30	17	120	2	1800x1000x1600	M.42 Male
CIM-4W	-30 to +170	66	90	45	24	120	2	2000x1200x2000	M.42 Male

Note:

- Suffix "W" in model is for water cooled machine
- The given cooling power is at 35°C ambient temperature. Increase in ambient temperature will affect performance of machine
- The temperature range mentioned above is at outlet of the machine hence temperature inside the process / load may vary due to various factors like process design, distance, head, insulation etc.
- *Pump flow rates are at atmospheric pressure
- Custom built models on request for larger capacity
- Since development is continuous process, the above specifications are subjected to change without prior notice.

OPTIONAL ACCESSORIES



TEMPERATURE CONTROL UNIT



Flame proof control panel
for HTC series



HTC



HCB



Chiller

HTC series (ambient to 350°C): High temperature circulator

Model	Temperature Range	Heating kW	Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
HTC-1	Amb. to +350	3	30~35	0.7	410 x 410 x 700	M.24 Male
HTC-2	Amb. to +350	6	30~35	0.7	600 x 600 x 900	M.24 Male
HTC-3	Amb. to +350	12	50~55	1	900 x 900 x 1100	M.42 Male

• Control panel dimensions: 300 x 300 x 300 mm

HCB series (-25°C to +175°C): Heating cooling bath

Model	Temperature Range °C	Heating KW	Cooling power kW			Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
			0°C	-20°C	-25°C				
HCB-1	-25 to +175	1	0.4	0.2	0.05	14~16	0.4	300 x 500 x 650	M.16 Male
HCB-2	-25 to +175	2	1.1	0.7	0.3	14~16	0.4	420 x 520 x 1000	M.16 Male
HCB-3	-25 to +175	3	1.5	1.0	0.45	30~35	0.7	510 x 620 x 1050	M.24 Male

HCL series (-70°C to +100°C): Heating cooling cryo bath

Model	Temperature Range °C	Heating KW	Cooling power kW			Pump Flow Max (lpm)*	Max Pump Pressure (bar)	Dimensions mm (W x D x H)	End Connection
			-20°C	-40°C	-60°C				
HCL-1	-70 to +100	1	0.4	0.3	0.2	14~16	0.4	610 x 700 x 1150	M.16 Male
HCL-2	-70 to +100	2	1.1	0.8	0.4	14~16	0.4	610 x 700 x 1150	M.16 Male
HCL-3	-70 to +100	3	1.5	1.2	0.6	30~35	0.7	700 x 700 x 1300	M.24 Male

CHL series (ambient to -15°C)

Model	Temperature Range °C	Cooling power in kW @ (Bath Fluid IPA)		Pump Flow (lpm)*	Dimensions mm (W x D x H)	End Connection
		0°C	-10°C			
CHL-1	Ambient to -15	0.35	0.15	12~14	330 x 370 x 550	3/8" Hose Nipple
CHL-2	Ambient to -15	0.7	0.3	12~14	360 x 460 x 600	1/2" Hose Nipple
CHL-3	Ambient to -15	1.2	0.6	25~30	550 x 650 x 700	1/2" Hose Nipple
CHL-4	Ambient to -15	2.4	1.5	30~35	450 x 650 x 1150	3/4" Hose Nipple
CHL-5	Ambient to -15	4.5	2.5	30~35	700 x 700 x 1200	3/4" Hose Nipple
CHL-6	Ambient to -15	10	6	55~60	1300 x 800 x 1600	1" Hose Nipple
CHL-7	Ambient to -15	15	8	70 ~ 75	1500 x 950 x 1700	1" Hose Nipple
CHL-8	Ambient to -15	20	12	85~90	1650 x 1100 x 1600	1" Hose Nipple

Note:

- The given cooling power is at 30°C ambient temperature. Increase in ambient temperature will affect performance of machine
- The temperature range mentioned above is at outlet of the machine hence temperature inside the process / load may vary due to various factors like process design, distance, head, insulation etc.
- In HTC series, machines with higher heating capacity also available on request
- In HTC series, flame proof options are available on request
- *Pump flow rates are at atmospheric pressure
- Since development is continuous process, the above specifications are subjected to change without prior notice.

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 (N₂), 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 N₂ 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, M.O.C. & 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: ½ ltr, 1 ltr, 2 ltr, 5 ltr, 10 ltr, 25 ltr, 50 ltr

Optional:

- Forward pressure regulators can be provided at the outlet of the charging pot if they are used as gas charging.
- Pots upto 200 bar / 350 bar
- Pots in MOC 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: 1 ltr, 2 ltr & 5 ltr

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



LIQUID METERING PUMP SYSTEM

This system is used to charge liquid at a desired rate from as low as 1 ml/hr to 100 ltr/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:

- Diaphragm metering pumps for pressures upto 100 bar & minimum flow range of 60-600 ml/hr to maximum 10-100 lit/hr. The flow rates are varied by varying the motor speed with variable frequency drive. Materials: SS316, option: Hastelloy C, Titanium, PTFE
- High pressure more accurate HPLC type low flow metering pumps for high pressures upto 350 bar & flow range from 0.01 upto 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.



(b)



(a)

LOAD CELLS & 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-prrof load cells & weighing scales are available



Load cell



Weighing scale

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 m² 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 upto 10 bar pressure. It is offered in different surface areas such as 0.1, 0.2, 0.5, 1 & 2 m². The condensate can be collected separately in a receiver or optionally refluxed back into the reactor.

Optional:

- Higher area & pressures upto 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 condensor to collect the condensate separately. It is also provided with a port to apply vacuum & offered in 250 ml, 500 ml, 1 ltr, 2 ltr & 5 ltr volumes. Higher volumes & other materials can be offered on special request. It can be optionally provided with level indication.

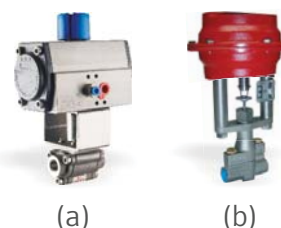


FLOW CONTROL VALVES

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:

- On/off pneumatic ball valve actuated by 230V output from panel to solenoid valve inline of air supply
- Pneumatic proportionate flow control valves with I to P convertor (for accurate temperature / pressure control).

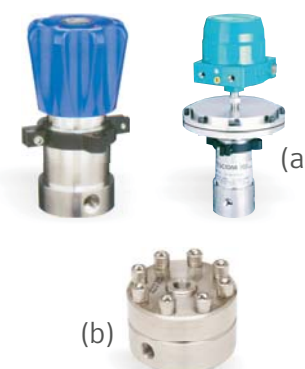


BACK PRESSURE REGULATOR (BPR)

It is SS 316 regulator mounted on the vent line of the autoclave & is used for maintaining constant pressure inside the autoclave upto 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:

- 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).
- Pneumatically actuated pilot operated back pressure regulator (air / N₂ gas supply for rated pressure is required to activate the same)
- Electronic control unit & forward pressure regulator with 4 mtr. hose for activating (b) above.
- Materials: Hastelloy C, PTFE etc.



CHAIN PULLEY HEAD LIFTING SYSTEM

For autoclave volumes from 10 ltr to 250 ltr & removable head design, the head & vessel are too heavy to lift manually. Hence chain pulley block mounted on same trolley with SS Stand can be offered for lifting the head with minimum efforts.





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 upto 50 m or higher is also supplied.

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



LINERS

Removable PTFE / metal liner can be offered for autoclaves from 100 ml - 5 ltr. These liners can be used for reactions that are corrosive, to prevent the autoclave body from corrosion. PTFE liner can be used upto 200°C & metal upto 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.



Teflon



Metal

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 500 ml - 10,000 ltr autoclaves.

Optional: Materials: Hastelloy C



CATALYST FILTRATION & RECYCLING SYSTEM

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 2 ltr to 10,000 ltr reactor volume. These filters are available with zero hold-up volume.



For small autoclaves

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 upto 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 free vacuum pumps can be supplied for vacuum from 100 mbar upto 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 upto 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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"Product quality is very nice and available within committed time frame, All the Equipment received from Amar is very reliable in performance. Service from Amar is always appreciated. "Excellent service !!!!!!!!!!"

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Head Development Manager,
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