Autoclaves

High Pressure Systems

Pressure Reactor Specialist™

Your Research Partner

Volume 06

Our Profile

Experience

The company was founded in 1974 by Mr. Naresh Shah (Chairman) B.Tech. Mech., IIT & M.S. (USA). Mr. Vishal Shah (Director) B.E. Mech., son of Mr. Naresh Shah joined the business in 1998 to take it forward. It started designing, manufacturing & exports of high pressure reactor, magnetic coupling, continuous flow reactors, fixed bed reactors, industrial filters & heating cooling circulators with a vision to provide import substitute products in India at reasonable rates & international quality. Amar Equipment is a leader in pressure reactor designing & can supply the same with all desired certifications / approvals like **ISO, ASME, CE, U, UL, CSA, Ex** etc. complying to various international safety regulations. We have over 40 years of rich experience in manufacturing & supplying high pressure reactor systems globally.

Facilities

We have complete in-house setup well-equipped to design, manufacture & test all the products & components with latest gauges, measuring instruments & machines like

- CNC turning centre
- Vertical machining centre (VMC)
- Conventional lathes
- Plasma cutting machine
- Overhead Cranes
- Buffing / polishing/ cleaning equipment
- Laser marking
- Cutting machines
- Rivetting machine
- Drilling machines
- Welding machines
- Grinding machines
- PMI machine
- Packaging machines etc....

We are a team of around 100 people with qualified staff, skilled workers & a core team of 15 highly skilled & experienced professional engineers, required to produce the desired quality repetitively as per international quality standards & design codes.

Vision / Motto

Quality / Safety / Service

- To become a leading global player in manufacturing all our products.
- To continuously upgrade the quality of our product & always offer the latest & the best.
- To develop & manufacture safe products that work virtually life long without maintenance.
- To attend all customer demands, complaints & provide prompt services to ultimately see a delighted customer.
- To make products that are technically complete, physically reliable, economically competent & ergonomically superior.

Achievements

Pioneers & largest manufacturer of high pressure reactor & magnetic drive couplings in India year after year since 40 yrs. Over 5000 successful installations world over with more than 2000 delighted customers. Exports to more than 50 countries world wide with 40 international distributors & 4 exclusive dealers in different parts of India for local support. The growth & success of our firm in terms of quality, production & profitability has been positive since its inception.

Product Range

- High Pressure Autoclaves
- High Throughput Catalyst Screening
- Gas Induction Reactors
- Glass Autoclaves
- Non Stirred Pressure Vessels
- HPHT Corrosion Testing
- Supercritical Fluid Extraction
- Reaction Calorimeters
- Gas Hydrate System
- Acid Digestion Bombs`
- Continuous Flow Reactors
- Fixed Bed Reactors
- Magnetic Couplings / Stirrers
- Heating & Cooling Circulators
- Sparkler & Leaf Filters

Certifications & Approvals

- An **ISO-9001-2008** certified company.
- All our pressure reactor / vessel designs are as per **ASME** codes-section Vlll Div 1 / Div 2 with suitable design approval certificate.
- Our welders are qualified as per **ASME** section IX codes for welded pressure vessels.
- **'U'** stamp coded vessels & electrical / instrumentation with **UL / CSA** making can be offered on request
- **CE** marked autoclave of desired size, pressure & material can be supplied on request with **EMC, LVD** & **PED** directives as applicable.
- Design approval as per **AS1210** Australian standards, Malaysian standards etc.
- **Explosion** / flame proof motors, pumps, heaters, sensors & panels for hazardous area for group IIA, IIB & II C gases like hydrogen.
- **ATEX** certified autoclaves
- **DQ, IQ, PQ, OQ** can be given on special request.
- Most of our products comply to **GMP / cGMP** standards.

Index

*Model no. / coding of various autoclave types, sizes, MOC, ratings, motor, heating & mounting style etc. options are given in short to enable the user to check on all options available & with the codes one can send inquiry / order in short.

Since development is a continuous process the specifications in the catalogue can change without prior notice

Trademarks used in the catalogue

- Viton, Kalrez & teflon are registered trademarks of Dupont
- Grafoil is registered trademark of UCAR Carbon Co.
- Monel & Inconel are registered trademark of Special Metals Corp.
- Hastelloy is registered trademark of Haynes International

Abbreviations used in the catalogue

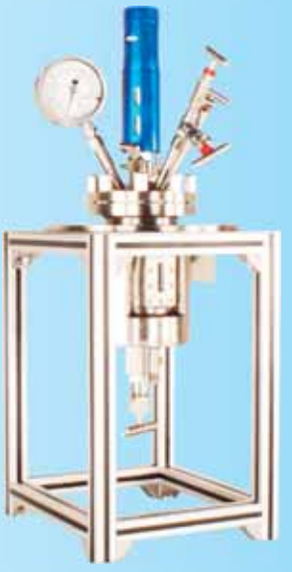
• QRC: Quick release coupling • NRV: Non-return valve • MOC: Material of construction
• FLP: Flame proof/Explosion proof • Temp.: Temperature • Pr.: Pressure • Ø: Phase • Ltr.: Liter • NA: Not applicable/ available

All the pressure ratings are in bar which is nearly same as kg/cm² (1 bar = 1.02 kg/cm²)

Autoclave Types

- High pressure autoclaves.
- Multiple parallel 4 or 6 reactors for high throughput catalyst screening / research.
- Bottom stirred autoclaves.
- Low pressure reactors.
- Continuous flow stirred tank reactor (CSTR).
- Glass-metal / peek autoclaves.
- Interchangeable metal & glass autoclaves.
- Non stirred pressure vessels.
- Acid digestion bombs.
- Gas induction reactors.
- Rocker / shaker hydrogenator.

Autoclave - Salient Features



- Stirred & non-stirred reactors / pressure vessels.
- Sizes from 25ml to 1000ltrs. capacity.
- M.O.C SS-316/316L, Hastelloy B/C, Monel, Inconel, Nickel, Titanium, Tantalum lined, Zirconium etc.
- Max. design pressures upto 10,000psig (690 bar) & temperatures upto 650°C.
- All designs as per ASME codes & CE, 'U' stamp marked autoclaves on request.
- High torque maintenance free zero leakage magnetic drive coupling.
- Complete pilot plant with automatic temperature, pressure, RPM, motor torque/ current, liquid & gas flow, pH, ORP, DO, turbidity, IR, level etc. controlling, auto cooling system, chiller, condensor for distillation or reflux, thermic fluid heating / cooling system etc.
- Fully automated PC controlled high pressure system / pilot plant to continuously monitor, control & record various parameters with touch panels.
- Complete FLP certified / explosion proof systems suitable for group IIA, IIB, IIC gases like H_2.
- CE, UL, CSA certified electricals & controls options.
- ATEX certification on request.

Autoclave System - 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.
  - To produce chemicals in small quantity in batch or continuous mode.
  - For synthesis.
  - For quality control & process improvements
  - For high throughput catalyst screening.
- For supercritical CO_2 solvent extraction / reaction / drying / evaporation system.
- For reaction calorimetry to study heat of reaction & various parameters.
- For static, dynamic, loop & electrochemical HPHT corrosion testing.
- Gas hydrate formation.
- For hydrogen disbonding test.
- Soaking of diamonds / precious stones.

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 & also in chemical engineering colleges / research institutes / defence organisations where high pressure reactions / testing is carried out.

Model No. / Coding of Autoclaves for inquiry / order

Autoclave Type & Volume

Sr. No.	Autoclave Type Options	Code	Available for autoclave size (net water filling capacity)
1.	Overhead stirred high pressure metal autoclaves (≥ 100 bar)	A	25, 50, 100, 250, 450, 750 ml, 1, 2, 5, 10, 20, 25, 50, 75, 100 ltrs.
2.	Interchangeable metal stirred autoclaves*	IM	50 & 100, 450 & 750 ml, 1 & 2 ltrs.
3.	Multiple 4/6 overhead stirred metal autoclaves*	M4 / M6	25, 50, 100, 250, 450, 750 ml, 1, 2, 5 ltrs.
4.	Bottom stirred metal autoclaves	B	25, 50, 100, 250, 450, 750 ml, 1, 2 ltrs.
5.	Multiple 4/6 bottom stirred metal autoclaves*	BM4 / BM6	25, 50, 100, 250, 450, 750 ml, 1, 2 ltrs.
6.	Overhead stirred low pressure reactor (20 bar)	L	500 ml, 2, 5, 10, 25, 50, 100 ltrs.
7.	Glass overhead stirred autoclaves	G	100, 250, 450, 750 ml, 1, 2 ltrs.
8.	Interchangeable stirred metal & glass autoclaves*	IG	100, 250, 450, 750 ml, 1, 2 ltrs.
9.	Non stirred pressure vessels	P	25, 50, 100, 250, 450, 750 ml, 1, 2, 5, 10, 20, 25, 50, 75, 100 ltrs.
10.	Acid digestion bomb**	D	25, 50, 100, 250, 400, 700 ml
11.	Gas induction / pilot-plant scale fabricated reactors**	F	>100 ltrs. ≤ 1000 ltrs. as required
12.	Rocker/shaker hydrogenator**	R	100, 250, 500 ml, 1, 2 ltrs.

IM, M4 & M6 specifications & options would be same as A
BM4, BM6 specifications & options would be same as B
IG specifications & options would be same as G for glass & A for metal
****Sr. no. 10, 11 & 12 do not have product coding refer their specifications page to inquire / order.***

Autoclave MOC

Sr. No.	MOC options	Code	Available for autoclave types	Available for autoclave volume	Max. design temperature
1.	SS 316 / SS 316L	316 / 316L	All	All	575°C / 475°C
2.	Hastelloy C 276	HC6	All	All	550°C
3.	Hastelloy C 22 / Hastelloy C2000	HC2 / HCO	All	All	575°C / 450°C
4.	Hastelloy B2	HB2	All	All	450°C
5.	Monel - 400	MN4	All	All	450°C
6.	Inconel - 600 / Inconel - 625	IN6 / IN5	All	All	475°C / 650°C
7.	Nickel - 200	NK2	All	All	325°C
8.	Titanium Gr. 2 / Gr. 4	TI2/TI4	All	All	325°C
9.	Zirconium - 702	ZR7	All	All	375°C
10.	Tantalum / Tantalum lined	TAN /TNL	All	25 ml - 250 ml	275°C
11.	PEEK	PEK	G (only Jacketted)	100 ml - 2 ltr.	180°C

Note: *Many of the above material may not be available for a particular type or size at the time of inquiry.*

Design Pressure / Maximum Allowable Working Pressure (MAWP) & Temperature

Design pressure		Corresponding Temp. Rating at design pressure	Available for autoclave type	Available for autoclave volume	Available in MOC
bar (kg/cm²)	psi				
	6 / 10	87 / 145 heater & 200°C for jacketted	150°C for bottom electrical		G, IG100 ml - 2 ltr.GLS body with any material for lid & parts
20	300	200°C	L	100 ml - 2 ltr.	316, 316L, HC6, HC2, HCO, HB2, MN4, IN5, IN6, NK2, TI2/TI4, ZR7, TNL
50	725	250°C, 350°C	A, P	50 ltr. - 100 ltr.	316, 316L, HC6, HC2, HCO, HB2, MN4, IN5, IN6, NK2, TI2/TI4, ZR7, TNL
100	1450	250°C, 350°C, 500°C	A, B, P	25 ml - 100 ltr.	316, 316L, HC6, HC2, HCO, HB2, MN4, IN6, IN5, NK2, TI2/TI4, ZR7, TAN, TNL
200	2900	250°C, 350°C, 500°C	A, B, P,	25 ml - 25 ltr.	316, 316L, HC6, HC2, HCO, HB2, MN4, IN6, IN5, NK2, TI2/TI4, ZR7, TAN, TNL
350	5075	250°C, 350°C, 500°C	A, P	25 ml - 10 ltr.	316, 316L, HC6, HC2, HCO, HB2, MN4, IN6, IN5, NK2, TI2/TI4, ZR7, TAN, TNL
690	10,000	200°C	A, P	100 ml - 2 ltr.	316, HC2, HCO, HB2, MN4, IN6, IN5, NK2, TI2/TI4, ZR7, TAN, TNL

Note: *• The design pressure & temp. rating may vary from above for many materials to keep standard designs & also subject to max. design temperature column as per autoclave MOC table above. • B upto max. 200°C.*

Body & Head Sealing Type

Sr. No.	Head & body sealing options	Code	Available for autoclave volume	Available for autoclave types
1.	Split clamp with clamp bolts & flat gasket	N	25 ml - 100 ltr.	A, B, G, P
2.	Split taper clamp with bolts	T	25 ml - 100 ltr.	A, B, P
3.	Split clamp with 'O' ring & without clamp bolts *	V	25 ml - 2 ltr.	A, B, P
4.	Threaded clamp & vessel with 'O' ring	C	25 ml - 2 ltr.	A, P
5.	Nut & bolts with flange & gasket	Z	50 ltr. - 100 ltr.	L

* This design is suitable for maximum 100 bar pressure at 225°C for Viton & 275°C for Kalrez 'O' rings

Head Mounting Style

Sr.	Head mounting options	Code	Available for autoclave volume	Available for autoclave types
1.	Removable head design	H	All sizes	A, B, L, G, P
2.	Fixed head design with removable vessel & heater (Manual)	K	50 ml - 1 ltr.	A, L, G, P
3.	Fixed head design with removable vessel & heater (Motorized)	M	450 ml - 5 ltr.	A, L, G, P
4.	Fixed head design with removable vessel & heater (Hydraulic)	M	10 - 100 ltr.	A, P

Stirring Motor Type

Sr. No.	Stirring motor options	Code	Available for autoclave volume	Available for autoclave types
1.	Top mounted CE marked AC motor (Non Flame Proof)	NX	25 ml - 100 ltr.	A, L, G
2.	Top mounted FLP / Ex-proof AC motor IIB	XB	25 ml - 100 ltr.	A, L, G
3.	Top mounted FLP / Ex-proof AC motor IIC	XC	25 ml - 100 ltr.	A, L, G
4.	Top mounted compact in line brushless DC motor	BD	50 ml - 25 ltr.	A, L, G

Heating Style

Sr. No.	Heating options	Heating code	Available for autoclave volume	Available for autoclave types
1.	Electrical ceramic band heater	EC	25 ml - 100 ltr.	A, B, L, P
2.	Electrical flame proof aluminum cast heater, IIB + H2 certified	EA	100 ml - 25 ltr.	A, L, P
3.	Jacket SS 304 / Glass	JS	100 ml - 100 ltr.	A, L, G, P
4.	Jacket SS 304 with electric heater	JH	100 ml - 100 ltr.	A, P
5.	Limpet coil SS 304	LC	50 ltr. - 100 ltr.	A, P

Autoclave Mounting Style

Sr. No.	Autoclave mounting options	Code	Available for autoclave volume	Available for autoclave types
1.	Benchtop / table top	TT	25 ml - 2 ltr.	All
2.	Trolley	TL	25 ml - 100 ltr.	All
3.	Floor stand	FS	25 ml - 1000 ltr.	All
4.	Lugs	LG	20 ltr. - 1000 ltr.	A, L, P

Power Supply

Sr. No.	Power supply options	Code	Available for autoclave volume	Available for autoclave types
1.	1 ph 220 V AC, 50 / 60 Hz	S2	All	All
2.	1 ph 110 V AC, 60 Hz	S1	All	All
3.	3 ph 400 V AC, 50 / 60 Hz	T4	All	All
4.	3 ph 230 V AC, 60 Hz	T2	All	All

Certification for Autoclave

Sr. No.	Certification options	Code	Available for autoclave volume	Available for autoclave types
1.	ASME design approval certificate	DAC	All	A, B, L, P
2.	CE-PED	PED	All	A, B, L, P
3.	'U' stamp	ASU	All	A, B, L, P
4.	AS1210 for Australian	ASA	All	A, B, L, P
5.	CE marked panel & electrical parts	ECE	All	A, B, L, P
6.	UL/CSA marked panel & electrical parts	USC	All	A, B, L, P

How to inquire / order autoclaves - reactors - pressure vessels

Metal / Glass / Multiple / Interchangeable SS & Glass / Interchangeable Metal Stirred Autoclave

Autoclave type code	Volume with unit	MOC code	Pressure rating (bar)	Temp. rating in °C at max. pressure	Head sealing type code	Head mounting style code	Stirring motor type code	Heating style	Autoclave mounting style code	Power supply	Certification

1. E.g. to order a 2 ltr. **stirred autoclave** of SS 316 with 100 bar pressure @ 250°C, with split clamp bolt sealing, removable head with FLP top mounted IIB motor, electrical ceramic heater & trolley model**,** 1 ph, 220 V AC supply & CE-PED code should be made **A-2Ltr.-316-100-250-N-H-XB-EC-TL-S2-PED. For multiple autoclaves** prefix should be M4 or M6 rest all same
2. **Bottom stirred autoclave**: The coding remains the same as above, except remove the head mounting style code, stirring motor code, heating style code & temperature code. i.e. **B-100 ml - 316 - 100 - N-TL-S2.** For multiple bottom stirred autoclaves prefix should be BM 4 /BM 6
3. **Low pressure reactor** the coding remains the same as above for stirred autoclaves except prefix to be L i.e **L-2 ltr.-316-100-250-Z-H-XB-EC-TL-S2**
4. Similarly for **glass** it will be, **G-2ltr.-316-6-150-N-H-X-EF-TL-S2** (where 316 is the MOC of other wetted parts like head & fittings)
   For **interchangeable autoclaves** mention the first size only, 2nd will automatically be considered, Use IM or IG as prefix.
5. **Non stirred pressure vessel** - the coding remains the same as above, except remove the stirring motor type code in between i.e. **P-2Ltr-316-100-250-N-H-EC-TL-S2-PED.**
6. Some of the optional accessories can be inquired / ordered as per their codes.

High Pressure Stirred Autoclave/Reactor (A)

Specifications:

DESCRIPTION	STANDARD	OPTIONAL
Volume – (net water filling capacity)	25 ml, 50 ml, 100 ml, 250 ml, 450 ml, 750 ml, 1 ltr., 2 ltr., 5 ltr., 10 ltr., 20 ltr., 25 ltr., 50 ltr., 75 ltr., 100 ltr.	Other volumes can be customized, if possible
Material of construction (MOC) wetted parts (Refer page 16 for details)	SS-316	SS-316L, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Tantalum, Tantalum lined, Zirconium etc.
Design Pressure	100 bar (1450 psi)	I. 200 bar (3000 psi) for 50 ml - 25 ltr. II. 350 bar (5000 psi) for 50 ml - 10 ltr. III. 690 bar (10000 psi) for 100 ml - 2 ltr.
Design Temperature	250°C (482°F)	I. 350°C (662°F) II. 500°C (932°F) (50 ml - 25 ltr.) III. 650°C (1202°F) (750 ml - 2 ltr.)
Nozzles, Valves & Fittings (Refer page 18 for details)	Pressure gauge, vent needle valve, safety rupture disc, Internal cooling, thermowell (with temp. sensor), gas inlet & liquid sampling needle, valve with common dip tube (sparger), Ball valve for powder/Liquid inlet (10-100Ltrs), flush bottom valve (10-100 Ltrs)	I. Ball valve for powder / liquid inlet (BVP) (450 ml - 5 ltr.), II. Flush bottom valve(FBV) (450 ml - 5 ltr.) III. Serpentine cooling coil (SCC)(450 ml - 100 ltr.) IV. Pressure safety valve (PSV)
Body & Head Sealing (Refer page 18 for details)	Split clamp type quick opening system with clamp bolts & flat gasket (N)	I. Split taper clamp with bolts (T) II. Split clamp with 'O' ring & without clamp bolts (V) III. Threaded clamp & vessel with 'O' ring seal (C) IV. Nut & bolts with flange & gasket (Z)
Gasket	PTFE (upto 350°C)	Metallic Grafoil (for temperature >350°C)
Head Mounting Style (Refer page 19 for details)	Removable head and vessel design (H)	I. Fixed head design with removable vessel & heater (manual)- for 50ml – 1lit size (K) II. Fixed head design with removable vessel & heater (motorized) – for 450ml – 5lit size (M) III. Fixed head Design with removable vessel & heater (Hydraulic) – for 10Ltrs – 100Ltrs) (M)
Motor & Drive (Refer page 19 for details)	Non flame proof (NX)	I. Flameproof (Explosion proof) AC motor for Group IIA & IIB gases (XB) II. Flame proof/ Ex-proof certified for group IIC gases like H2 (XC) III. Compact in line brushless DC motor (50ml – 25lit) (BD)
Stirrer RPM	I. 100 - 1450 rpm variable speed (25 ml - 5 ltr.) II. 100 - 750 rpm (10 ltr. - 100 ltr.) III. 50 - 440 rpm (50 - 100 ltr.)	I. 2900 rpm (Up to 5 ltr. Autoclaves) II. 1450 rpm (for 10 ltr. -25 ltr.)
Shaft Sealing (Refer pg. 20)	Zero leakage Magnetic Drive coupling	Refer page 21
Stirrer (Refer page 21 for details)	I. 4 bladed pitch blade turbine (50ml - 250ml) II. 6 bladed pitch blade turbine (450ml - 100ltr.)	Hollow shaft with gas induction Impeller, propeller, anchor, spiral, Ruston turbine, paddle.
Heating System (Refer page 22 for details)	Electrical ceramic band heater with ceramic wool insulation cladding (EC)	I. Flame proof/Ex-proof certified Aluminum cast heater for IIB + H2 gases (EA) II. SS – 304 Jacket for oil / steam heating (IS) III. External electrical heater on SS jacket with oil inside (JH) IV. Limpet Coil - for 50 -100 Ltrs (LC)
Control Panel (Refer page 22 for details)	Compact SS – control Panel with microprocessor based programmable PID temperature controller cum indicator, variable motor speed drive & other digital indicators/ controllers (as ordered) mounted on it	I. Digital temperature indicator in flameproof enclosure with SS control panel mounted at a safe distance of 10m (FTI) II. Flame proof Group IIA / IIB (F2B) or IIC (F2C) control panel. III. Touch screen panel (TSP)
Mounting	I. Table top (TT) (50 ml – 250 ml) II. SS trolley (TL) (450 ml – 100 ltr.)	I. SS trolley (50 ml – 250 ml) (TL) II. SS table top (upto 2 ltr.) (TT) III. Floor stand (25 - 100 ltr.) (FS) IV. Lugs (20 - 100 ltr.) (LG)
Power Supply	1Ø, 220 V AC, 50 Hz / 60 Hz (S2) upto 10 ltr. 3Ø, 400 V AC, 50 Hz / 60 Hz (T4) 20 - 100 ltr.	1Ø, 110 V AC, 60 Hz (S1) upto 5 ltr. 3Ø, 230 V AC, 60 Hz (T2) 10 - 100 ltr.

- For certificate options refer page 3.
- For product coding to inquire / order refer page 2 & 3.

Technical Specifications - Stirred Autoclaves

Sr. No.	Autoclave volume	Minimum stirrable volume	Vessel I/D mm	Vessel internal height mm	AC Motor hp	Overall dimensions table top/floor stand model without panel* W x D x H (mm)	Overall dimensions trolley model W x D x H (mm)	Powder/ liquid inlet size (inch)	Flush bottom valve dia. (mm)
1.	25 ml	12 ml	30	40	1/4	275 x 230 x 780	1010 x 410 x 1300	N.A.	N.A.
2.	50 ml	20 ml	40	63	1/4	275 x 230 x 780	1010 x 410 x 1300	N.A.	8
3.	100 ml	20 ml	40	83	1/4	275 x 230 x 780	1010 x 410 x 1300	N.A.	8
4.	250 ml	50 ml	65	80	1/4	275 x 230 x 780	1010 x 410 x 1300	N.A.	8
5.	450 ml	60 ml	75	118	1/4	320 x 270 x 900	1010 x 410 x 1340	1/4"	10
6.	750 ml	60 ml	75	193	1/4	320 x 270 x 980	1010 x 410 x 1340	1/4"	10
7.	1 ltr.	130 ml	101.6	163	1/4	355 x 310 x 925	1040 x 410 x 1350	1/4"	10
8.	2 ltrs.	130 ml	101.6	303	1/4	355 x 310 x 1065	1040 x 410 x 1350	1/4"	10
9.	5 ltrs.	360 ml	152	310	1/4	420 x 355 x 1350	1100 x 410 x 1350	1/4"	10
10.	10 ltrs.	1 ltr.	183	400	1/2	585 x 560 x 1550	1310 x 585 x 1550	1/2"	15
11.	20 ltrs.	2.6 ltrs.	248	495	1/2	585 x 560 x 1700	1310 x 585 x 1700	3/4"	15
12.	25 ltrs.	2.6 ltrs.	248	595	1/2	585 x 560 x 1800	1310 x 585 x 1800	3/4"	15
13.	50 ltrs.	6 ltrs.	355/343	558/600	1	675 x 675 x 2350	1500 x 675 x 2350	1"	25
14.	75 ltrs.	8 ltrs.	396/384	600/650	1	725 x 725 x 2350	1500 x 725 x 2350	1"	25
15.	100 ltrs.	12 ltrs.	456/440	699/735	1	780 x 780 x 2350	1550 x 780 x 2350	1"	25

Note:

* Panel size is 300 x 300 x 300mm (For standard 1 phase supply & 400 W x 380 D x 340 H mm for 3 phase supply with temp, RPM and Pressure controllers) for other accessories it may change.

- Standard power rating: 1 ph, 230 V, 15 amp upto 5 ltr., 20 amp for 10 ltr. & 3 ph, 415 V, 32 amp for 20 - 100 ltr.
- The dimensions are for table top models upto 2 ltrs. & floor stand models from 5 ltrs to 100 ltrs.
- The above specifications are for design pressure of 100 bar (except 50 to 100 ltr. is for 50/100 bar) & 350 °C temperature and MOC SS316. The same may change for higher pressure/ temperature & different MOC autoclaves.
- Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.
- Maximum reaction volume will be 75% of net filling volume (i.e. autoclave volume).

Since development is a continuous process, the above specifications are subject to change without prior notice.

Interchangeable Stirred Metal Autoclaves- IM

a) Autoclaves with common head, external fittings, panel, motor, trolley etc. & interchangeable separate 2nos. vessel, heater & internal fittings (possible for 50ml & 100ml, 450ml & 750ml, 1Ltr. & 2Ltrs autoclaves). Amar does not promote this option as this is possible in autoclaves having same diameter, only the height being different the minimum stirrable volume is same hence it is advisable to go for only higher volume autoclave as changing the internal fittings like cooling coil & thermowell is not advisable regularly (if not refitted properly, user may face leakage problem). Fixed head design is mandatory for this option.

b) Interchangeable, any 2 different size autoclaves with common panel, motor & trolley. If space is the constraint, cost of panel, motor & trolley of one autoclave can be saved but the user loses the flexibility of using 2 autoclaves at a time. This option is possible for 50ml-5Ltrs., any two size autoclaves at a time.

For technical specifications refer pg. 4 & 5 & for coding to inquire / order refer pg. 2 & 3

50ml & 100ml interchangeable reactors with fixed head design (k)

Multiple Overhead Stirred Autoclave System (M4, M6)

4 or 6 parallel reactor can be offered on the same mounting with common control panel with complete data acquisition on PC & optionally individual gas mass flow controllers to control & indicate the gas consumed (ideal for hydrogenation). The system can have all reactors of same (preferable) or different sizes. Simultaneous reactions can be carried on each reactor with different parameters & comparative studies can be done from the data received. It saves lot of space, cost & helps in advanced & faster research i.e. high throughput testing.

Salient Features:

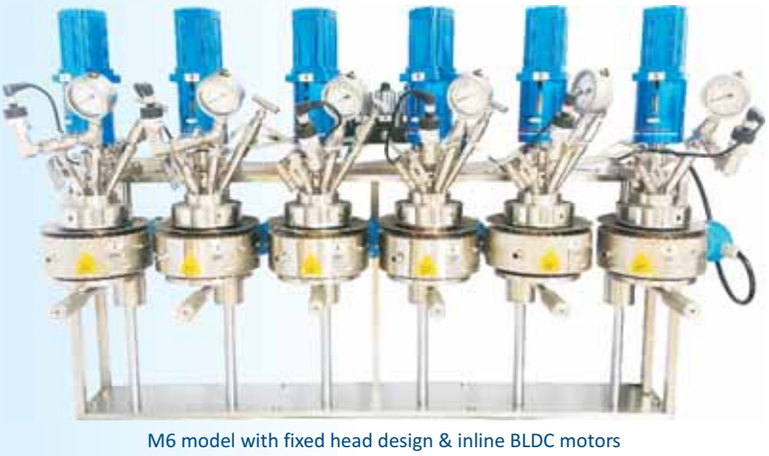
- 25ml - 5 ltr parallel 4 or 6 autoclaves can be offered.
- Optional common PC / HMI / Touch screen to monitor all the parameters of all autoclaves on single screen.
- Very compact & economical.

For technical specifications refer pg. 4 & 5 & for coding to inquire / order refer pg. 2 & 3

FLP M6 model with remote common control panel & PC

M4 model with 100 ml autoclaves & common panel

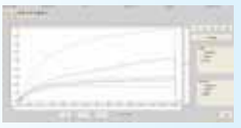
M4 model with 250 ml autoclaves & common panel



M6 model with fixed head design & inline BLDC motors

High Through-put Catalyst Screening System M4 / M6 - Fully Automated (HCS)

- Faster Screening of Catalysts by running all in parallel with similar conditions
- Volumes: 25 ml, 50 ml, 100 ml, 250 ml, 450 ml, 750 ml, 4 or 6 nos. parallel autoclaves
- Pressure: 30 bar (Optional upto 200 bar)
- Temperature: 150 °C (Optional upto 250 °C)
- MOC: SS 316, Hastelloy B/C, Monel, Inconel, Titanium etc.
- Fully automated process without human intervention with manual mode for emergency/ malfunction/ bypass
- SCADA software with suitable laptop for remote set points, recording & control of temperature, pressure, speed control, H2 gas flow rates, total H2 consumed with batch report & online / history graphs
- Programming for leak test, N2 / H2 flushing, temperature profile, speed control, H2 purging, pressure control with H2 gas uptake, cooling, vent etc.
- Safety alarm & interlock for high & low temperature / pressure & suitable safety rupture discs
- Very compact to fit in fume hood & highly advanced
- Complete SS construction



- For technical specification refer pg. 4 & 5 & for product coding to inquire / order refer pg. 2 & 3. Prefix the model with HCS for fully automated system.

ECO Catalyst Screening System (ECS)

Salient Features

- Parallel 6 no. reactor vessels of each 25ml volume.
- Design pressure of 100 bar at 250°C.
- Maximum stirring speed 1000 RPM.
- MOC SS 316, Hastelloy C, Inconel, Monel & Titanium etc.
- Very compact & economical system.
- Ideal for high through-put catalyst screening or pressure reactions.
- Common bottom stirrer, heating & cover plate for 6 vessels.
- Optional glass/ PTFE liner available.

Stirred Autoclaves - Various Models

(a) 100 ml bench top model

(b) 2 ltr. floor stand model

(c) 2 ltr. removable head trolley model

(d) 2 ltr. taper clamp autoclave mounted on aluminum trolley

(e) 5 ltr. metal vessel with PEEK / PTFE wetted parts

(f) 5 ltr trolley model

(g) 10 ltr. autoclave with taper clamp sealing

(h) 25 ltr trolley model

(i) 100 lit autoclave with hydraulic head raising lowering arrangement

Bottom Stirred Autoclaves (B)

BM4 model with multiple 4 no.
250 ml stirred reactors

Bottom stirred with automatic pressure control system

Specifications:

DESCRIPTION	STANDARD	OPTIONAL
Volume – (net water filling capacity)	25 ml, 50 ml, 100 ml, 250 ml, 450 ml, 750 ml, 1 ltr. & 2 ltr. net filling capacity	Multiple autoclaves 4 nos. or 6 nos. of same volume
Material of construction (MOC) wetted parts (Refer page 16 for details)	SS-316	SS-316L, Hastelloy B/C, Monel, Inconel, Titanium, Tantalum, Tantalum lined, Zirconium etc.
Design Pressure	100 bar (1450 psi)	200 bar (3000 psi) (for 50ml – 750ml)
Design Temperature	200°C (482°F)	N.A
Nozzles, Valves & Fittings (Refer page 18 for details)	Pressure gauge, vent needle valve, safety rupture disc, Internal cooling, thermowell (with temp. sensor), gas inlet & liquid sampling needle, valve with common dip tube (sparger)	I. Ball valve for powder / liquid inlet (BVP) II. Pressure safety valve (PSV) III. serpentine cooling coil (SCC)
Body & Head Sealing (Refer page 18 for details)	Split clamp type quick opening system with clamp bolts & flat gasket (N)	I. Split taper clamp with bolts (T) II. Split clamp with 'O' ring & without clamp bolts (V) III. Threaded clamp & vessel with 'O' ring seal (C)
Gasket	PTFE	N.A.
Head Mounting Style	Removable head and vessel design (H)	N.A.
Stirrer RPM	300 – 1000 infinite variable speed	N.A.
Stirrer	Bottom magnetic stirrer & Teflon bar	N.A.
Heating System	Electrical ceramic band heater with insulation (EC)	N.A.
Control Panel	Built in control panel with microprocessor based programmable P.I.D temperature controller with high temperature alarm system & amp motor speed indicator mounted on it	N.A.
Mounting	Table top (TT)	SS trolley (TL)
Power supply	1 ph 220 V AC, 50 / 60 Hz (S2)	1 ph 110 V AC, 50 / 60 Hz (S1)

Technical Specifications - Non-Stirred Autoclaves

Sr No.	Autoclave Volume	Minimum Stirrable Volume	Vessel ID (mm)	Vessel Internal Height (mm)	Dimension (W x D x H) (mm)
1	25 ml	12 ml	30	40	280 x 320 x 480
2	50 ml	20 ml	40	60	280 x 320 x 480
3	100 ml	25 ml	45	80	280 x 320 x 480
4	250 ml	50 ml	65	80	280 x 320 x 480
5	450 ml	60 ml	75	115	280 x 320 x 500
6	750 ml	60 ml	75	190	280 x 320 x 570
7	1 Ltr.	130 ml	101.6	163	400 x 400 x 710
8	2 Ltr.	130 ml	101.6	303	400 x 400 x 850
9	4 x 25 ml / 50 ml / 250 ml	—	—	—	935 x 320 x 480
10	4 x 450 ml / 750 ml	—	—	—	1200 x 320 x 500 / 570
11	4 x 1 Ltr. /2 Ltr.	—	—	—	1500 x 400 x 710 / 850

Low Pressure Stirred Autoclave/Reactor (L)

Specifications:

DESCRIPTION	STANDARD	OPTIONAL
Volume – (net water filling capacity)	500 ml, 1 ltr., 2 ltr., 5 ltr., 10 ltr., 25 ltr., 50 ltr., 100 ltr. net filling capacity	N.A
Material of construction (MOC) wetted parts (Refer page 16 for details)	SS-316	SS-316L, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Tantalum, Tantalum lined, Zirconium etc.
Design Pressure	20 bar (290 psi)	N.A
Design Temperature	250°C (482°F)	I. 350°C (662°F) II. 500°C (932°F) (50 ml - 100 ltr.) III. 650°C (1202°F) (450 ml - 2 ltr.)
Nozzles, Valves & Fittings (Refer page 18 for details)	Pressure gauge, vent needle valve, Pressure safety valve, Internal cooling, thermowell (with temp. sensor), gas inlet & liquid sampling needle, valve with common dip tube (sparger), Ball valve for powder/Liquid inlet (10 - 100 ltr.), flush bottom valve (10 - 100 ltr.)	I. Ball valve for powder / liquid inlet (BVP) (500 ml - 5 ltr.) II. flush bottom valve(FBV) (500 ml - 5 ltr.) III. serpentine cooling coil (SCC) (500 ml - 100 ltr.)
Body & Head Sealing (Refer page 18 for details)	Nut & bolts with flange & gasket (Z)	N.A
Gasket	PTFE (upto 350°C)	Metallic Grafoil (for temperature >350°C)
Head Mounting Style (Refer page 19 for details)	Removable head and vessel design (H)	I. Fixed head design with removable vessel & heater Refer (manual)- for 500 ml – 1 ltr. size (K) II. Fixed head design with removable vessel & heater (motorized) – for 500 ml – 5 ltr. size (M) III. Fixed head Design with removable vessel & heater (Hydraulic) – for 10 ltr. – 100 ltr.) (M)
Motor & Drive (Refer page 19 for details)	Non flame proof (NX)	I. Flameproof (Explosion proof) AC motor for Group IIA & IIB gases (XB) II. Flame proof/ Ex-proof certified for group IIC gases like H2 (XC) III. Compact in line brushless DC motor (520ml - 25 ltr.) (BD)
Stirrer RPM	I. 100 - 1450 rpm variable speed (25ml - 5ltr.) II. 100 - 750 rpm (10 ltr. - 100 ltr.) III. 50 - 440 rpm (50 - 100 ltr.)	I. 2900 rpm (Up to 5lit Autoclaves) II. 1450 rpm (for 10 ltr. - 25 ltr.)
Shaft Sealing (Refer pg. 20)	Zero leakage Magnetic Drive coupling	Refer page 21
Stirrer (Refer page 21 for details)	I. 4 bladed pitch blade turbine (50ml - 250ml) II. 6 bladed pitch blade turbine (450ml-100ltr.)	Hollow shaft with gas induction Impeller, propeller, anchor, spiral, Ruston turbine, paddle.
Heating System (Refer page 22 for details)	Electrical ceramic band heater with ceramic wool insulation cladding (EC)	I. Flame proof/Ex-proof certified Aluminum cast heater for IIB + H2 gases (EA) II. SS – 304 Jacket for oil / steam heating (IS) III. External electrical heater on SS jacket with oil inside (JH) IV. Limpet Coil - for 50 -100 Ltrs (LC)
Control Panel (Refer page 22 for details)	Compact SS - control Panel with microprocessor based programmable PID temperature controller cum indicator, variable motor speed drive & other digital indicators / controllers (as ordered) mounted on it	I. Digital temperature indicator in flameproof enclosure with SS control panel mounted at a safe distance of 10m (FTI) II. Flame proof Group IIA / IIB (F2B) or IIC (F2C) control panel. III. Touch screen panel (TSP)
Mounting	I. Table top (TT) (50ml – 250ml) II. SS trolley (TL) (450ml – 100lit)	I. SS trolley (50ml – 250ml) (TL) II. SS table top (upto 2lit) (TT) III. Floor stand (25-100 Ltrs) (FS) IV. Lugs (20-1000 Ltrs) (LG)
Power Supply	1Ø, 220 V AC, 50 Hz / 60 Hz (S2) 3Ø, 400 V AC, 50 Hz / 60 Hz (T4)	1Ø, 110 V AC, 60 Hz (S1) 3Ø, 230 V AC, 60 Hz (T2)

For product coding to inquire / order refer page 2 & 3.

1 ltr. table top model jacketed reactor
with full length view window

Technical Specifications - Low Pressure Reactor

Size	Minimum Stirrable Volume	Vessel ID (mm)	Vessel Height (mm)	Motor HP	Heater KW	Table Top / Floor Stand (Without Panel) (W x D x H) (mm)	Trolley (W x D x H) (mm)	Powder / Liquid Inlet Size	Flush Bottom Valve Dia (mm) (if Jacket)
500ML	60ml	85	108	1/4	1.25	320 x 270 x 980	1010 x 410 x 1340	1/4"	10
1L	160ml	117	153	1/4	1.5	355 x 310 x 925	1040 x 410 x 1350	1/4"	10
2L	160ml	117	288	1/4	1.75	355 x 310 x 1065	1040 x 410 x 1350	1/4"	10
5L	400ml	168	290	1/4	2.5	420 x 355 x 1350	1100 x 410 x 1350	1/4"	10
10L	1.4Ltr.	195	385	1/2	3.5	585 x 560 x 1550	1310 x 585 x 1550	1/2"	15
25L	3Ltrs.	260	500	1/2	5	600 x 560 x 1800	1310 x 600 x 1800	3/4"	15
50L	8Ltrs.	363	626	1	10.5	675 x 675 x 2350	1500 x 675 x 2350	1"	25
100L	14Ltrs.	468	777	1	13.5	780 x 780 x 2350	1550 x 780 x 2350	1"	25

Note:

* Panel size is 300 x 300 x 300mm (For standard 1 phase supply & 400 W x 380 D x 340 H mm for 3 phase supply with temp, RPM and Pressure controllers) for other accessories it may change.

- Standard power rating: 1 ph, 230 V, 15 amp upto 5 ltr., 20 amp for 10 ltr. & 3 ph, 415 V, 32 amp for 20 - 100 ltr.
- The dimensions are for table top models upto 2 ltrs. & floor stand models from 5 ltrs to 100 ltrs.
- Overall dimensions are indicative, they may change depending on the optional accessories or specific design modifications opted.
- Maximum reaction volume will be 75% of net filling volume (i.e. autoclave volume).

Continuous Flow Stirred Tank Reactors System (CSTR)

This system is used when the product is developed / produced on continuous basis for better productivity. In such system gases & liquids are added continuously in stirred reactor & product is recovered on continuous basis at high pressure & temperature. Such system may employ 1 or more reactors in series. When connected in series the overflow of 1st becomes the inlet to 2nd & so on. They are available in sizes from 100ml to 100 Ltr.

Such system is normally supplied with multiple inlets & outlets for addition & transfer/removal of gases & liquids for accessories to such systems refer below

Specially designed high pressure continuous slurry charging system is offered when suitable pumps are not available for slurry.

Gas mass flow controller, metering pumps, level controller, catalyst filtration system with SCADA software etc. are provided for a typical hydrogenation application.

For technical specification refer pg. 10 for low pressure CSTR upto 20 bar & pg. 4 for high pressure upto 100 bar.

Glass Autoclaves (G)

Specifications:

DESCRIPTION	STANDARD	OPTIONAL
Volume – (net water filling capacity)	100 ml, 250 ml, 450 ml, 750 ml, 1 ltr. & 2 ltr. net filling capacity	N.A.
Material of construction (MOC) wetted parts (Refer page 16 for details)	Borosilicate glass cylinder with other wetted parts of SS-316	I. Jacketed / non-jacketed glass with wetted parts of PTFE/ PTFE coated SS316, Hastelloy C, Titanium, Monel, Inconel, Nickel, Zirconium, Tantalum lined etc II. Glass-PEEK inert autoclaves: All wetted parts of PEEK / PTFE / PFA coated on SS316 (including lid, valves, fittings & magnetic drive) with jacketed glass vessel
Design Pressure	6bar (87 psi)	10 bar (145 psi) upto 1 ltr.
Design Temperature	150°C	200°C for jacketed vessels (by circulation of hot oil through jacket)
Nozzles, Valves & Fittings (Refer page 18 for details)	Pressure gauge, vent needle valve, Pressure safety valve, Internal cooling, thermowell (with temp. sensor), gas inlet & liquid sampling needle, valve with common dip tube (sparger)	I. Ball valve for powder / liquid inlet (BVP) II. Flush bottom valve(FBV) for jacketed vessel III. Serpentine cooling coil (SCC) (450 ml - 2 ltr.)
Body & Head Sealing (Refer page 18 for details)	Split clamp type quick opening system with clamp bolts & flat gasket (N)	Nut & bolts with flange & gasket (Z) for jacketed autoclave
Gasket	PTFE	N.A
Head Mounting Style (Refer page 19 for details)	Removable head and vessel design (H)	I. Fixed head design with removable vessel & heater (manual) for 100 ml - 1 ltr. size (K) II. Fixed head design with removable vessel & heater (motorized) for 450 ml - 2 ltr. size (M)
Motor & Drive (Refer page 19 for details)	Non flame proof (NX)	I. Flameproof (Explosion proof) AC motor for Group IIA & IIB gases (XB) II. Flame proof/ Ex-proof certified for group IIC gases like H2 (XC) III. Compact in line brushless DC motor (BD)
Stirrer RPM	100 – 1450 rpm variable speed	2900 rpm
Shaft Sealing (Refer Pg. 20)	Zero leakage Magnetic Drive coupling	Refer page 20 -21
Stirrer (Refer page 21 for details)	I. 4 bladed pitch blade turbine (50ml - 250ml) II. 6 bladed pitch blade turbine (450ml - 2ltr.)	Hollow shaft with gas induction Impeller, propeller, anchor, spiral, Ruston turbine, paddle & specially designed stirrer for highly viscous material
Heating System (Refer page 22 for details)	Electrical plate heater from bottom (EC)	I. By circulation of hot oil through glass jacket II. Triple walled double jacket glass vessel for heating & vacuum insulation without pressure
Control Panel (Refer page 22 for details)	Compact SS – control Panel with microprocessor based programmable PID temperature controller cum indicator, variable motor speed drive & other digital indicators/ controllers (as ordered) mounted on it	I. Digital temperature indicator in flameproof enclosure with SS control panel mounted at a safe distance of 10m (EI) II. Flame proof Group IIA / IIB (F2B) or IIC (F2C) control panel. III. Touch screen panel (TSP)
Mounting	I. Table top (TT)	I. SS trolley (TL) II. Floor stand (FS)
Safety Shield	I. Polycarbonate transparent cover provided for safety in case of breakage	N.A
Power Supply	1Ø, 220 V AC, 50 Hz / 60 Hz (S2)	1Ø, 110 V AC, 60 Hz (S1) 3Ø, 230 V AC, 60 Hz (T2)

For product coding to inquire / order refer page 2 & 3.

Only glass wetted parts
reactor without pressure

Glass-PEEK inert autoclave

Technical Specifications - Glass Autoclaves

Size	Minimum Stirrable Volume	Approx. Vessel ID (mm)	Vessel Height (mm)	Motor HP	Table Top (Without Panel)* (W x D x H) (mm)	Trolley (W x D x H) (mm)	Powder / Liquid Inlet Size	Flush Bottom Valve Dia (mm) (if Jacket)
100ML	20ml	40	83	1/4	300 x 300 x 700	1010 x 410 x 1450	N.A.	N.A.
250ML	50ml	65	80	1/4	300 x 300 x 700	1010 x 410 x 1450	N.A.	N.A.
450ML	60ml	75	118	1/4	320 x 300 x 700	1010 x 410 x 1450	1/4"	10
750ML	60ml	75	193	1/4	320 x 300 x 775	1010 x 410 x 1525	1/4"	10
1L	130ml	101.6	163	1/4	380 x 310 x 910	1040 x 410 x 1660	1/4"	10
2L	130ml	101.6	303	1/4	380 x 310 x 1050	1040 x 410 x 1800	1/4"	10

Note:

* Panel size is 300 x 300 x 300mm (For standard panel with temp, RPM and Pressure controllers) for other accessories it may change.

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

– Maximum reaction volume will be 75% of net filling volume (i.e. autoclave volume).

Interchangeable Stirred Metal & Glass Autoclaves (IG)

Interchangeable glass cylinder assembly with top bottom SS / other metal flanges, external bottom plate heater or jacketted glass, pressure safety valve & safety shield to fit in a existing standard metal autoclave for sizes from 100ml to 2Ltrs. The top lid, motor drive, panel etc. are common. It is highly economical, compact & versatile. This option is available only with split clamp head sealing (N). For jacketted interchangeable autoclave fixed head design is standard & for bottom heating model removable head design (H) is standard.

Design pressure (glass autoclave) : 6 bar (kg/cm²) or 85 psig.

Design pressure (metal autoclave) : 100 bar

Design temperature (glass autoclave) : 150°C (for electrical heating) / 200°C (for jacket heating).

Design temperature (metal autoclave) : 250 / 350 / 500°C

All other specifications same as glass autoclave above.

Fixed Head Interchangeable
Jacketted glass & metal autoclave

Interchangeable triple walled double jacket
glass autoclaves of only glass wetted parts with
Hastelloy / PEEK magnetic drive's without pressure

2 ltr. Interchangeable SS & glass autoclaves
with bottom electrical heating

Non-Stirred Pressure Vessels (P)

Specifications:

DESCRIPTION	STANDARD	OPTIONAL
Volume – (net water filling capacity)	25 ml, 50 ml, 100 ml, 250 ml, 450 ml, 750 ml, 1 ltr., 2 ltr., 5 ltr., 10 ltr., 20 ltr., 25 ltr., 50 ltr., 75 ltr., 100 ltr. net filling capacity	Other volumes can be customized, if possible
Material of construction (MOC) wetted part (Refer page 16 for details)	SS-316	SS-316L, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Tantalum, Tantalum lined, Zirconium etc.
Design Pressure	100 bar (1450 psi)	I. 200 bar (3000 psi) for 25 ml - 25 ltr. II. 350 bar (5000 psi) for 25 ml - 10 ltr. III. 690 bar (10000 psi) for 100 ml - 2 ltr.
Design Temperature	250°C (482°F)	I. 350°C (662°F) II. 500°C (932°F) for 50 ml - 100 ltr. III. 650°C (1202°F) for 750 ml - 2 ltr.
Nozzles, Valves & Fittings (Refer page 18 for details)	Pressure gauge, vent needle valve, safety rupture disc, Internal cooling, thermowell (with temp. sensor), gas inlet & liquid sampling needle, valve with common dip tube (sparger), Ball valve for powder/Liquid inlet (10 - 100 ltr.), flush bottom valve (10 - 100 ltr.)	I. Ball valve for powder / liquid inlet (BVP) (450 ml - 5 ltr.) II. Flush bottom valve(FBV)(450ml-5Ltrs) III. Serpentine cooling coil (SCC) (450 ml - 100 ltr.) IV. Pressure safety valve (PSV)
Body & Head Sealing (Refer page 18 for details)	Split clamp type quick opening system with clamp bolts & flat gasket (N)	I. Split taper clamp with bolts (T) II. Split clamp with 'O' ring & without clamp bolts (V) III. Threaded clamp & vessel with 'O' ring seal (C) IV. Nut & bolts with flange & gasket (Z)
Gasket	PTFE (upto 350°C)	Metallic Grafoil (for temperature >350°C)
Head Mounting Style (Refer page 19 for details)	Removable head and vessel design (H)	I. Fixed head design with removable vessel & heater (manual)- for 50 ml - 1 ltr. size (K) II. Fixed head design with removable vessel & heater (motorized) – for 450 ml - 5 ltr. size (M) III. Fixed head Design with removable vessel & heater (Hydraulic) – for 10 ltr. - 100 ltr. (M)
Heating System (Refer page 22 for details)	N.A	I. Electrical ceramic band heater with ceramic wool insulation cladding (EC) II. Flame proof/Ex-proof certified Aluminum cast heater for IIB + H2 gases (EA) III. SS – 304 Jacket for oil / steam heating (IS) IV. External electrical heater on SS jacket with oil inside (JH) V. Limpet Coil - for 50 -100 ltr. (LC)
Control Panel (Refer page 22 for details)	N.A	I. Compact SS – control Panel with microprocessor based programmable PID temperature controller cum indicator, variable motor speed drive & other digital indicators/ controllers (as ordered) mounted on it II. Digital temperature indicator in flameproof enclosure with SS control panel mounted at a safe distance of 10m (FTI) III. Flame proof Group IIA / IIB (F2B) or IIC (F2C) control panel. IV. Touch screen panel (TSP)
Mounting	I. Table top (TT) (50 ml – 250 ml) II. SS trolley (TL) (450 ml – 100 ltr.)	I. SS trolley (25 ml – 250 ml) (TL) II. SS table top (upto 2 ltr.) (TT) III. Floor stand (FS) IV. Lugs (20-100 ltr.) (LG)
Power Supply	N.A	I. 1Ø, 220 V AC, 50 Hz / 60 Hz (S2) II. 3Ø, 400 V AC, 50 Hz / 60 Hz (T4) III. 1Ø, 110 V AC, 60 Hz (S1) IV. 3Ø, 230 V AC, 60 Hz (T2)

For certification options refer page 3.
For product coding to inquire / order refer page 2 & 3.

Technical Specifications - Non-Stirred Pressure Vessels

Autoclave Volume	Vessel I/D (mm)	Vessel Internal Height (mm)	Table Top / Floor Stand Without Panel* (W x D x H) (mm)	Trolley (W x D x H) (mm)	Powder / Liquid Inlet Size	Flush Bottom Valve ID (mm)
25 ml	30	40	280 x 280 x 250	N.A.	N.A.	N.A.
50 ml	40	63	275 x 230 x 500	1010 x 410 x 1020	N.A.	8
100 ml	40	83	275 x 230 x 500	1010 x 410 x 1020	N.A.	8
250 ml	65	80	275 x 230 x 500	1010 x 410 x 1020	N.A.	8
450 ml	75	118	320 x 270 x 620	1010 x 410 x 1060	1/4”	10
750 ml	75	193	320 x 270 x 700	1010 x 410 x 1060	1/4”	10
1 ltr.	101.6	163	355 x 310 x 645	1040 x 410 x 1070	1/4”	10
2 ltrs.	101.6	303	355 x 310 x 785	1040 x 410 x 1070	1/4”	10
5 ltrs.	152	310	420 x 355 x 1070	1100 x 410 x 1070	1/4”	10
10 ltrs.	183	400	585 x 560 x 1230	1310 x 585 x 1230	1/2”	15
20 ltrs.	248	495	600 x 560 x 1380	1310 x 600 x 1380	3/4”	15
25 ltrs.	248	595	600 x 560 x 1480	1310 x 600 x 1480	3/4”	15
50 ltrs.	355/343	558/600	675 x 675 x 1825	1500 x 675 x 1825	1"	25
75 ltrs.	396/384	600/650	725 x 725 x 1825	1500 x 725 x 1825	1"	25
100 ltrs.	456/440	699/735	780 x 780 x 1825	1550 x 780 x 1825	1"	25

Note:

* Panel size is 300 x 300 x 300mm (For standard 1 phase supply & 400W x 380D x 340H mm for 3 phase supply with temp, RPM and Pressure controllers) for other accessories it may change.

– Standard power rating: 1 ph, 230 V, 15 amp upto 5 ltr., 20 amp for 10 ltr. & 3 ph, 415 V, 32 amp for 20 - 100 ltr.

– The dimensions are for table top models upto 2 ltrs. & floor stand models from 5 ltrs to 100 ltrs.

– The above specifications are for design pressure of 100 bar (except 50 to 100 ltr. is for 50/100 bar) & 350 °C temperature and MOC SS316. The same may change for higher pressure/ temperature & different MOC autoclaves.

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

Since development is a continuous process, the above specifications are subject to change without prior notice.

Acid Digestion Bomb (D)

They are used for dissolving or digesting inorganic or organic samples in strong acids or alkalis in chemically resistant teflon-lined vessels & lid at high temperature & pressures with complete containment & recovery. They have no valves, nozzles, fittings or pressure gauge except a safety rupture disc. The lid is openable with split clamp & bolt design.

Volume : 25, 50, 250, 400 ml & 700ml

Max. design pressure : 100 bar optional: 200 bar

Design temperature : 180°C (356°F)

MOC : SS316, Hastelloy B/C, Monel, Nickel, Inconel, Titanium, Zirconium, Tantalum etc.

Optional : Microwaveble digestion bombs can be manufactured from PEEK matarial

Material of Construction (MOC)

All wetted parts are made from SS-316 as standard.

Optional:

SS-316L, Hastelloy B/C, Titanium, Monel, Nickel, Inconel, Zirconium, Tantalum, Carbon Steel etc. for different liquids corrosive to SS-316. Other special alloys like A286, Alloy 20, duplex steel etc. can also be offered.

Note: Amar offers all the internal & optionally external wetted parts in the same material of construction as that of body & head to give complete corrosion resisting autoclaves.

Most of the above material are available for stirred, non-stirred, fabricated, glass & shaker autocalves.

Material Selection Guide

AMAR gives recommendation for material selection for particular media, however it does not guarantee 100% corrosion resistance of a particular M.O.C to a particular corrosive media, as it also depends on various parameters like temperature, pressure, concentration etc. of the reactions. Reactor vessels of MOC SS316, upto 5 ltrs. are machined from rolled / forged bar stock & reactors above 5 ltrs. are normally fabricated from plates. The lid is always from rolled / forged bar stock upto 100 lit. SS316 autoclaves. The material listed below may not be available in all possible sizes.

GENERAL CORROSION PROPERTIES OF SOME METALS AND ALLOYS* :

RATINGS

0. Unsuitable:. Not available in form required or not suitable for fabrication requirements or not suitable for corrosion conditions.
1. Poor to fair
2. Fair: For mild conditions or when periodic replacement is possible. Restricted use.
3. Fair to good
4. Good: Suitable when superior alternative are uneconomical
5. Good to excellent
6. Normally excellent

Small variations in service condition may appreciably affect corrosion. Choice of material is therefore guided wherever possible by a combination of experience and laboratory and site tests.

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

*From perry, chemical engineer's handbook

Stainless Steel 316/316L

SS316 & 316L has almost identical corrosion resistance properties, only that 316L is a low carbon stainless steel.

It has excellent corrosion resistance to

- Most organic acid systems like acetic, formic etc.
- Ammonia & most ammonia compounds
- Many salts except chlorides
- Most commercial gases at moderate temperature & pressures.
- Hydrogen chloride, fluoride & chloride in scrupulously anhydrous systems

It has poor resistance to

- Organic halides
- Dilute sulfuric, sulfurous, phosphoric & nitric acids at high temperatures & pressures.
- Halogen acids at low temperature & in dilute forms
- Caustics, halogen salts, chlorides

Hastelloy C 276 / C22/ C2000

It is a nickel, chromium, molybdenum alloy that has the widest corrosion resistance & is the most widely used alloy for corrosive media & next most popular after SS316

It has excellent corrosion resistance to

- Variety of chloride compounds & chlorine contaminated material
- Strong oxidizing chloride solutions such as wet chlorine & hydrochloride & sodium hypochlorite solutions
- Concentrated hydrochloric, sulfuric & phosphoric acids

Depending on the application C276, C22 or C2000 can be selected but C276 is the most common & easily available grade.

Hastelloy B2

It is a nickel molybdenum alloy & offers excellent corrosion resistance to solutions of hydrochloric, sulfuric & phosphoric acid in all concentrations & at all temperatures in the absence of oxidizing agents.

Alloy 230

It combines excellent high temperature strength & oxidation resistance with superior long term stability. It has most resistance to nitriding. It is also resistant to carburization & aqueous corrosion.

Monel 400

It has more better resistance than nickel in reducing environments. It has excellent corrosion resistance to

- Caustic Solutions
- Chloride salts
- Fluorine & hydrogen fluoride

It has poor resistance to nitric acid & ammonia systems.

Inconel 600

It is a nickel alloy & offers excellent resistance to

- Caustic & chlorides at high temperature & pressure when sulfur compounds are present.
- Also suitable for very high temperature applications.
- Reducing - oxidizing environment
- Sulfur free gases

Nickel 200/201

It offers excellent corrosion resistance to

- Handling concentrated alkalis
- Hot caustic environment
- Chlorinated solvents & Phenol

Titanium Gr 2 / Gr 4

It is lighter material & has excellent corrosion resistance to

- Oxidizing agents such as aqua regia & other mixed acids
- Nitric acid at all concentrations except red fuming nitric acid
- Chloride ions, ferric chloride, cupric chloride & other hot chloride solutions.
- Mild reducing media such as sulfuric & hydrochloric acid
- Titanium burns vigorously in presence of oxygen at high temperatures & pressures.

The material becomes softer above 200°C & hence not advisable above 200°C.

Zirconium

It offers excellent corrosion resistance to

- Reducing environments
- All chlorides except ferric & cupric
- Hydrochloride & sulfuric acids below 70% concentrations.
- Phospheric, nitric acids & alkaline solutions.

It has poor resistance to oxidizing agents.

Tantalum

Tantalum is practically inert to many oxidizing & reducing acids. It offers the best & most outstanding resistance to wide variety of corrosive media including hydrochloric, nitric, sulfuric & phosphoric acids. It is attacked by hot alkalis & hydrofluoric acid. The costs are prohibitive, however tantalum liner or tantalum lined wetted parts can be offered. Small sizes such as 50ml - 700ml can be manufactured completely in Tantalum. The maximum temperatures are restricted upto 250°C only.

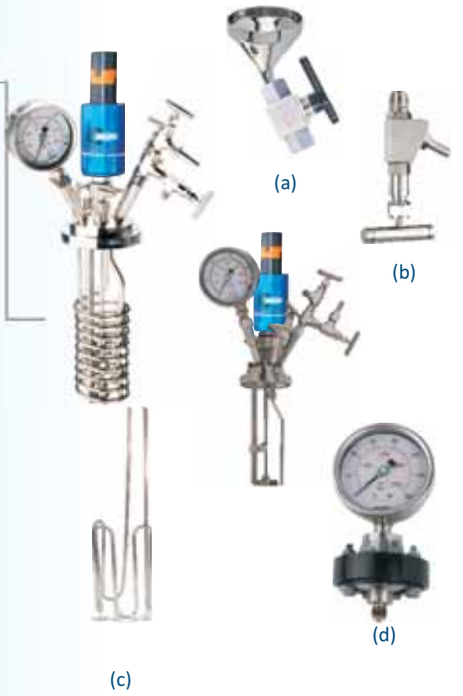
Chemical Composition of material of construction of autoclave (Major Elements in %)

Sr. No.	Material	Fe	Ni	Cr	Mo	C	Other
1.	Stainless Steel SS316	60-67	9-12	18-21	2-3	0.08	2.0 Si, 1.5 Mn
2.	Hastelloy-C276	4-7	55-63	14.5-16.5	15-17	0.01	Co 2.5, 3-4.5W
3.	Hastelloy-B2	2	67-71	1	26-30	0.01	Co 1
4.	Alloy - 230	3	57	22	2	0.1	5 Co, 14W
5.	Monel - 400	2	65	—	—	0.3	2.3 - 3.1 Al, 0.35-0.85 Ti, 30 Cu
6.	Inconel - 600	6-10	73-80	14-17	—	0.15	—
7.	Nickel - 200	0.4	99.4	—	—	0.15	—
8.	Titanium Gr. 2/Gr. 4	99% Pure Titanium				—	—
9.	Zirconium 702	95.5 — Zr, 4.5 HF				—	—

Autoclave Specifications

Nozzles, Valves & Fittings

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



Optional:

a) **Ball valve with funnel (BVP)** for powder / slurry / liquid inlet. These are valves with 1/4"-2" size, depending on autoclave volume they can be used for charging solids or liquid slurry at atmospheric pressure or higher pressure, if high pressure liquid charging pot is also ordered.
b) **Flush bottom valve (FBV)** with almost zero dead volume (some times additional ball valve at the outlet of flush bottom valve can be provided on special request).
c) **Serpentine cooling coil (SCC)** instead of helical for easy cleaning (450ml to 100 ltrs.)
d) **Diaphragm pressure gauge:** Teflon coated SS diaphragm (PDS), Hastelloy C (PDC) / Tantalum (PDT) etc. diaphragm pressure gauge or Monal pressure gauge (DGM) for corrosive media in non SS autoclaves.

Options (a) & (b) are standard for 10ltrs & above autoclaves.
Options (a), (b) & (c) are available in most materials.

Body & Head Sealing

i) Split clamp bolt design (N):

Split clamp type quick opening system with clamp bolts & tongue & groove sealing with PTFE head gasket for temperatures upto 350°C & metallic grafoil head gasket for temperatures upto 500°C for reactors upto 100ltrs. The split clamps are held in position together by a latch to prevent flying of clamps in event of accidental over pressure. This design is available upto 350 bar pressure.

ii) Taper clamp design (T):

Taper split clamp type quick opening design with 2 clamp bolts & tongue & groove sealing with PTFE head gasket for temperatures upto 350°C & metallic grafoil head gasket for temperatures upto 500°Cfor reactors upto 100ltrs. The split clamps can be tightened together with 2 bolts with hand to give leak tight seal. This design is available upto 350 bar pressure.

iii) Self sealing design (V):

The head & body can alternatively be sealed by a self sealing design in which there are no clamp bolts. Only the split clamps & Viton / Kalrez 'O' ring can be used to give sealing under pressure. The head with 'O' ring is fixed to the body by just sliding the split clamps with latch. This is very easy & convenient for closing & opening the autoclave. However with Viton 'O' ring max. temp. is 225°C & with Kalrez max temperature is 275°C. Although Kalrez has better chemical resistance than Viton but the same is exhorbitantly expensive. This sealing can be offered for pressures of 100 bar only. While selecting a Viton 'O' ring customers have to check the suitability with solvents, ammonia etc. as Viton gets easily attacked by many of them. This design is available upto 2 lit. size only.

iv) Threaded sealing (C):

For 50 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 690 bar (10000 psi) & temperature upto 275°C for Viton & 275°C for Karlz oring.

Head Mounting Style

Removable Head Design (H)

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. Also the vessel is removable 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. & is more economical. The head can be lifted & lowered by chain pulley or hydraulic arrangement on special request.

Optional: Fixed Head Design (K / M)

In this system the head of the autoclave is fixed with motor stand & the vessel & heater are raised & lowered manually by sliding or manually by rotating screw or electrically by motor & gear box or hydraulically. The vessel or heater can be slided manually up & down for assembly or disassembly for 50 ml to 250 ml autoclaves, manually screwed up & down for 450 ml to 1 lit. autoclaves & motorized lift is provided for 450 ml & 5 ltr.& hydraulic lift for 10 - 100 ltr. autoclaves. 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. Also removing the heater for faster cooling & ease of lifting or lowering the vessel is advantageous.

50ml & 100ml interchangeable reactors with fixed head design (k)

1 litr. fixed head design with manual screwed raising lowering (k)

2 liter fixed head with motorized lift (m)

Motor & Drive

a) Top mounted ACmotor

Non flameproof CE marked (NX) - Flameproof (FLP)/ Explosion proof AC motor (for Group IIA/ IIB gases-XB) suitable in hazardous area for all flammable liquids / gases except hydrogen & acetylene with variable frequency drive & stirrer RPM indication. 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 loses, 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.

Non FLP AC motor

IIA, IIB FLP motor

IIC FLP motor

Variable speed drive

Motor with gear box

RPM Range: 100 - 1450

Motor Options:

- Flameproof AC Motor group IIC (XC), Ideal for H_2 gas.
- Motors with gear box can be offered for stirring highly viscous material at low rpm & are standard for 50-100 lit reactors (50 - 440 rpm).
- Motors with 2900 rpm for stirring at high speeds.

b)Compact Motor Drive (BD):

Compact inline brushless DC motor & magnetic drive (refer Pg. 8 for the same) & speed controller with indicator for 300-1200 rpm for 50 ml - 5 ltr. & 300 - 750 rpm for 10 - 25 ltr. autoclaves. Very compact, economical & light weight. No external rotating part.

(b)

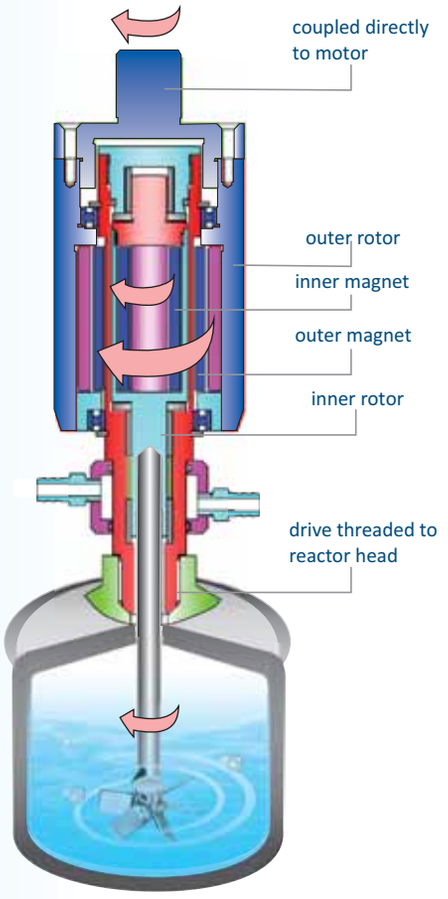
Zero Leakage Magnetic Drive Coupling

Application

These couplings are extremely useful for high pressure or high vacuum applications where leakages are not permitted for continuous running. They have replaced the gland & mechanical sealing.

Construction & Working

It is a zero leakage maintenance free coupling directly driven by the motor. It consists of external magnet rotor, which is driven by the motor. A stationery shell is threaded / bolted / press fitted to reactor head & completely isolates the external rotor from the inner rotor. As the external rotor rotates, the internal rotor also rotates in synchronism. The reactor's shaft is threaded / bolted / keyed to the inner rotor. High energy permanent rare earth magnets are fixed inside the inner & outer rotors. A water cooling jacket protects the magnets & other components from excessive temperature arising from the reactor.



Cross-Sectional view of Magnetic drive connected to reactor vessel.

Benefits of Magnetic Drive Coupling Over Gland / Mechanical Sealing

- The gland/mechanical sealing needs 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 with minimum maintenance & can be designed for pressures upto 10,000 psi.
- 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 savings in maintenance costs for years.
- Safe while using toxic & hazardous chemicals as its leakage is totally prevented.
- No waste 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 breakage of coupling, shaft or failure of motor.

Magnetically Coupled Compact Stirrer (BD)

- Top mounted compact integral Inline motor & magnetic drive.
- Zero leakage during rotation under vacuum & under pressure.
- No external rotation, rotation inside housing.
- Noiseless, vibration free with infinite variable speed regulator & indicator.
- No stand for motor mounting required, hence no alignment, vibration & noise problems.
- Light weight, economical & very compact & hence occupies very less table space.
- Brushless DC motor with BL DC drive & RPM indicator.
- Available for autoclaves from 50ml - 25 ltrs. volumes.
- RPM: 300 - 1200 for 50 ml - 5 ltr.
  300 - 750 for 10 ltr. - 25 ltr.

Magnetic Drive Coupling Specifications

Models - Magnetic Drive

- M-Series : Magnetic drives for metal autoclaves.
- MM-Series : Inline motor & magnetic drive for metal autoclaves.

Note: The number after the series indicates the torque capacity in Kg.cm for SS316 & standard pressure rating, for other MOC's the actual torque may vary.


M-Series


M-Series


MM-Series

Various Models as per Torque Capacity

Sr. No.	Static torque capacity					For reactor volume	
	Model No.	Kg-cm.	N-m.	N-cm.	Lb-in.	Standard	Optional
(a)	M08/MM08	8	0.78	78.5	6.93	25 ml	50 ml - 250 ml
(b)	M20/MM20	20	1.96	196	17.3	50 ml - 250 ml	450 ml - 750 ml
(c)	M40/MM40	40	3.92	392	34.6	450 ml - 5 ltr.	–
(d)	M80/MM80	80	7.85	785	69.2	–	450 ml - 5 ltr.
(e)	M120/MM120	120	11.7	1176	104	–	450 ml - 25 ltr.
(f)	M200/MM200	200	19.6	1960	173	10 - 100 ltr.	–
(g)	M400	400	39.2	3920	346	–	100 - 500 ltr.
(h)	M600	600	58.8	5880	520	–	500 - 1000 ltr.
(i)	M1200	1200	117.6	11760	1040	–	1000 - 2000 ltr.
(j)	M1800	1800	177	17700	1560	–	2000 - 3000 ltr.
(k)	M2400	2400	235.2	23520	2080	–	3000 - 5000 ltr.
(l)	M3000	3000	294	29400	2600	–	5000 - 10,000 ltr.

Note: Magnetic drives of higher torque capacity for reactors of any make can be designed on request. Higher or lower than recommended torque drives can be used for particular reactor size depending on motor hp / viscosities / stirrer design etc.

Technical Specifications

Description	Standard	Optional
M.O.C wetted parts	SS-316	Hastelloy C, Monel, Inconel, Zirconium, Titanium, PEEK*
Design pressure / max. allowable working pressure	Full Vacuum to 200 bar for (a) to (e), 100bar for (f) & (g), 50 bar for (h) - (i)	Upto 690 bar for (a) to (e) Upto 350 bar for (f) & (g) 100 bar for (h) - (i)
Max. working temp. at rated pressure	500°C with water cooling jacket & 200 °C PEEK MOC	- -
Maximum RPM	1450 for (a) to (e) 750 for (f) & (g) 500 for (h) to (i)	Upto 3000rpm for (a) to (e) 1500 rpm for (f) & (g)

* For PEEK MOC, design pressure 10 bar @ 180°C available in model no. (b), (C), (d) & (e) only with 50% torque.
* As the pressure increases torque will decrease for same models.

Stirrer Types


(a) (b) (c) (d)

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

Optional:

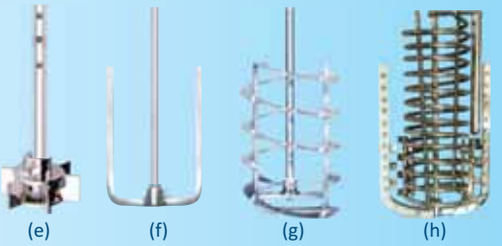
b) Propeller. c) Ruston turbine. d) Paddle.

e) Hollow shaft for max. gas dispersion at higher rpm, Ideal for hydrogenation or any gas-liquid reaction.

f) Anchor / anchor with PTFE blades for viscous liquids at low rpm (max. 200 rpm).

g) Spiral for highly viscous polymers/ mixtures with downward thrust at low rpm (max. 200 rpm).

h) Specially designed for highly viscous material for inside and outside mixing.


(e) (f) (g) (h)

Note:
- Other specially designed stirrers like helixane (helix cum anchor) etc. can be offered on request.
- Gear box has to be provided & cooling coil has to be removed & plugged for (f), (g) & (h).

Autoclaves - Specifications

Heating

Electrical ceramic band heater (EC) with ceramic wool insulation & SS cladding.

Optional:

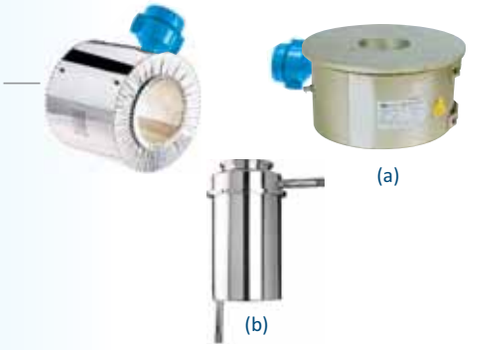
a) Flameproof / explosion proof IIB + H_2 certified, aluminium cast Heater for H_2 gas with totally enclosed heating element inside metal tubes (EA). Optionally the heater also has inbuilt cooling coils & is useful when internal cooling coils are not possible / required. It is suitable for max. 250°C inside the autoclave. Heating rates are lower in FLP heaters in comparison to ceramic band heaters

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

c) If direct electric heating is not permitted (due to spot heating), heater can be provided on jacket with oil inside. The heater can heat the oil which can in turn heat autoclave uniformly.

d) External heater temperature thermocouple is provided for cascade temperature control to ensure safety of heater, vessel & accurate temperature control. It is standard feature in aluminum cast heaters.

e) All ceramic band heaters are CE marked.



(a)

(b)

Control Panel

Compact SS-304 (for corrosion resistance & longer life) control panel with microprocessor based accurate programmable PID temperature controller cum indicator with temperature alarm system (settable), 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 indicator. This helps in identifying if any of the 3 heaters 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/ totaliser/ motor current indicator/ heater temperature cascade controller/ torque indicator / level indicator/ pH / DO / ORP / turbidity etc. indicators are provided additionally on same common control panel depending on the optional accessories selected.

1Ø panel

3Ø panel

Optional:

a) Digital temperature indicator in flameproof enclosure mounted on trolley & non FLP SS panel mounted remotely in safe area.

b) Complete flame proof (FLP) Group IIA/IIB or IIC control panel 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.*

c) Touch screen panel with SCADA software for single or multiple autoclaves.

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.

(a)

(b)

(c)

Power Supply

50 / 60 Hz, 1Ø 230V (S2) 16 amp for autoclaves upto 5 ltr. & 20 amp for 10 ltr. autoclave (or any size autoclave with heating through jacket) & 50 / 60 Hz, 3Ø, 415V for 20Ltrs. & bigger autoclaves with electrical heating.

Optional: 1Ø, 110V (S1) or 3Ø, 230V (T2) with 50Hz or 60Hz.

Autoclave Mounting Options

Trolley (TL), table / bench top (TT), floor stand (FS), lugs (LG)

Complete autoclave with motor drive assembly is mounted on easily movable SS-304 / aluminum trolley (for corrosion resistance & longer life) with 4 lockable wheels & the trolley top is big enough to mount the optional accessories & also the control panel. Table / bench top model is for keeping the autoclave on platform. Table top mounting is offered for sizes from 25ml to 2ltrs only. In table top model the panel & accessories if any have to be mounted separately. In floor stand mounting the autoclave mounting plate is supported by 4, SS-304 legs without wheels & there will be no space for mounting any accessories or panel. This is useful when there is space constraint or panel is mounted remotely. SS lugs (LG) mounting can be provided for 20 - 100 ltr. autoclaves.Refer page 8 for pictures of various mounting options.

450 ml Bench Top Reactor

High Pressure Systems for different applications

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

Autoclave with multiple view windows

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

1 ltr. automated hydrogenator with hydrogen uptake measurement.

2 ltr. Interchangeable SS & glass autoclaves for ethoxylation

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

350 bar, 500°C interchangeable metal autoclaves with automatic inlet outlet pressure control, heat exchanger & receiver

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 crystalization
- For solubility studies of oxides
- For carrying out pulping & pulp bleaching experiment
- Polymer mini reactor for synthesis

Pilot Plants

Ex-proof hydrogenation pilot plant with catalyst charging, catalyst filter with recycle & catch pot

Multipurpose pressure reactor with column & distillation assembly

High pressure polytest reactor system

Pilot Plant for Styrene Butadiene Emulsion Polymerisation

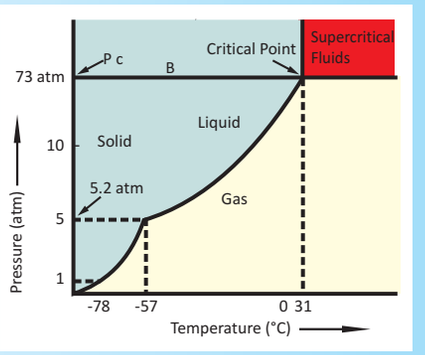
Fully automated ex-proof alkoxylation pilot plant with touch panel & SCADA

Supercritical Fluid (CO_2) Extraction (SFE)

Supercritical Fluid Extraction (SFE) system uses supercritical carbondioxide (CO_2) as solvent instead of any organic solvent.

What is Supercritical CO_2?

Carbon dioxide is in its supercritical fluid state when both the temperature and pressure equals or exceeds the critical point of 31°C and 73 atm (see diagram). In its supercritical state, CO_2 has both gas-like and liquid-like qualities, and it is this dual characteristic of supercritical fluids that provides the ideal conditions for extracting compounds with a high degree of recovery in a short period of time. By controlling or regulating pressure and temperature, the density or solvent strength of supercritical fluids can be altered to simulate organic solvents ranging from chloroform to methylene chloride to hexane. This dissolving power can be applied to purify, extract, fractionate, infuse and recrystallize a wide array of materials.



CO_2 Phase diagram

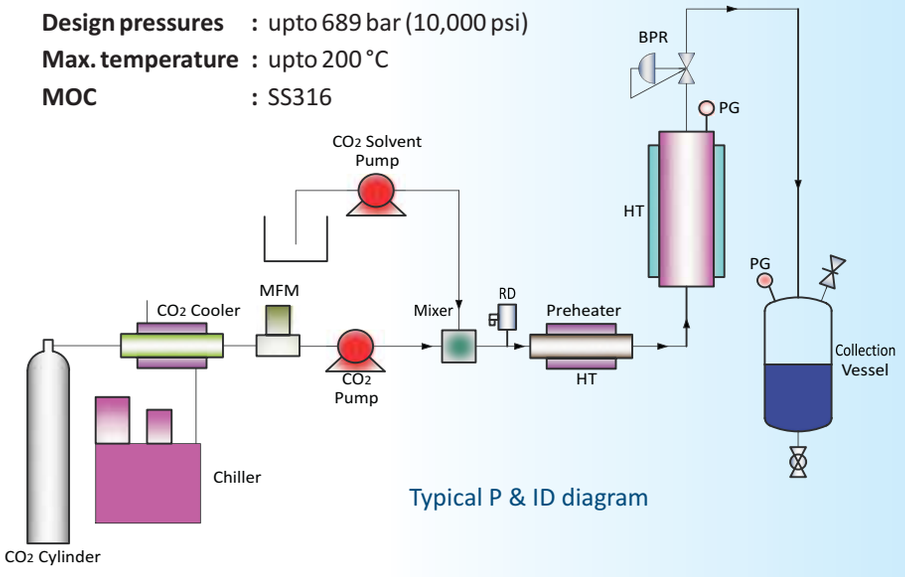
Application

- Extraction of herbs, spices, fragrance, pharmaceuticals, chemicals compounds etc.
- Extraction of essential oils
- Extraction from natural products, food, polymers etc.
- Drying of aerogels
- Extraction of nicotine & caffeine
- Cleaning of high precision components & photo resists

These system consists of stirred autoclave / pressure reactor or a non-stirred extraction pressure vessel. Liquid CO_2 is charged into it through a booster or a plunger/diaphgram pump. CO_2 is maintained at low temperature to keep it in liquid stage at lower pressure by providing a heat exchanger before the pump. Suitable chiller is used to maintain low temperature of CO_2. The material to be extracted is placed in an extraction vessel & pressurized with CO_2 to dissolve the sample with desired temperature control. It is then transferred to a separator where it is depressurized (by manual / automated back pressure regulator) resulting in precipitation of desired material & separated CO_2 can be recycled. Optionally CO_2 pumps with inbuilt peltier cooling is supplied to avoid the heat exchanger & cooler before the pump. PC operated complete automated system can be offered. Special booster pump for liquid CO_2 is also available on request.

1 ltr. extraction vessels in serial & parallel for 690 bar (10,000 psi) pressure with CO_2 pump

Volume : 100 ml - 200 lit.
Design pressures : upto 689 bar (10,000 psi)
Max. temperature : upto 200 °C
MOC : SS316



Typical P & ID diagram

Supercritical drying of Aerogels

Reaction Calorimeter

Reaction calorimeters are used to measure heat of the reaction (Enthalpy) which helps in scale up of reaction & avoiding potential safety hazards. They can be provided with different probes to measure the temperature, pH, turbidity, DO, ORP, IR etc. in glass or metal reactors or interchangeable glass & metal for low or high pressure applications.

Autoclaves for Corrosion Testing

Autoclaves for corrosion application are mainly used in aggressive environments like H_2S & supercritical waters in oil refineries & defence industries.

Applications

- 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 par API standard.
- Polymer testing /curing/processing under HPHT conditions
- Rocking autoclave for chemical reactions kinetics studies.
- Slow strain rate tests for stress corrosion cracking under HPHT conditions
- Any other types simulating particular environments including gas hydrate CO2 / CH4 based

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 the testing. Autoclaves are then fed with the corrosive media & designed temperature & pressure are raised & maintained in the autoclaves. Optionally suitable electrodes like pH or ORP (MOC: SS316 / Hast-C) are provided to measure the pH & redox potential under pressure. Autoclaves with working, counter / reference & auxillary electrodes can also be offered with potentional measurement system for electrochemical corrosion testing.

Re-circulating Loop Autoclaves for Corrosion Testing

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

Rotating coupon holder assembly

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 in 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 of hydrate-inhibitors and can be optimized in a pressure range of up to 200 bar or up to 350 bar.

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. The overhead stirrer can be connected to a torque sensor to perform torque measurements to study viscosity changes.

High Pressure Vessel System for Hydrogen Induced Disbonding Tests

Amar has manufactured & supplied system 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 refinery. The results would give the resistance of bimetallic steels & its alloy to hydrogen induced disbonding. Thus 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 optionally completely automated. Initially the test samples are put inside the vessel & pressurized with hydrogen to very high pressure upto 150 – 200 bar & then heated to desired temperature of around 400 - 500°C for a period of around 48 hrs. After the test is over, the vessel is cooled at a pre-defined rate of around 150°C /hr. till the temperature reaches 200°C. The vessel pressure is then released completely & cooled further to remove the test samples.

Pressure Vessels for Soaking of Diamonds & Precious Stones

High pressure high temperature pressure vessel are often used to purify & improve the finish of diamonds & precious stones by subjecting them to high pressure & temperature conditions.

Pressure Vessel for Gas / Liquid Storage

It can be used as a gas/ liquid storage pressure pot to transfer liquid/ gas in the autoclave/ other pressure vessel at higher pressure.

250 ltr.

Gas Induction Reactors - Hydrogenators / Pilot to Plant Scale Pressure Reactors (F)

250 ltr.

500 ltr.

1000 ltr.

Salient Features

- Sizes >100 ltrs. ≤1000 ltr. working volumes.
- MOC SS-316, 316L, Hastelloy B/C, Monel, Inconel, Nickel, Titanium, Zirconium etc.
- Design pressures upto 100bar (1450 psi).
- Max. working temperatures upto 350 °C.
- Zero leakage magnetic drive coupling from 20-300 N-m torque capacity.
- High mass transfer hollow shaft with gas induction impeller (ideal for hydrogenation, oxidation, ammination, chlorination, bromination etc. gas liquid reactions) pitch blade turbine, anchor, propeller, paddle etc. for other applications.
- Very efficient for gas liquid mixing.
- Fabricated with dished ends & 100% X ray radiography of welded joints.
- All designs as per ASME codes.
- 'U' stamp coded, PED certified reactors can be offered on special request.
- Jacketed or single / double limpet coil with insulation & cladding.
- Upto 440 rpm infinite variable speed with suitable gear box.
- Body flanges with bolts & teflon / spiral wound metallic gaskets for shell & dish sealing (Z).
- Without body flange, monoblock design offered depending on pressures & application.
- Internal cooling coil, vent, liquid / powder charging, dip tube, thermowell, flush bottom outlet, baffles, light & sight glass, handhole / manhole etc. nozzles, fittings, ex-proof control panel & accessories offered as required.
- Optionally with safety rupture disc / pressure safety valves, all other valves & fittings.
- Suitable catalyst filtration & recycle system offered for hydrogenation. (refer page 31)
- With suitable catch pot & flame arrester to collect the vent.
- Lugs or floor stand skid mounted structure.

125Ltr., 100 bar

For other optional accessories refer page 30 onwards.

Rocker/Shaker Hydrogenator (R)

Salient Features

- Charging, operating etc. very simple & vigorous mixing reduces the reaction time considerably.
- Very small & compact system without gland hence minimum spares & maintenance.
- Very economical considering the interchangeability of different capacity vessels in common setup.
- Used mainly for synthesizing or modifying organic compounds by catalytic hydrogenation.
- Used to study catalyst activity.

Table Top Model

Technical Specifications

Volume	:	100ml, 250ml, 500ml, 1 Ltr., 2Ltr. with option of using more than one vessel of any size & MOC in same setup.
MOC	:	SS-316 & Glass Optional: Hastelloy C wetted parts.
Design pressure	:	20 bar (300 psi) for metal vessels & 3 bar (45 psi) for glass vessel.
Design temperature	:	200°C for SS vessel & 150°C for glass vessel with optional Electrical heating arrangement & control panel with PID controller & alarm system.
Drive	:	1/2 H.P. flame proof AC Group IIA, IIB or IIC motor with about 200 oscillations/min. fixed rocking speed. Optional: Variable speed rocking with variable frequency drive.
Mounting	:	Table top or SS floor stand.
Gas cylinder	:	Around 4 Ltrs. capacity H2 gas cylinder of SS-304 with inlet, outlet valves, pressure gauge & flexible hose pipe with NRV to feed gas into the vessel while it is in motion.
Standard fittings (for metal vessel only)	:	Vent valve, dip tube with sampling valve, 2" opening on top for powder / liquid inlet & cleaning, thermowell, pressure safety valve.
Overall Dimensions (without panel)	:	850mm (W) x 700mm (D) x 700mm (H) for table top models & 1300mm (H) for floor stand models
Panel Size	:	300mm (W) x 300mm (D) x 300mm (H)
Power Supply	:	3Ø, 415V, 50Hz / 60Hz for fixed speed & 1Ø, 220V, 50Hz / 60Hz for variable speed shakers
Safety Shield	:	SS wire grid is provided for glass bottles for safety in case of breakage due to accidental over pressure.

Floor Stand Model

Shaker with SS Vessel, electrical heating & 3Ø control panel

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, rocker & fabricated autoclaves unless specified.

Gas Pressure Regulator

To manually charge different gases at desired pressures upto 140 bar (Kg/cm²) / 2000 psi or higher into the reactor from gas cylinder. Nitrogen, Oxygen & Hydrogen can be charged through same regulator(with special adaptor). Regulator for other gases like NH3, CO_2 etc. can also be offered. The regulator comes with inlet - outlet pressure gauges & flexible SS braided teflon high pressure hose pipe (4m long) with non return valve.

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 upto 10,000 psig. 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.

Complete SS mounting with all fittings & valves is optional

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 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 300 bar (Kg/cm²) 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 max. flow rate range, pressure, gas & mode (flow control or pressure control) for ordering MFM/MFC. Optionally MFM / MFC certified for use in zone 1 hazardous area offered on request.

MFC

Flow Indicator & Totaliser

Ex-proof MFC

Coriolis Gas - Liquid Mass Flow Meter/Controller

These are used for higher & accurate gas or liquid flow rate indication or control where thermal mass flow meters are not suitable. Common meter can be used for all the gases & liquids with only change in pressure drops and flow rate ranges.

Coriolis Mass Flow Meter

Coriolis Mass Flow Controller

Digital Pressure Indicator / Controller

It consists of SS316 pressure sensor (transmitter) & digital pressure indicator/ controller (mounted on common control panel) with pressure alarm & optionally heater cut off for safety. Digital pressure indicator has pressure reading in bar & psi, where as controller reads any one of the units. The controller is normally used with mass flow controller (MFC) or solenoid/flow control valve 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 80-100°C & hence the same is provided with water cooling jacket. Optionally intrinsically safe pressure sensor with IIC certification is provided. Pressure sensors with Hastelloy C / Inconel wetted parts can be offered on request.

- *Complete mounting of all the accessories shall be done on autoclave stand / trolley.*
- *All the indicators / controllers are mounted on a common SS panel.*

Solenoid Valve

Control Valve

Pressure Sensor

Optional Accessories

Liquid / Slurry / Gas Charging High Pressure Pot

It is used to transfer liquid or gases in to the autoclave under pressure. It consists of high pressure SS-316 pot designed for working pressure 100bar (kg/cm^2) or higher with port for nitrogen gas (N_2), liquid / slurry inlet with valve & funnel, outlet valve, pressure gauge, pressure safety valve, high pressure hose & NRV. The liquid to be charged is fed into the pot from top funnel & pressurized with N_2 gas until its pressure is higher than the autoclave pressure & then under pressure the liquid is charged into the autoclave. The quantity & rate of flow of liquid charged is not known precisely in this system. However a level indicator or sight glass or weighing balance or flow meter can be provided optionally to measure the liquid charged or it's 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 far off. With this option approximate quantity or flow of gas consumed can also be determined by measuring the pressure drop. Optionally forward pressure regulators can be provided at the outlet of pot if they are used as gas charging.

Sizes: 250 ml, ½ ltr., 1 ltr., 2 ltrs., 5 ltrs., 10 ltrs.

Ethylene EO / Polypylene 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 (kg/cm^2) working pressure. It is used for ethoxylation. It can be supplied with flame proof weighing balance to measure the quantity of EO/PO charged.

Sizes: 2 ltrs. & 5 ltrs.

Liquid Metering Pump System

(b)

(a)

(c)

Weighing Scale

This system is used to charge the liquid at desired rate from as low as 1ml/hr. to 100Ltr./hr, when the autoclave is under pressurized condition. The system comes with metering pump, flow indicator, controller, liquid sump, pressure gauge, strainer & high pressure hose. Optionally pressure safety valve, flow totalizer is also provided. AMAR offers 2 types of pumps.

a) Low cost diaphragm pumps for pressures upto 100 bar & min. flow range of 60-600ml/hr. to max. 10-100 lit/hr. The flow rates are varied by varying the motor speed with variable frequency drive.

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.

c) Syringe, PTFE diaphragm, peristaltic pumps can be offered for pumping corrosive chemicals at low / high pressures.

Optionally, in line flow meters can be connected to measure the actual flow of the liquids.

Auto Cooling System

(a) with FLP coil

(b)

This system is useful to control temperature overshoot for highly exothermic / out of control runaway reactions & for faster cooling after the reaction is over.

The control panel of the autoclave gives 230V, 1Ø output to connect external auto-cooling system. AMAR gives 2 options:

(a) **Solenoid valve,** flameproof IIC (for autoclaves upto 25 litr) or (b) **pneumatically actuated ball valves** (for autoclaves above 25 litr) connected at the inlet of the internal cooling coil with external source of water supply. This is standard for 50ml - 250ml autoclaves, however for bigger autoclaves if the cold water line pressure is <2bar 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 autocooling system gives positive pressure & faster cooling.

Optional Accessories

c) **Pump & Water Cooling Tank:** 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 non FLP / FLP monoblock pump tank, pipeline & flexible hose pipes with quick release coupling & is mounted on the autoclave trolley itself. It can also be used to circulate water in the cooling coil of external aluminum cast heater when internal coil is not possible. 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.

(c)

Magnetic Drive & Pressure Sensor Cooling System

It is a simple 5 ltr. SS 304 tank with submersible pump to circulate water in the magnetic drive & pressure sensor jacket to prevent temperatures from rising beyond 80°C. It is useful if tap water connection is not near the autoclave.

Low Temperature Cooling Circulator Bath

It is used to reduce the autoclave temperature to as low as upto -50°C from room temperature to carry out reactions at lower temperatures by circulating thermic fluid in the internal cooling coil / jacket of autoclave. It consists of single/double stage compressors, condensor, circulation pump & temperature controller for thermic fluid & reactor. The system can be with bath or closed loop bathless type for efficient & faster heat transfer.

Thermic Fluid Heating Circulator Bath

It is opted only if heating is jacket type & the area is totally flameproof or direct electric band heaters are not permissible. Heating can be done by circulating hot thermic fluid through the jacket of the autoclave. The system comes with SS tank, electric heaters, level switch, pump for thermic fluid & reactor. The heating system is non flame proof & can be kept at a distance in safe area, if the reactor is in flame proof area. The system can be with bath or closed loop bathless type for efficient & faster heat transfer. Open bath system can be offered upto max. 150°C inside the reactor (due to fuming of thermic fluid) & are available upto 25 lit. autoclaves only, whereas closed loop systems can be offer upto 250°C inside the reactor & upto 1000 ltr. volume.

Common single fluid heating cooling circulator baths can be offered from -30 to 200°C to -75 to 200°C.

Closed Loop Single Fluid Heating & Cooling Circulator

If heating & cooling both are to be done by circulating thermic fluid through reactor jacket then, common closed loop single fluid heating & cooling system for temperatures from -50 to 250°C inside the reactor can be offered. Closed loop ensures faster & efficient heat transfer with no fuming & higher temperature range.

Note: All the above systems are supplied with 6 ft flexible insulated hose & optionally suitable thermic fluid.

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 pressure control. Amar gives 2 options.

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

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

(a)

(b)

Optional Accessories

Reflux Condenser

It is a jacketed tube SS-316 (0.01m², 0.02m² or 0.05m² area) heat exchanger 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. Reflux condensers can be offered in different MOC & area.

Condenser

It is a SS-316 shell & tube reverse flow heat exchanger for distillation/condensing the vent vapours from the autoclave upto 10Kg/cm² pressure. It can be offered in all different MOC, higher pressure & different surface areas such as 0.1, 0.2, 0.5, 1 & 2 m^2. The condensate can be collected separately in receiver or optionally refluxed back into the reactor.

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 port to apply vacuum & offered in 250 ml, ½ ltr., 1 ltr., 2 ltrs. & 5 ltrs. volumes. Higher volumes & other MOC can be offered on special request. It can be optionally provided with level indication.

Back Pressure Regulator

It is mounted on the vent line of the autoclave & is used for maintaining constant pressure inside the autoclave. 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. Alternately electronic digital back pressure regulator can be offered on request, where the pressure is set digitally & can be released at preset rate of pressure release.

Pressure Safety Valve

High pressure autoclaves are provided with built in safety rupture disc, however additional safety can be offered by providing pressure safety valve whose release pressure can be set manually for a wide range by increasing or decreasing the spring tension. The set pressure should normally be around the design pressure. Safety relief valves are standard supply for glass & rocker autoclaves where rupture discs are not available for low pressures. These valves come with PTFE / Viton orings which may not be suitable for certain gases & solvents.

Chain Pulley / Hydraulic Head Lifting System

For autoclave volumes from 10 ltrs. to 250 ltrs. the head & vessel are too heavy to lift manually. Hence chainpulley block mounted on same trolley with SS Stand can be offered for lifting the head with minimum efforts. Electric chainpulley hoists can be offered on request.

Hydrate lid lifting arrangement can be offered on request for any reactor volume.

Refer page 8 (i) 100 ltr. model photo.

Optional Accessories

SCADA Software for remote operation & Recording

SCADA is a supervisory control & data acquisition software with all controllers / indicators having RS485 modbus communication port or PLC & HMI / touch panel, for online display, set point changes & data logging of pressure, temp., Motor RPM, motor, torque % & optionally 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 10m or higher is also supplied. Wireless data communication from PC to panel can be supplied on request.

PLC

When there are many autoclaves and or many parameters & IOs with interlocks & programming, PLCs with HMI (touch panel) or PC are offered.

Liners

Teflon Metal Glass

Removable Teflon / Metal / Glass liners can be offered for autoclaves from 100ml - 25Ltrs. size. These liners can be used for reactions that are corrosive, to prevent only the autoclave body from corrosion. Teflon & glass liners can be used upto 200°C, metal upto 500°C. The heat transfer is also very poor with teflon & glass liners. Glass liners cannot be fabricated accurately. Hence, Amar recommends the use of complete corrosion resistance 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, Nickel, Titanium etc.

Catalyst Basket

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 SS wire mesh & connected to the stirrer so that it rotates with the stirrer. It is available for 450ml-100 ltrs. autoclave. The catalyst basket can be static which is stationery & dynamic which rotates with the impeller. As standards, Amar offers dynamic basket.

Catalyst Filters

These are small 7 microns sintered cup filters which are threaded to bottom of the sampling dip tube so that while sampling liquid, the catalyst does not come out. 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 450ml-100Ltrs. autoclaves. These filters are available in SS 316 & Hastelloy C.

Catalyst Addition Device

It is used for one time catalyst charging under pressure during the reaction. It consists of a 3ml to 150ml (depending on Autoclave size) small container with airtight cap, that 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, sometimes 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.

Optional Accessories

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 1000 ltr. reactor volumes. These filters are available with zero holdup 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-diffined 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.

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 to release directly into the atmosphere. It is a pressure vessel, designed depending on volume of autoclave & it's design pressure. It is provided with inlet, outlet, vent, dip tubes, pressure gauge, safety valve & optionally a frame arrester. It is normally filled with water. The gases / vapours collected are safely released through the flame arrester to avoid any hazard. It is suitable & available for any autoclave volumes.

Vacuum Pump

Suitable rotary vane or diaphragm vacuum pumps can be supplied for vacuum from 700mm of Hg upto 10^{-3} mm of Hg in the reactor depending on the pump type selected. 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.

View Windows / Light & Sight Glass

Quartz / sapphire view glass windows / light & sight glass of small diameter or along the length with special cameras & software for continuous online viewing / recording in jacketted vessels to see the reaction. Suitable for high pressures upto 200 bar.

Multiple view windows

Round view window

Sight glass along the vessel length

In Situ FTIR Spectroscopy (IR Probe)

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.

Optional Accessories

Other Accessories / Options

a) Level transmitter / switch with indicator to measure or maintain level inside the reactor under high pressure. Used mainly in CSTR.

b) pH/ turbidity / DO / ORP sensors with indicators & controllers for high pressure & temperature application. pH can be controlled automatically by variable speed acid & base metering pump.

c) Removable internal baffles for better stirring (but cooling coil has to be removed in small autoclaves).

d) Sampling pot with condenser for cooling / condensing & collecting the sample taken at high pressure & temperature.

e) Torque sensor for accurate measurement of the motor torque, where change in torque indicates change in viscosity of the reaction.

(a) (b) (c) (d) (e)

2 lit. hastelloy trolley mounted autoclave with various optional accessories like flameproof temperature indicator, motor, auto cooling system, aluminum cast heater, high pressure liquid charging pot, flush bottom valve, ball valve for powder inlet, reflux condenser, flameproof motor, removable head design, hastelloy diaphragm pressure gauge, pressure sensor & pressure safety valve.

Conversion Table

Pressure Equivalents

MPa	atm	bar	kg/cm²	psi
1	9.8692	10	10.1971	145.04
0.101325	1	1.013525	1.0332	14.696
0.1	0.98692	1	1.01971	14.504
0.098067	0.96784	0.98067	1	14.223
6.8948×10^{-3}	0.06805	0.06895	0.07031	1

1 atm = 760 mm of Hg = 760 Torr

Temperature Equivalents

$°F = 1.8 \times (°C) + 32$

$°C = 5/9 \times (°F) - 32$

Power Equivalents

1 H.P. (Electric) = 746 W

1 H.P. (Metric) = 735 W

Torque Equivalents

Kg-cm	N-m	N-cm	lb-in
1	0.0981	9.81	0.868
10.2	1	100	8.85
0.101	0.01	1	0.0885
1.15	0.113	11.3	1

Trade Shows

Amar regularly exhibits at various domestic & international trade shows directly & through distributors as well.

Viz. Chemspec, CPHI, Analytika, PMEC, Achema (Germany), ACS (USA) etc.

Client Testimonials

TO WHOM IT MAY CONCERN

This is to certify that we have purchased a 5L Autoclave from Amar Engineering Works in June 1996. This is an excellent equipment and functioning very well. We are regularly using this Autoclave for high pressure and high temperature reactions without any problem. This equipment is very useful for carrying out catalytic hydrogenation and high pressure reactions.

We get very prompt after sales service from M/s. Amar Engineering particularly with respect spares and accessories.

For SANMAR SPECIALITY CHEMICALS LIMITED

Dr.R.Ramachandra
Assistant Vice President – R&D

SÜD-CHEMIE INDIA LTD.

TO WHOMSOEVER IT MAY CONCERN

We are in possession of one 500 ml. laboratory autoclave with magnetic d system supplied by Amar Equipments Pvt. Ltd., Mumbai. For the past three ye this is in continuous operation at our R&D lab. for various developmental project On many occasions this latest model has been under continuous operation upto 5 days at 200° C & 25 kg./cm² operating pressures without any interruption and breakdown. This unit hardly needs any maintenance evenafter several operation cycles. This unit finds several applications including different in-situ reactions and high temperature / high pressure synthesis under hydrothermal / organothermal processes.

The services rendered by Amar Equipment Pvt. Ltd., are exceedingly good at all times.

Johnson Matthey
Catalysts

Johnson Matthey Chemicals India Private Limited
Plot No 6 MIDC Industrial Estate Taloja Dist.Raigad Maharashtra 410208
Telephone: + 91 (0) 22 27401710 Fax: +91 (0) 22 27401711

Date:

TO WHOM IT MAY CONCERN

This is to certify that we have following AMAR Make Autoclaves.

Sr. No.	Size of Autoclave	Equipment No.	Year of Supply	Pressure Rating of use
1.	400ml	1179	16.08.2007	15Kg/ Cm²
2.	1000ml	1296	05.03.2008	15Kg/ Cm²

The performance of the Autoclaves is satisfactory under the & temperature. AMAR Equipments service and support is a

Thanking you,

Yours faithfully,
Deepak Satoskar
Manager- Development
Matthey, Taloja)

Thirumalai Chemicals Ltd.

S. H. KELKAR & CO. LTD.

Date: 04/09/2001

To,

TO WHOMESOEVER IT MAY CONCERN

We have purchased Autoclaves of different sizes from AMAR EQUIPMENTS Pvt.Ltd.as per following details

Yr. of supply	Size	No. of Autoclaves	Operating pressure	Operating Temperature	Performance of magnetic drive
1980-81	5000ml	01	Atm-500 psi	Ambient-300 deg C	excellent
1999-2000	2000ml	01	Atm-500 psi	Ambient-300 deg C	excellent
1999-2000	500ml	01	Atm-500 psi	Ambient-300 deg C	excellent

Performance is satisfactory .The and Amar Equipm

Ipca Laboratories Limited

Zydus dedicated to life

TO WHOMSOEVER IT MAY CONCERN

We have following Autoclaves (Amar Make)

Sr. No.	Capacity	Maximum Pressure used (Kg/cm²)	Maximum Temp. used (°C)	Year of supply
	0.5 lit	60	90	2000
			130	2001

31st August 2001

राष्ट्रीय रसायनिक प्रयोगशाला (Council of Scientific & Industrial Research, Govt. of India)
NATIONAL CHEMICAL LABORATORY

411 008

REF:

AMAR ENGINEERING WORKS,
6, PARMAR INDUSTRIAL ESTATE,
BEL BAZAR, KURLA,
MUMBAI 400 070.

Date :

KIND ATTN: Mr.N.A.SHAH

Dear Sir,

SUB : PERFORMANCE OF MAGNETIC DRIVE.

1. You had retrofitted a Magnetic Drive you on one of the reactors supplied by you earlier.
2. We have used this laboratory in which days from 8/4/99 pressure temp
3. We are

Cadila Healthcare Limited

RANBAXY

TO WHOM IT MAY CONCERN

This is to state that we have a 2 L pressure reactor / autoclave manufactured and supplied by M/s Amar Equipment, 6, Parmar Industrial Estate, Bell Bazar, Kurla (W) Mumbai for more than 10 years with us, working satisfactorily. The said Equipment has been serviced and serviced by M/s Amar Equipment.

at ~70 kg / cm2 and at maximum 140°C without any problem.

We have used

Lab. Ltd.

This is to certify that we have following AMAR Ma

Sr. No.	Size of Autoclave	Equipment No.
1.	2 Lit	
2.	2 Lit	
3.	2 Lit	

The performance of the Autoclaves is temperature. AMAR Equipments servic

king you.

ithfully,

Perstorp Chemicals India Private Limited

DATE: 08/07/2008

This is to certify that we have following AMAR make autoclaves:

Sr.	Size of	Equipment	Year of	Pressure	Temp.	No. of

st and Head R&D)
Ltd., Dahisar.

Some of our valued customers

Aarti Drugs Ltd.

aether elementally innovative

Aditya Birla Group

Alembic Touching Lives over 100 years

Anthem BioSciences

ARCH

asianpaints

AstraZeneca

Atul A memeber of Lalbhai Group

AUROBINDO Committed to healthier life!

BARC Atoms in the Service of the Nation

BASF The Chemical Company

BAYER

Biocon

Bharat Petroleum

CADILA PHARMACEUTICALS LIMITED

calyx

Cipla Caring for life

CHEMINOVA AYUDANDOLEA CRECER

Clariant

CSMCRI, NCL, IICT etc.

CRODA

All DRDO Labs

Deepak Nitrite Limited

dishman

DORF KETAL

Divis Laboratories Ltd.

DR. REDDY'S

ESTĒE LAUDER COMPANIES

EVONIK INDUSTRIES

EXCEL

FRESENIUS KABI

GE

Gharda

Glenmark PHARMACEUTICALS LTD.

GODAVARI

Godrej

gsk GlaxoSmithKline

GNFC

GFL GUJARAT FLUOROCHEMICALS LIMITED

GVK BIO

HETERO

heubach

HiKAL

HP

Hindustan Unilever Limited

Hospira

(Formerly UDCT)

All IIT's

IndianOil

INTAS Expresions for a Healthy Life

ipca A dose of life

ISRO

JAYCHEMICALS REALIZING IDEAS IN CHEMISTRY

Johnson Matthey

Some of our valued customers

Worldwide presence

Exports to over 50 countries worldwide with distributors for sales & service in following countries

• Australia	• Colombia	• Germany	• Mexico	• Portugal	• Slovakia	• Thailand
• Azerbaijan	• Czech Republic	• Iran	• Netherlands	• Russia	• South Africa	• Turkey
• Brazil	• Egypt	• Israel	• Peru	• Romania	• South Korea	• UK
• Cambodia	• Estonia	• Italy	• Phillippines	• Saudi Arabia	• Spain	• USA
• China	• France	• Malaysia	• Poland	• Singapore	• Taiwan	• Vietnam

Sales & service support available from following places in India

• Ahmedabad	• Bangalore	• Hyderabad	• Kolkatta	• Mumbai	• New Delhi

Our motto, customer's delight & not mere satisfaction

AMAR EQUIPMENTS PVT. LTD.

Serving Industry since 1974.

6, Parmar Industrial Estate, Bail Bazaar, Kale Marg, Kurla (W), Mumbai - 400 070. India.
Tel: +91-22- 6225 5000 • Fax: +91-22-2510 9565 • Website: www.amarequip.com
E-mail: scfe@amarequip.com / sales@amarequip.com / export@amarequip.com

• High Pressure Autoclaves • Continuous Flow Microreactors • Fixed Bed Tubular Catalyst Reactors
• CSTR • Gas Induction Reactors • Exproof & Automated Pilot Plants • Glass / Peek Autoclaves
• High Throughput Catalyst Screening System • Super Critical Fluid System (SCFE) Technology
• HPHT Corrosion Testing System • Magnetic Drive Couplings & Mixers / Agitators