



Multiple Autoclaves / Parallel Synthesizer



M6 model with fixed head design & inline BLDC motors



Salient Features

- 4 or 6 nos. of 50 ml to 2 ltr parallel overhead stirred autoclaves
- Common mounting & control panel with remote monitoring & control
- Pressures upto 350 bar & temperatures upto 500°C
- Simultaneous reactions can be carried out in each reactor with different parameters & comparative studies can be done from the data received. It saves lot of space & helps in advanced & faster research i.e. high throughput testing
- The optional accessories can be common or separate for all autoclaves

Standard models for multiple autoclave 50 ml

Description	M4 or M6						
	Model No.	1213	1215	1223	1225	1233	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			
Min. Stirrable Volume (ml)				20			

Standard models for multiple autoclave 100 ml

Description	M4 or M6						
	Model No.	1313	1315	1323	1325	1333	1335
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)				83			
Min. Stirrable Volume (ml)				20			

Standard models for multiple autoclave 250 ml

Description	M4 or M6						
	Model No.	1413	1415	1423	1425	1433	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			
Vessel Internal Height (mm)				80			
Min. Stirrable Volume (ml)				50			

Standard models for multiple autoclave 500 ml

Description	M4 or M6					
Model No.	2113	2115	2123	2125	2133	2135
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				65	
Vessel Internal Height (mm)	118				158	
Min. Stirrable Volume (ml)	60				50	

Standard models for multiple autoclave 750 ml

Description	M4 or M6					
Model No.	2213	2215	2223	2225	2233	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					
Vessel Internal Height (mm)	193					
Min. Stirrable Volume (ml)	60					

Standard models for multiple autoclave 1 ltr

Description	M4 or M6					
Model No.	2313	2315	2323	2325	2333	2335
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				75	
Vessel Internal Height (mm)	163				273	
Min. Stirrable Volume (ml)	130				60	

Standard models for multiple autoclave 2 ltr

Description	M4 or M6					
Model No.	2413	2415	2423	2425	2433	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					
Vessel Internal Height (mm)	303					
Min. Stirrable Volume (ml)	130					

Note: The above ratings are only for SS316, Hastelloy C & Inconel materials, for other materials the ratings will change depending on its stress value & maximum allowable temperature as per ASME code for which refer page 21 in material of construction.

Technical specification for multiple autoclaves standard models

Sr.	Description	Specification
A	Material of Construction	SS 316 wetted parts
B	Head Mounting Style	Removable head and vessel design
C	Heating Type	Electrical ceramic band heater with cladding & insulation & heater temperature control for 500°C
D	Motor	1/8 hp AC motor with 100-1450 RPM (50 ml to 250 ml) ¼ hp AC motor with 100-1450 RPM (500 ml to 2 ltr)
E	Shaft Sealing	Zero leakage magnetic drive coupling M8 with 0.8 Nm torque for 50 ml - 2 ltr & M20 with 2 Nm torque for 450 ml - 2 ltr
F	Stirrer	4 bladed turbine stirrer (50 ml to 250 ml) 2 stage 6 bladed turbine stirrer (500 ml to 2 ltr)
G	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, solenoid valve at inlet of cooling coil (50 ml to 250 ml) Internal Fittings: Serpentine cooling coil (50 ml to 250 ml), Helical cooling coil (500 ml to 2 ltr), dip tube, thermowell with RTD PT 100 sensor
H	Gasket	PTFE up to 300°C and metallic grafoil gasket up to 500°C
I	Closure Type	Split clamp with clamp bolts
J	Control Panel	SS control panel with programmable PID temperature controller, high temperature alarm and variable frequency drive for motor speed control
K	Power Supply	1 Ø, 220 V AC, 50 / 60 Hz
L	Mounting	Table top (50 ml to 1 ltr) SS Trolley (2 ltr)



Enquiry guide for multiple autoclaves customized models

Enquiry code structure is **Standard Model no. A-B-C-D1-D2-D3-E-F-G-I-J-L-M** where A, B, C, D1,D2, D3, E, F, G, I, J, L & M options can be selected from below tables. The below options will be in place of standard supply. For example 4 nos. of 500 ml, 100 bar, 300°C, Hastelloy C, fixed head autoclave with ATEX Zone1 certified, heater & motor will read as **M4 2113-HC6-K-EZ-AZ**

Options

A Material of Construction

SS 316 L	316L	Inconel 625	IN5
Hastelloy C 276	HC6	Nickel 200	NK2
Hastelloy C 22	HC2	Titanium Gr. 2	TI2
Hastelloy B	HAB	Zirconium 702	ZR7
Monel 400	MN4	Tantalum	TAN
Inconel 600	IN6	Tantalum lined	TNL

B Head Mounting Style

Fixed head with manual vessel raising lowering (50 ml to 750 ml)	K
Fixed head with pneumatic vessel raising lowering (500 ml to 2 ltr)	P
Fixed head with manual vessel raising lowering & tilting (50 ml to 750 ml)	KT
Fixed head with pneumatic vessel raising lowering & tilting (500 ml to 2 ltr)	PT

C Heating Style

Electrical ex-proof, IIB + H ₂ certified	EA
Electrical ex-proof ATEX Zone1 certified	EZ
Electrical ex-proof Class 1 Div 2 certified	EC
Welded SS 304 jacket with insulation	JS
Welded SS 304 jacket with electrical band heater	JH
Peltier cooler for -25 to 150°C (for 50 ml - 250 ml)	PL

D1 Motor HP

¼ hp (50 ml - 250 ml)	H02
½ hp (500 ml - 2 ltr)	H05

D2 Motor RPM

Up to 3000 rpm	RT
Gear box up to 440 rpm	R4

D3 Motor Type

Ex-proof gas group IIB (Zone 1)	XB
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
1/8 hp compact in line brushless DC motor	BD
¼ hp compact in line brushless DC motor	QD

E Mag Drive Torque

2 Nm (for 50 ml - 250 ml)	M20
4 Nm (for 500 ml - 2 ltr)	M40
8 Nm (for 500 ml - 2 ltr)	M80
12 Nm (for 1 ltr - 2 ltr)	M120

F Stirrer Options*

Hollow shaft with gas induction Impeller	SH
Anchor (with serpentine cooling coil, max 100 rpm)	SA
Spiral (No cooling coil, max 100 rpm)	SS
Ruston turbine	SR
Paddle	SD
Propeller	SP

G Valves & Fittings** (for 500 ml - 2 ltr)

Serpentine cooling coil	SCC
Ball valve powder inlet (¼")	BVP
Flush bottom valve (10 mm)	FBV
Baffles (with serpentine cooling coil)	BFL

I Closure Type

Threaded cap with 'O' ring-FKM (Viton) upto 225°C	CV
Threaded cap with 'O' ring FFKM (Kalrez) upto 275°C	CK
Split clamp with 'O' ring-FKM (Viton) upto 225°C (upto 100 bar, 500 ml - 2 ltr)	CV
Split clamp with 'O' ring FFKM (Kalrez) upto 275°C (upto 100 bar, 500 ml - 2 ltr)	CK

J Control Panel

Touch screen -HMI panel	TSP
-------------------------	-----

L Mounting

SS Trolley (50 ml to 1 ltr)	TL
-----------------------------	----

M Certifications***

Design approval as per ASME code by notified body	DAC
CE-PED 2014/68/EU	PED
ASME U/U2 stamp coded	ASU
ATEX certified reactor 2014/34/EU	ASA
CE marked panel & electrical parts	ECE
UL/CSA marked panel & electrical parts	USC

Note: 1) Customer is advised to select best suited options for most optimized price & delivery.

2) For other optional accessories please refer page 44.

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) Different power supply options may be possible on request.

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

*Stirred options can be in place of standard or additional multiple interchangeable.

**All option specified in G are add-ons & multiple/ all of them can be availed at the same time.

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



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 (FPR)

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:**
- 1) Regulators upto 350 bar, automated regulator
 - 2) Regulator for other gases like NH₃, CO₂ etc. & MOC of Hastelloy C
 - 3) Pressure reducing station with auto changeover



Gas Booster (GB)

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 CO₂ 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 (MFM) / Controller (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:**
- 1) Ex-proof MFM / MFC can be offered on request.
 - 2) MFM/MFC upto 300 bar pressure



Coriolis Gas - Liquid Mass Flow Meter/Controller (CFM/CFC)

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 (DPI)

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



Optional Accessories

Liquid / Slurry / Gas Charging High Pressure Pot (HPP)

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: 250 ml, ½ ltr, 1 ltr, 2 ltr, 5 ltr, 10 ltr

Optional: a) Forward pressure regulators can be provided at the outlet of (FPR) pot if they are used as gas charging.

b) Pots upto 200 bar / 350 bar

c) Pots in MOC Hastelloy C, Inconel, Monel, Titanium



Ethylene EO / Polypylene PO Oxide Pot (EPP)

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 (LMP)

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.

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

a) 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

b) 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

c) High pressure syringe, PTFE diaphragm, gear, peristaltic pumps can be offered for pumping corrosive chemicals at low / high pressures for specific application & flow rate condition.

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



Auto Cooling System (ACV / ACP)

This system is useful to control temperature overshoots for highly exothermic / out of control / runaway reactions as well as for faster cooling upon completion of reaction.

The control panel of the autoclave gives 230V, 1Ø output to connect external auto-cooling system. Options available are:

a) Solenoid valve (ACV) for autoclaves upto 25 ltr or

b) Pneumatically actuated ball valves (ACV) for autoclaves above 25 ltr connected at the inlet of the internal cooling coil with external source of water supply.

This is standard for 50 ml - 250 ml autoclaves, however for bigger autoclaves if the cold water line pressure is less than 2 bar then it is better to opt for external pump & tank water cooling system. Normal tap water cooling is not effective at higher temperatures due to steam back pressure whereas pump & tank auto cooling system gives positive pressures & faster cooling.



(a) with FLP coil



(b)

Optional Accessories

c) Pump & Water Cooling Tank (ACP): It consists of a SS 304 water tank & pump to circulate water in the internal cooling coil of reactors. Cooling starts automatically if the rate of heating rises suddenly. It comes with monoblock pump, tank, pipeline & flexible hose pipes with quick release coupling & is mounted on the autoclave trolley itself. Ice can be put in the water or the hot water can be discharged & fresh water replenished on continuous basis for more effective and faster cooling.

Optional: Ex-proof group IIC pump



(c)

Magnetic drive & pressure Sensor Cooling System (MCS)

It is a simple 10 ltr SS 304 tank with submersible pump to circulate water in the magnetic drive & pressure sensor jacket to prevent temperature rise beyond 80°C. It is useful if tap water connection is not near the autoclave & when water needs to be condensed.



Open Bath Heating Circulator (HB)

It is used to heat jacketed autoclave from ambient to 150°C by circulating thermic fluid inside the jacket. It consist of bath, pump, level switch, heater & internal cooling coil for cooling from high temperature to ambient temperature using chilled water or brine solution.

It is suitable for reactors up to 5 liter volume

Optional: Ex-proof heating bath



Closed Loop Heating Circulator (CLH)

It is used to heat jacketed autoclave from ambient to 350°C by circulating thermic fluid. It consist of a closed pressure withstanding tank, magnetically coupled pump, heater, level indicator & internal cooling coil for cooling from high temperature to ambient temperature using chilled water or brine solution.

Suitable for reactors up to 100 ltr volume

Optional: Ex-proof circulator



Low temperature open bath circulator (CB)

It is used to cool or control reactor temperature to -50°C by circulating thermic fluid cooled to up to -75°C inside the jacket or internal coil. It consists of a bath, pump, compressor, condenser & level switch.

Suitable for reactors up to 100 ltr volume



Heating Cooling open bath circulator (HCB)

It is used to heat, cool & control reactor temperature by circulating thermic fluid in the autoclave jacket. It consists of a bath, pump, heater, compressor, condenser & level switch.

Temperature range: -25°C to 175°C.

Suitable for reactors up to 5 ltr volume



Closed loop heating cooling circulator (CLS)

It is used to heat, cool & control reactor temperature by circulating thermic fluid in the autoclave jacket. It consists of a bath, pump, heater, compressor, condenser & level switch.

Temperature range: -35°C to 200°C / -80°C to 180°C.

Suitable for reactors up to 1000 ltr volume.



Flow Control Valves (FOV / FCV)

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:

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



FOV



FCV

Reflux Condenser (RC)

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.



Optional Accessories

Condenser (CN)

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 350 bar
 - Different materials
 - Corrugated tubes heat exchangers for better efficiency / compact size.



Receiver Pot (RP)

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.

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.

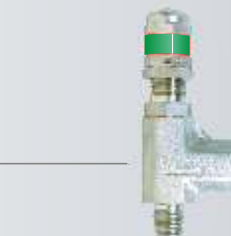
- Optional:**
- Electronic actuated digital pneumatic back pressure regulator, where the pressure is set digitally & can be released at preset rate of pressure release (6 bar air supply is required).
 - Pneumatically actuated pilot operated back pressure regulator (air / N₂ gas supply for rated pressure 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.



Pressure Safety Valve (PSV)

High pressure autoclaves are provided with built in safety rupture disc, however additional safety can be offered by providing pressure safety valve for which release pressure can be set manually by increasing or decreasing the spring tension or by simply changing the spring. The set pressure should normally be around the design pressure. Safety relief valves are standard supply for glass autoclave & shaker hydrogentor where rupture discs are not available for low pressures. These valves come with PTFE / Kalrez O-rings.

Optional: Materials: Hastelloy C, inconel



Chain Pulley / Hydraulic Head Lifting System (PL/EL/HL)

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:**
- Electric (EL) chain pulley lift
 - Hydraulic lid (HL) lifting arrangement can be offered on request for any reactor volume. Refer page 8 for picture of the same.



SCADA Software for remote operation & recording (SCD)

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.



Optional Accessories

Liners (LN)

Removable PTFE / Metal / Glass liners can be offered for autoclaves from 100 ml - 25 ltr. These liners can be used for reactions that are corrosive, to prevent the autoclave body from corrosion. PTFE & glass liners can be used upto 200°C & metal upto 500°C. The heat transfer is poor with PTFE & glass liners. Glass liners cannot be fabricated accurately. Hence, Amar recommends the use of completely corrosion resistant metal autoclaves made from special alloys like Hastelloy, Inconel, Titanium etc. over glass/teflon liners. Liners should be used only if cost is the constraint or corrosive chemicals are to be used sparingly. Metal liners can be offered in Hastelloy C , Inconel , Monel , Titanium etc.



Catalyst Basket (CBS/CBD)

It is provided to improve the efficiency of the catalysts & for holding the catalyst so that it will not be destroyed or changed by the stirring action of impeller. The baskets are made from SS316 wire mesh & connected to the stirrer so that they rotate with the stirrer. It is available for 450 ml-100 ltr autoclaves. The catalyst basket can be static which is stationary (CBS) or dynamic (CBD) which rotates with the impeller.



Catalyst Filters (CF)

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 - 100 ltr autoclaves.



Optional: a) Different micron sizes
b) Materials: Hastelloy C

Catalyst Addition Device (CAD)

It is used for one time catalyst charging under pressure during the reaction. It consists of a 3 ml to 150 ml (depending on Autoclave size) small container with airtight cap, which is openable. The powder is filled in the container which is then threaded to the autoclave head from below to a separate port with needle valve on the top. Under atmospheric & pressurized conditions the powder remains inside the container as the cap remains closed.

One has to apply gas pressure greater than autoclave pressure from the needle valve on that port so that the cap opens & releases the catalyst inside the autoclave under pressure.

Depending on the optional accessories selected, the catalyst addition device may not be possible due to space constraint on the head. Available for autoclave sizes 100 ml - 100 ltr & upto 250°C.



Catalyst Filtration & Recycling System (CFR)

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 2000 ltr reactor volume. These filters are available with zero hold-up volume.



Catalyst Slurry Charging System (CSC)

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 materials.



Optional Accessories

Catch Pot (CP)

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 (VP)

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 (SG)

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

In Situ FTIR Spectroscopy (IR)

In situ high temperature, high pressure infrared (IR) probe is offered for real time chemical reaction monitoring. It provides specific information about reaction initiation, conversion, intermediates & end point. Suitable for 1 ltr to 100 ltr reactors upto 100 bar & 200°C.

Other Accessories / Options

- Level transmitter (LT) / switch (LS) with indicator to measure or maintain level inside the reactor under high pressure. Used mainly in CSTR.
- pH/ turbidity (TB) / DO / ORP sensors with indicators & controllers for high pressure & temperature application. pH can be controlled automatically by variable speed acid & base metering pumps.
- Sampling pot with condenser for cooling / condensing & collecting the sample taken at high pressure & temperature.
- Torque sensor for accurate measurement of the motor torque, where change in torque indicates change in viscosity of the reaction.
- High pressure ultrasound transducer for high frequency mixing.
- Ex-proof certified gas purge panels for electrical accessories / utilities like heating cooling circulators etc.



(a)



(b)



(c)



(d)



(e)



(f)