



JAS-ANZ



## Product Overview

- Glass Reactor Systems
- Kilo Lab (Reaction/Distillation Units)/Hood Application
- Rotary Film Evaporator
- Glass Overhead Assembly for GLR
- Shell & Tube Heat Exchanger
- Glass Absorber Systems
- HCL Gas Generator Systems
- Glass Nutsche Filters
- Bromine Recovery Plants from Bromides
- Bromine Recovery Plants From Sea Bittern
- Bench Scale Reaction Units
- Bench Scale Reaction + Filter
- Mixer Settlers
- Thin-Film Evaporator
- Glass Process Equipments



# ABOUT SIGMA

Sigma Scientific Glass Pvt. Ltd. Is the leading ISO 9001:2000 certified manufacturer company engaged in manufacturing of borosilicate glass 3.3 industrial process equipments/process plants in India, for chemical industry growing at rapid pace. All our glass equipment comply with ISO 3585/3586/3587 for SIGMA FLAT BUTRESS ENDS DN 25 to DN 600 and find extensive use in the construction of complete glass process plants/pilot plants in the chemical process industry.

The company was established in 1997 by managing director Mr. Dharmendra Patel with a vision of setting up one reliable source of complete range of industrial glass for chemical industry with highest quality and affordable price. In one decade of its existence the company has proved to be a reputed source of high quality glassware with unmatched service of international standards.



The company has achieved consistent progress every year since inception based on the large numbers of satisfied customers who buy exclusively from us. We are also the largest OEM supplier to the glass industry; we have now entered into the international markets and have received excellent response from countries like Dubai, Sri Lanka etc.

We are committed to constant innovation and development of new products to meet your increasing demands and requirements. We started Manufacturing SIGFOLDI-JACKET™ Vessels up to 200ltr cap. from an entirely new design (100% Folding Design) with designed patent (No. 207576) first time in the world with our capabilities of design, manufacturing and installation, we are perfect one stop for your requirement of borosilicate 3.3 process plant and pilot plants.

We also are engaged in manufacturing of complete range of Glass Plant supporting Cast Iron and Stainless Steel (die mould) Structure Parts along with Metal Parts like couplings etc. required for Glass Assemblies.

Our Equipments are built for batch and semi-batch mode operations of perfectly matched components of top quality materials which guarantee economical and high performance solutions tailored for customer requirements.

In R & D as well as pilot plants, Kilo-labs and API Processing companies our equipments especially Reactor Assemblies are used for multiple processes as batch reactors. The operation temp of such Systems can be  $-50^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ . These reactors can be used for scale-up processes because of maintained L/D Ratio.



# TECHNICAL INFORMATION

## PROCESS PLANT IN BOROSILICATE GLASS 3.3

Sigma glass plants, pipelines & components are fabricated as per following international standards.

- > BS EN 12585:1999 - Glass plant, pipeline & fittings compatibility & interchangeability.
- > BS EN 1595:1997 - General rules for design, manufacture & testing.

The full range of standard components & associated equipments available is described in the following sections of the catalogue.

## CHEMICAL COMPOSITION OF BOROSILICATE GLASS 3.3

The Borosilicate glass 3.3 used in the fabrication by SIGMA complies generally with the following chemical composition

Component	% by weight
SiO <sub>2</sub>	80.6
B <sub>2</sub> O <sub>3</sub>	12.5
Na <sub>2</sub> O	4.2
Al <sub>2</sub> O <sub>3</sub>	2.2
Others	0.5

## PROPERTIES OF BOROSILICATE GLASS 3.3

The very wide use of this material throughout the world in the chemical and pharmaceutical industries as well as many other allied areas, is mainly due to its chemical and thermal properties (see also ISO 3585) together with a great number of other benefits that distinguish borosilicate glass 3.3 from other materials of construction. These include special properties e.g

- \* Smooth non-porous surface
- \* Transparency
- \* Outstanding corrosion resistance
- \* No adverse physiological properties
- \* Neutral smell and taste
- \* Non-flammability
- \* Catalytic inertness.

## CHEMICAL RESISTANCE

Borosilicate glass 3.3 is resistant to corrosion by almost all chemicals. This makes its resistance more comprehensive than that of other well known materials. It is highly resistant to water, saline solutions, organic substances, halogens & many acids. There are only few chemicals which cause noticeable corrosion of glass namely, hydrofluoric acid, concentrated phosphoric acid & strong caustic solutions at elevated temperature.

The curves in fig .1 show a maximum corrosion for different acids in the concentration range between 4 and 7 N (HCl for example at the azeotrope with 20.2 wt%). Above that reaction speed decreases markedly so that the eroded layer amounts to only a few thousandths of millimeter after some years. There is, therefore, justification for referring to borosilicate glass 3.3 as an acid-resistant material.

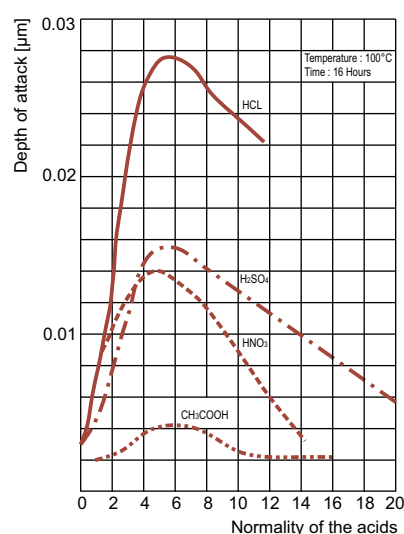


Fig. 1  
Acid attack on borosilicate glass 3.3 as a function of concentration

It can be seen from the corrosion curves in fig .2 that the attack on the glass surface initially increase as the concentration of the caustic solution increases but after exceeding a maximum it assumes a virtually constant value. Rising temperatures increase the corrosion, While at low temperatures the reaction speed is so low that reduction of the wall thickness is hardly detectable over a number of years.

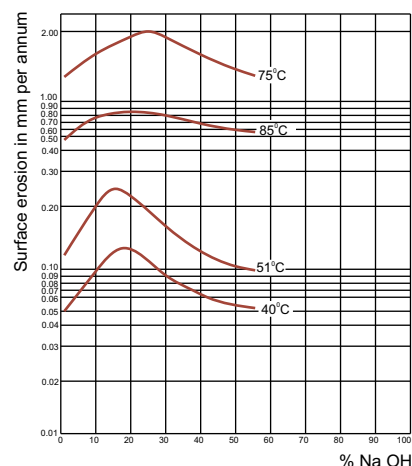


Fig. 2  
Alkali attack on borosilicate glass 3.3 as a function of temperature & Concentration

## OPTICAL PROPERTIES

Borosilicate glass 3.3 shows no appreciable light absorption in the visible range of the spectrum, thus it is clear & colorless. Transmission of UV light is significant in the middle spectrum compared to normal glass. Borosilicate glass 3.3 is ideally suited for photochemical reactions such as chlorination & sulphochlorination.

## THERMAL SHOCK

Quick changes in temperature across the walls of glass components should be avoided during operation both indoors and outside. They result in increased thermal stress in the glass, which as described above, has an adverse effect on the permissible operating pressure of the plant components. Although it is not possible to give a definite figure applicable to all the operating conditions likely to be encountered in practice, a maximum permissible thermal shock of 120°C can be taken as a general guide.

# TECHNICAL INFORMATION

## PERMISSIBLE OPERATING TEMPERATURE

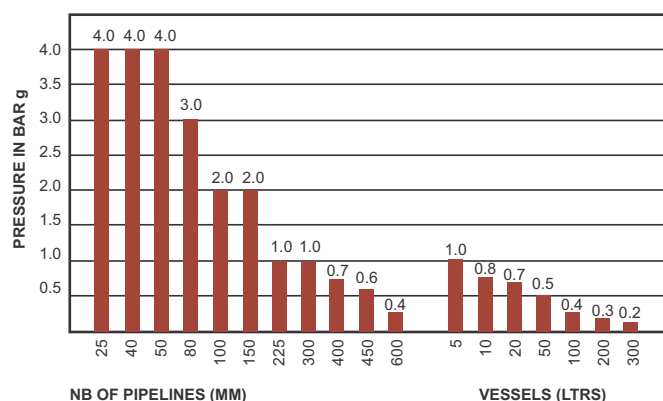
Borosilicate glass retains its mechanical strength and will deform only at temperature which approach its strain point. The practical upper limit for operating temperature is much lower and is controlled by the temperature differentials in the glass which depends on the relative temperature of the contents of the equipment and the external surroundings. Provided Borosilicate glass is not subject to rapid change in temperature, creating undue thermalshock, it can be operated safely at temperature upto 250°C

It must be realised that in complete plants, composed not only of borosilicate glass, but also include other materials such as PTFE. The recommended max. Operating temperature is 200°C. Operating temperatures may have to be modified so as to compensate for the effects of other factors such as pressure, thermal cycling, rapid heating & cooling etc.

At sub zero temperature, the tensile strength of borosilicate glass tends to increase and equipment can be used safely at temperature as low as - 50°C for Sigma Flat Buttress end components.

## PERMISSIBLE OPERATING PRESSURE

The permissible internal operating working pressure depends on the nominal diameter size of glass components and external temperature. The maximum working pressure for a complete glass plant is determined by the lowest rated components in the system. All glass components are suitable at full vacuum over the entire temperature range. Bar g is a measure of absolute pressure.



## COMPOSITE MATERIALS

The last two decades have seen further developments of particularly corrosion resistant plant construction materials. Typical examples of these are PTFE, tantalum, titanium, graphite and of course, borosilicate 3.3 glass.

The combination of different corrosion resistant materials with the utilization of the specific advantages of each permits both safe and economic construction.

### Borosilicate glass/PTFE

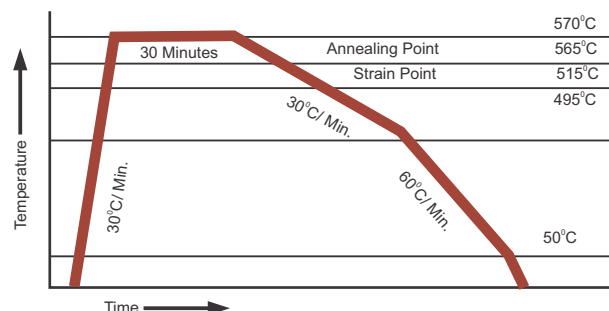
Borosilicate Glass with PTFE is of particular importance for construction of glass installation. For example, In Seals, Bellows, Stirrers, Heat Exchangers, Column Inserts etc.

PTFE is used with Glass because of its excellent mechanical & thermal properties. They have near universal fluid compatibility. Wear life when compared with others is very low. Particularly PTFE is maintenance free and have cryogenic stability with non wetting property.

Service temperature of PTFE is considered as - 50°C to + 200°C

## ANNEALING

Annealing of glass is the process where the glass is heated and kept for a defined period of time to relieve internal stresses.

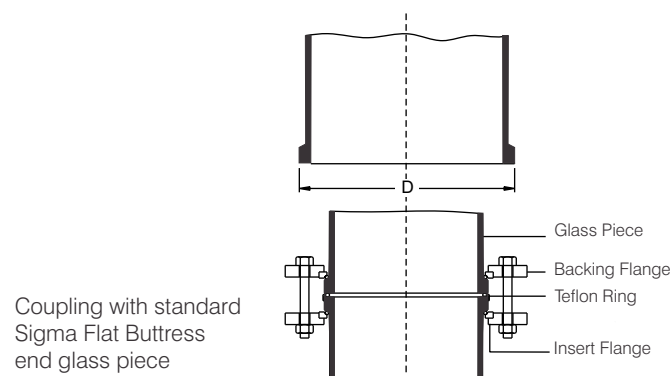


## SIGMA FLAT BUTTRESS END

The glass process plant and pipeline components detailed in this catalogue have standard Sigma Flat buttress end which are interchangeable with any international standard. We can also supply Ball & socket (Spherical end forms), and tapered type buttress end as per international standard on request.

The major dimensions of the Sigma flat buttress ends can be found in the table below, in conjunction with the illustrations alongside.

Nominal bore DN mm	Buttress end diameter D mm	Tolerances (±)
25	41.5	(+) 0.0, (-) 1.5
40	56.5	(+) 0.0, (-) 1.5
50	69.5	(+) 0.0, (-) 1.5
80	99.5	(+) 0.0, (-) 1.5
100	132.5	(+) 0.0, (-) 2.0
150	184	(+) 0.0, (-) 2.0
200	233	(+) 0.0, (-) 2.0
225	259	(+) 0.0, (-) 2.0
300	340	(+) 1.0, (-) 3.0
400	464	(+) 1.0, (-) 4.0
450	525	(+) 1.0, (-) 4.0
600	684	(+) 2.0, (-) 6.0



## LENGTH & TOLERANCE OF GLASS COMPONENTS :

The tolerances on length L together with dimensions L1, L2 and L3 of components, unless otherwise specified for given components in this catalogue.

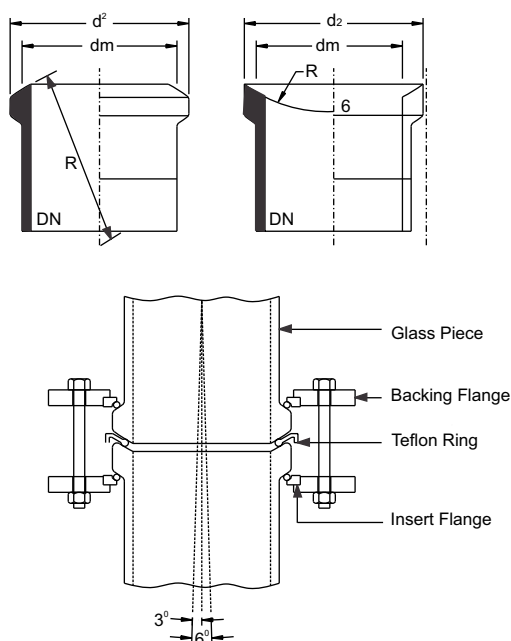
Nominal Bore	Length (L, L1, L2, L3) up to 1500 mm
DN 15 to DN 40	± 3.0 mm
DN 50 to DN 225	± 3.5 mm
DN 300 to DN 450	± 4.0 mm
DN 600	± 5.0 mm

# TECHNICAL INFORMATION

## FLANGE DIMENSIONS BALL SOCKET

(as per International Standard)

DN	d2 mm	dm	R mm
15	30	23	18
25	44	34	25
40	62	51	40
50	76	63	50
80	110	96	80
100	130	116	100
150	184	169	150
200	233	220	200
300	338	321	300
400	465	435	-
450	526	492	-
600	684	646	-



Coupling with standard Ball-Socket end glass piece Articulation is possible to a maximum of 3°, depending on the diameter

## JACKETED COMPONENTS

SIGMA can supply jacketed version of all major components listed in the catalogue, such as pipe and fitting, column components, heat exchangers and vessels. The glass jacket is sealed on to the component either by fusing, by silicon rubber or in a combination of both. The jacketed components help in saving energy by minimizing heat loss, and to maintain the product characteristics at the desired temperatures.

The permissible operating temperature for the inner component	: form (-) 40° C to 180° C
The permissible operating temperature for jacket	: form (-) 40° C to 180° C
The permissible operating pressure	: 0.5 kg/cm <sup>2</sup> g to Full Vacuum

## STATIC ELECTRICITY

### Electrostatic charge generation

Electrostatic charge generation in glass vessels and piping systems occurs due to :-

- \* The agitation of a low conductivity fluid in a vessel, or The flow of a low conductivity liquid through a piping system.
- \* The charge generated is retained in the fluid and due to the low conductivity cannot be dissipated (even if the fluid is in contact with a high conductivity pure metal vessel /pipe wall)

Charge generation will occur whether the vessel/pipework is glass or of metal construction.

The charge generated depends on the actual operating conditions. For more information contact our technical department.



# PACKAGE UNITS

## OUR EXPERTISE

We from a combine of chemical engineers in the field of process engineering and it's application in the glass equipments / process packages .

## COMPLETE ENGINEERED SYSTEM

### Reaction Units

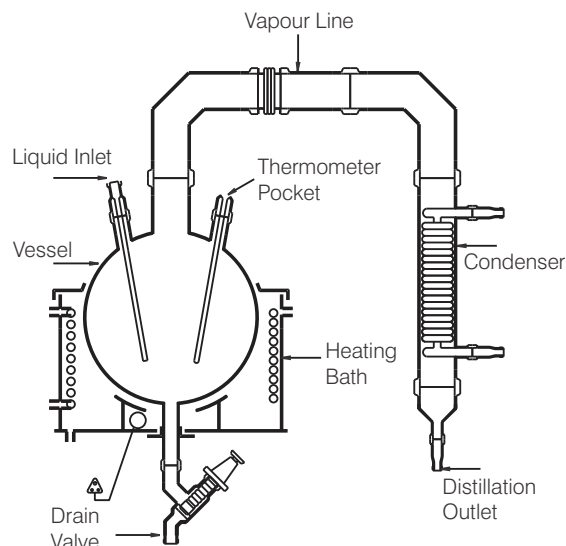
#### SIMPLE DISTILLATION UNIT

It consists of a vessel mounted in a heating bath and fitted with a condenser for condensing the fumes. Receiver with drain valve can be added for receiving the condensate. The unit are available in vessel sizes of 20, 50, 100, 200, & 300 Ltr. and is suitable for operation under atmospheric pressure and full vacuum.

Reactor Cap. Ltr.	Bath KW	Vapour Line	Condenser M <sup>2</sup>	Reference
10 L	2	50 DN	0.2	SFSDU 10
20 L	3	80 DN	0.35	SFSDU 20
50 L	4.5	100 DN	0.5	SFSDU 50
100 L	6	150 DN	1.5	SFSDU 100
200 L	9	150 DN	1.5	SFSDU 200
300 L	10.5	225 DN	2.5	SFSDU 300

#### Optional items

- Heating mantle instead of jacketed heating / cooling bath.
- Flush bottom valve instead of simple drain valve.
- Cylindrical vessel instead of spherical vessel.
- SIGFOLDI-JACKET<sup>TM</sup> vessel instead of spherical vessel without heating bath and heating mantle.



## REACTION UNIT

This unit is used for carrying out reactions under stirred condition and with provision for simple reflux distillation.

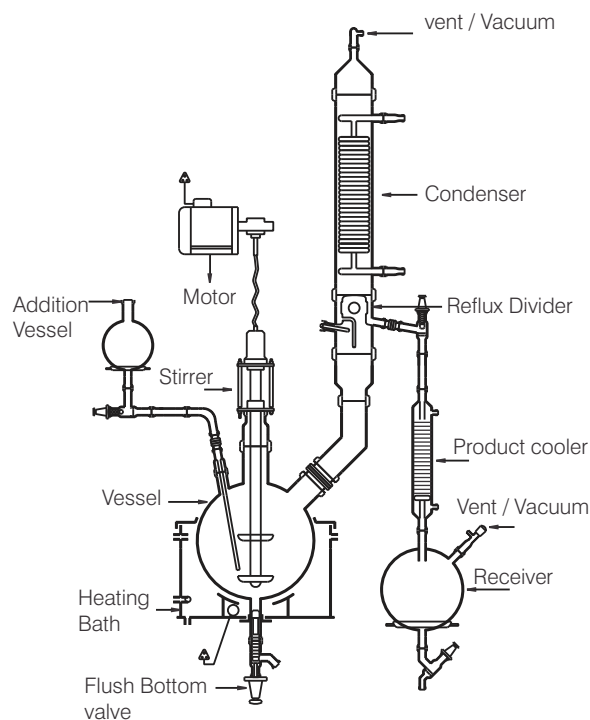
The reaction vessel is mounted in a heating bath and fitted with addition vessel, motor-driven stirrer and provision for condensation with refluxing. The product is sub-cooled and collected in a receiver.

The units are available in vessel sizes of 20, 50, 100, 200 & 300Ltr is suitable for operation under atmospheric pressure and full

Reactor Cap. Ltr.	Bath KW	Addition Vessel	Vapour Line	Condenser HTA M <sup>2</sup>	Cooler HTA M <sup>2</sup>	Receiver Size	Reference
10 L	2	2L	50 DN	0.2		0.1	2L SFRDU 10
20 L	3	2L	80 DN	0.35		0.10	5 L SFRDU 20
50 L	4.5	5 L	100 DN	0.50		0.20	10 L SFRDU 50
100 L	6	10 L	150 DN	1.50		0.35	20 L SFRDU 100
200 L	9	20 L	150 DN	1.50		0.35	20 L SFRDU 200
300 L	10.5	20 L	225 DN	2.50		0.5	20 L SFRDU 300

#### Optional items

- Heating mantle instead of jacketed heating / cooling bath.
- Simple drain valve instead of flush bottom valve.
- MS PTFE lined stirrer instead of glass stirrer.
- Variable frequency drive for variable speed.
- Cylindrical vessel instead of spherical vessel.
- SIGFOLDI-JACKET<sup>TM</sup> vessel instead of spherical vessel without heating bath and heating mantle.



## REACTION DISTILLATION UNIT

The unit has been designed to suit the customers requirement of combination of versatile reaction / distillation or combination for pilot plant work.

This has a flexibility of working at atmospheric pressure as well as under vacuum.

Typical unit has a reaction vessel fitted in a metal heating/cooling bath having facility for heating and cooling bath by means of heating/cooling Fluids as a media.

The Standard system is equipped with stirrer heaving mechanical seal, a packed column on the side neck of the vessel, reflux divider, coil type condenser and or receiver system having a product, cooler, vent, drain and vacuum valves, Option of speed variation by machanical variator or electronic variator can be provided.

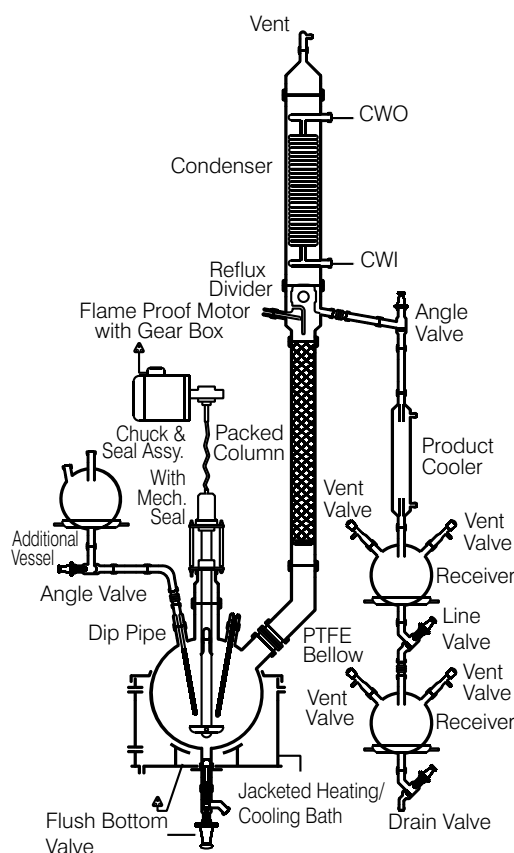
Receiver system is equipped with product cooler. Vent / vaccum valve and drain valve.

The above unit are available in 10 Ltr., 20 Ltr., 50Ltr., 100 Ltr., 200 Ltr. & 300Ltr capacity with spherical reactor.

Reactor Capacity	Bath KW	Addition Vessel	Vapour Line	Condenser HTA M <sup>2</sup>	Cooler HTA M <sup>2</sup>	Receiver Size	Reference
10 L	2	2 L	50 DN	0.2	0.1	2L, 2L	SFFRU 10
20 L	3	2 L	80 DN	0.35	0.1	2L, 5L	SFFRU 20
50 L	4.5	5 L	100 DN	0.5	0.2	5L, 10L	SFFRU 50
100 L	6	10 L	150 DN	1.5	0.35	10L, 20L	SFFRU 100
200 L	9	20 L	150 DN	1.5	0.35	10L, 20L	SFFRU 200
300 L	10.5	20 L	225 DN	2.5	0.5	20L, 20L	SFFRU 300

### Optional Items :

- Heating mantle instead of jacketed heating / cooling bath.
- Simple drain Valve instead of flush bottom valve.
- MS PTFE lined stirrer instead of glass stirrer.
- Variable frequency drive for variable speed.
- Cylindrical vessel instead of spherical vessel.
- SIGFOLDI-JACKET<sup>™</sup> vessel instead of spherical vessel without heating bath and heating mantle.



## FRACTIONAL DISTILLATION UNIT

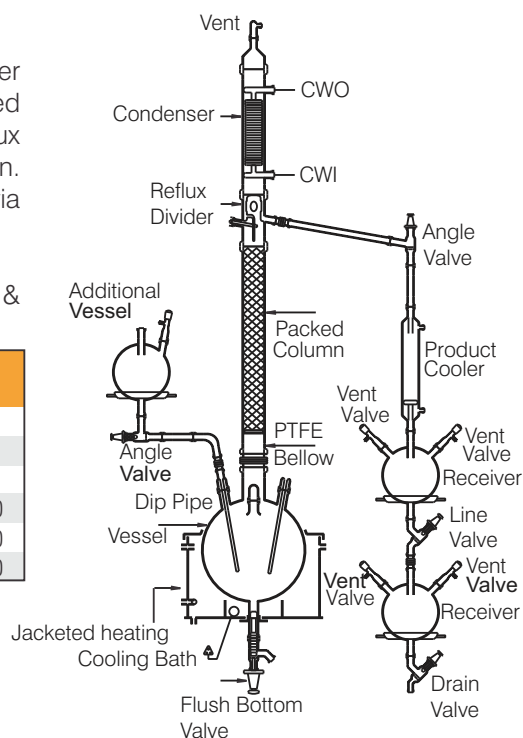
This unit is typically used for only distillation and fractionation under vacuum or at atmospheric pressure. Typical unit has distillation vessel fitted in a metal heating / cooling bath and with a packed column above reflux divider and coil condensers below are fitted on the packed column. Condensed material is either taken back to the vessel or to the receiver via product cooler.

The above units are available in 10 Ltr., 20 Ltr., 50 Ltr., 100 Ltr., 200 Ltr. &

Reactor Capacity	Bath KW	Addition Vessel	Vapour Line	Condenser HTA M <sup>2</sup>	Cooler HTA M <sup>2</sup>	Receiver Size	Reference
10 L	2	2 L	50 DN	0.2	0.1	2L, 2L	SFFDU 10
20 L	3	2 L	80 DN	0.35	0.1	2L, 5L	SFFDU 20
50 L	4.5	5 L	100 DN	0.5	0.2	5L, 10L	SFFDU 50
100 L	6	10 L	150 DN	1.5	0.35	10L, 20L	SFFDU 100
200 L	9	20 L	150 DN	1.5	0.35	10L, 20L	SFFDU 200
300 L	10.5	20 L	225 DN	2.5	0.5	20L, 20L	SFFDU 300

### Optional Items :

- Heating mantle instead of jacketed heating / cooling bath.
- Simple drain valve instead of flush bottom valve.
- Cylindrical vessel instead of spherical vessel.
- SIGFOLDI-JACKET<sup>™</sup> vessel instead of spherical vessel without heating bath and heating mantle.



# GLASS REACTOR SYSTEMS

## SIGMA CLASS GLASS JACKETED REACTOR

SIGFOLDI – JACKATED® (First time in world's glass ind.) is manufactured with 100% folding design up to a nominal capacity of 200 L. Which is registered under Patents Registration No.: 207576.

It is a system of two concentric vessels held together by flange and seal arrangement. The end flexible seals absorb the different expansion levels and prevent high stresses of the inner component and the jacket by allowing the movement flexibility between two due to thermal expansion.

Fused Jacketed Glass Reactors are at a huge disadvantage in case of damage to the system due to mechanical impact are not repairable and have to be discarded. While in our system, if per chance the inner vessel or outer vessel get damaged either is replaceable adding to the longevity of the equipment.

All our reactor systems are designed to keep L/D ratio within standard limits.

Because of being a two component i.e. Vessel and Top cover agitators can be designed for maximum sweep for better mixing & turbulence with no vortex formation by very effective second stage pitched blade agitator.



## TRIPLE WALL REACTOR

Sigma started manufacturing SIGFOLDI – TRIPLE JACKETED® reactor up to 50Ltr. Cap. from an entirely new design with design Registered No. 1681023.

Vacuum Jacket Eliminates heat losses to the atmosphere and allows process to be monitored with no frost formation on the jacket for operations below freezing point.

The vacuum is extended over the service nozzles to facilities a clear view.

PTFE spiral Baffle can be fitted between Reaction Vessel and the service side of the jacket for maximum efficient heat transfer area utilization.

All reactors are designed with little dead spaces to keep L/D Ratio within 1.0 to 1.5 for safety of the equipment, smooth performance and easy scale up.

Operation Temperature Range : -80°C to +200°C



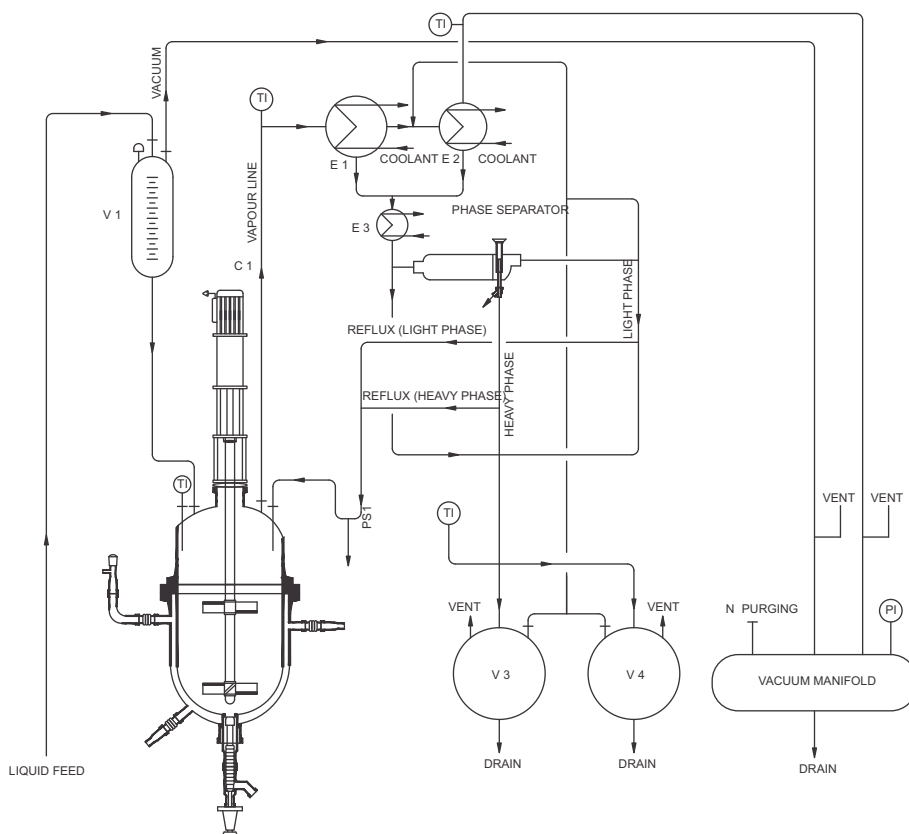


# KILO LAB (REACTION / DISTILLATION UNIT)

Reaction systems are developed to fulfill the actual needs of chemical and pharma industry. Sigma Reactors are built for batch and semi – batch operation mode, with perfectly matched components and quality materials. Conforming to GMP / FDA Guide lines and Explosion proof installations.

## Reactor Options :

Glass Single Wall, Glass Double Wall, Glass Triple Wall Reactor, Glass Reactor with SS Jacket, Glass Lined Reactor with Glass top and Glass Lined Reactor



**Multi purpose Unit with  
Reactor Bottom Pan -  
Raising/Lowering Device**



## Operating Parameters

Pressure Range	: Full Vacuum up to 0.5 bar (g)
Temperature Range	: -80°C to +200°C
Capacities	: 5 L up to 500 L
Installation Sites	: R & D Lab, Pilot Plant, Kilo Lab, Production.
Salient Features	: <ul style="list-style-type: none"><li>* GMP design</li><li>* Skid Mounted / Lab - Hood Adaptability</li><li>* Documentation</li><li>* Instrumentation Safety Control</li><li>* Pure and corrosive Media Handling</li><li>* Safe operation</li><li>* Customized Reactor System-for up scaling</li><li>* Excellent thermal Process Control</li></ul>

## Reactor Bottom Pan

Single wall Round bottom Reactor up to 300L  
Single wall Cylindrical Reactor up to 500L  
Double wall Cylindrical Jacketed up to 200L  
Triple wall Reactor up to 50L  
Glass Lined Reactor (20L, 50L, 100L, 250L), pre-insulated (with SS cladding)  
Glass Reactor with SS Jacket (Pre insulated with SS cladding).

## Reactor Top Cover

Glass Top Cover  
Glass Lined Top Cover  
PTFE lined / Coating Top Cover

## Bottom Outlet Valve

Flush bottom outlet valve – Glass / PTFE  
Glass lined with Temperature Sensor (Optional)  
Flush bottom outlet valve with Temperature Sensor

## Stirrer System

Easy interchangeable stirrers made of PTFE lined  
Glass lined, anchor, turbine agitators  
PTFE coating/ lined Anchor, Pitch blade turbine, interchangeable impellers also.  
Glass stirrers with PTFE Blade, Vortex Stirrer, Propeller Stirrer  
Motor : Flame Proof, Speed control by VFD or mechanical variator with suitable gear box.  
Seal : Sic, Single dry running  
Complete SS construction (option), SS hood for motor, gear box, housing

## Safety Devices

Rupture Disc  
Vent nozzle in Jacket (For Glass Jacketed Reactor only)  
Glass / PTFE Pressure Relief Valve  
Coating of Glass components  
To avoid static discharge PTFE thermometer pocket with Tantalum Tip

## Sigfoldi-Triple Jacketed<sup>®</sup> Reactor



## Glass Reactor with S.S. Jacket



## GLASS OVERHEAD ASSEMBLY

The standard overhead glass assembly is designed to conduct reactions under reflux, followed by distillation. The following process equipment are standard.

- Feed Vessel
- Vapour line
- Primary condenser
- Vent condenser
- Distillate cooler
- Phase separator for azeotropic distillation with re-cycle of any phase
- Twin distillate receivers
- Interconnecting glass pipeline with vessels



### Reactor Bottom Pan-Raising / Lowering Device

- Manual or motorized
- Also removable after lowering

### Flanges & Structure Option

- C.I. Flanges with G.I. Pipes and Nut bolts
- S.S. 304 or S.S. 316 also available
- PTFE coated as option.

### Hand Hole

Sigma manhole closure with easy openable without any tools

### Heating / Cooling System

- Single fluid with precise temperature control
- Temperature range  $-80^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$
- Transparent fluid allowing clear vision of process

### Glass Lined Reactor with Glass Top





# ROTARY EVAPORATORS

## Working Principle :

A rotary evaporator is a device used in Chemical Laboratories for efficient and gentle removal of solvents from samples by evaporation.

## The main components of a rotary evaporator are :

1. Motor unit which rotates the evaporation flask containing sample material.
2. A vapour duct which acts as axis for sample rotation, and a vacuum tight conduit for the vapour being drawn off of the sample.
3. A vacuum system (not integral part of the equipment) to substantially reduce the pressure within the vaporator system.
4. A heated fluid (water / thermic fluid) bath to heat the sample being evaporated.
5. A condenser with double coil through which the coolant passes.
6. A condensate collecting flask at the bottom of the condenser, to collect the distilling solvent after it recondenses.
7. A mechanical or motorized mechanism to quickly lift the evaporation flask from the heating bath or lower the heating bath so that the evaporation flask does not remain in contact with bath.

The vacuum evaporators as a class function because lowering the pressure lowers the Boiling Points of component liquids in it. Generally the component liquids of interest in applications of rotary evaporation are solvents that one desires to remove from a sample after an extraction, for instance, following a natural product isolation or a step in an organic synthesis. Use of a Rota – Evaporator therefore allows liquid solvents to be removed without excessive heating of what are often complex and sensitive solvent – solute combinations.



## Advantages :

1. The centrifugal force and the frictional force between the wall of the rotating flask and the liquid sample result in the formation of a thin film of warm solvent being spread over a large surface.
2. The forces created by the rotation suppress violent, unpredictable boiling / bumping.
3. Allows quick and gentle evaporation of solvents from most samples.
4. Low temperature and vacuum control also help in curbing bumping / foaming during evaporation process.



# GLASS OVERHEAD ASSEMBLY FOR GLR



The standard overhead glass assemblies on GLR's (Glass Lined Reactors) are designed for reactions under reflux and distillation.

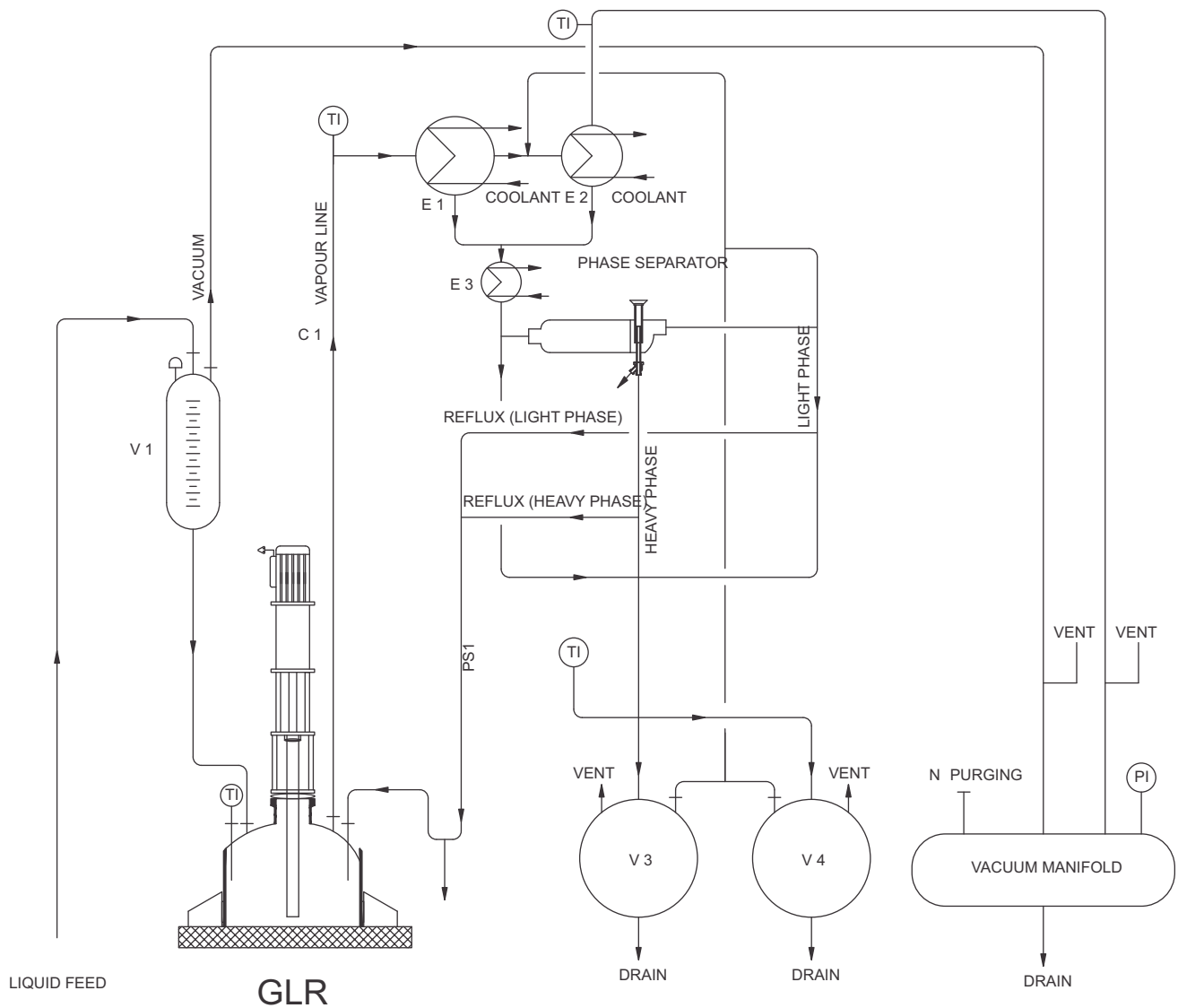
## **The Standards Process Equipments are :**

1. Spherical / Cylindrical Graduated Feed Vessels for controlled addition of Liquid Reactants.
2. Vapour Column – Packed or Hollow
3. Primary Condenser – Coil Type Glass Heat Exchanger or Shell & Tube Type Heat Exchanger.
4. Vent or Secondary Condenser
5. Product Cooler – For cooling distillate
6. Phase Separators – For multi component distillation or Azeotropic Distillations
7. Distillate Receivers for continuous operation without breaking of Vacuum
8. Pressure Equalization ensured by process pipe line design being to maintain complete hydraulic integrity and single point application of vacuum over the complete system.

## **Objects :**

1. Various options for which our system can be adapted are shown in figure 1, 2, 3, 4.
2. Stainless Steel / Glass , GL Bottom Pan with Glass Top Constructions
3. Suitable for installation in Fume Hoods
4. Skid mounted mobile unit also

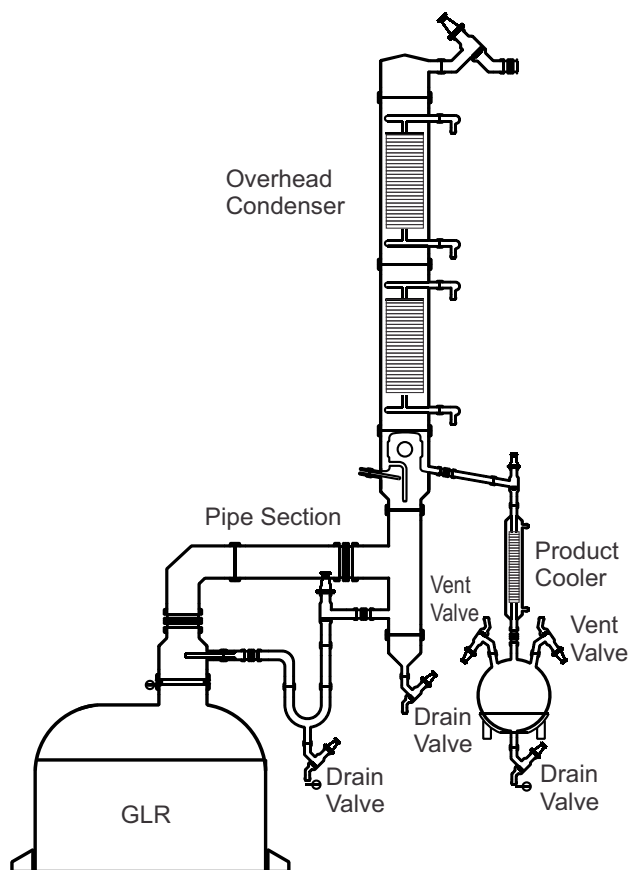
## Typical Overhead Glass Assembly For GLR



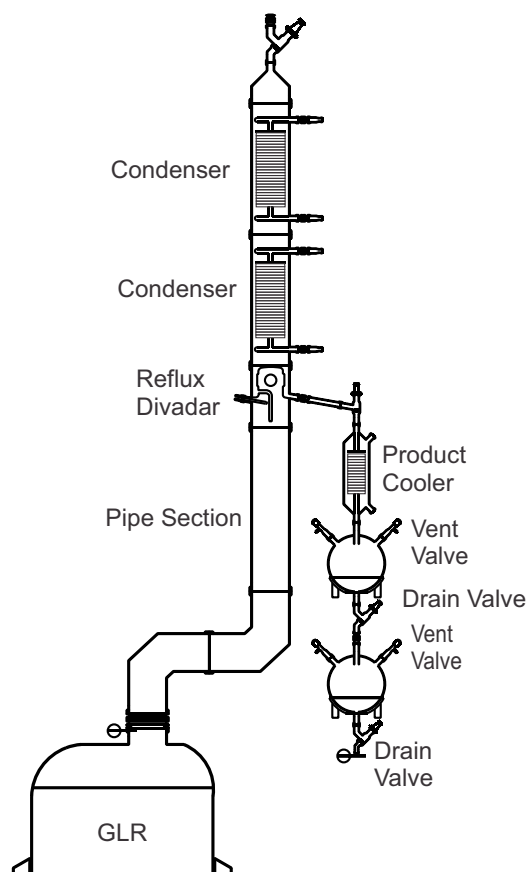
## Suggested Configurations

Reactor (AE)	Heat Exchange Area (m2)	Shell & Tube Heat Exchanger_Glass (m2)	Shell & Tube Heat Exchanger_Sic (m2)	Vent Condenser Glass (m2)	Feed Vessel (Lit)	Receiver Vessel (Lit)	Vapour Line (DN)
63	0.53	2.5	-	0.3	20	2x20	80
100	0.85	2.5	-	0.6	50	2x50	80
160	1.23	4.0	-	1.0	50	2x50	80
250	1.66	5.0	-	1.0	100	2x100	80
400	2.40	8.0	2.5	1.0	100	2x100	100
500	2.56	8.0	2.5	1.5	100	2x100	150
630	3.10	10.0	3.2	1.5	100	2x100	150
1000	4.56	12.5	4.0	1.5	200	2x200	200
1600	6.00	16.0	5.0	1.5	200	2x200	200
2000	7.10	16.0	5.0	1.5	200	2x200	200
2500	8.30	20.0	6.3	1.5	200	2x200	200
3000	9.10	20.0	6.3	1.5	200	2x200	200
4000	11.70	25.0	8.0	1.5	200	2x200	200
5000	13.10	25.0	8.0	2.5	200	2x200	300
6300	16.20	25.0	8.0	4.0	200	2x200	300

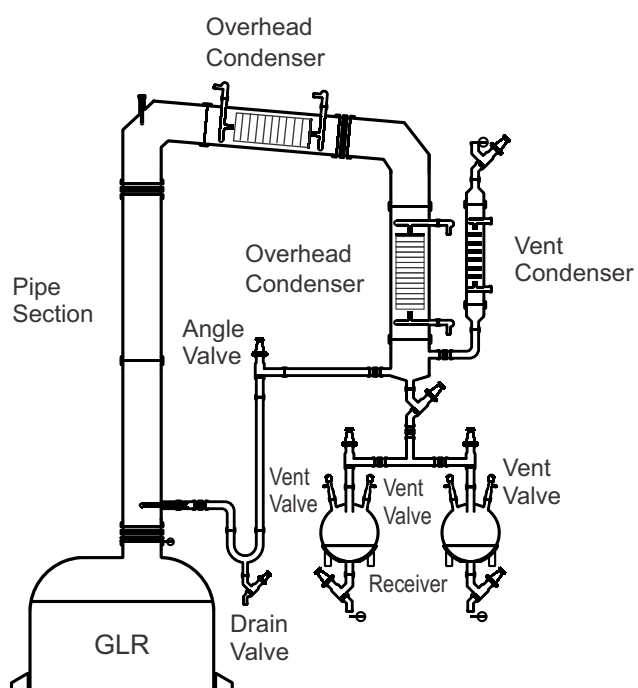
## GLASS OVERHEAD ASSEMBLYFOR GLR



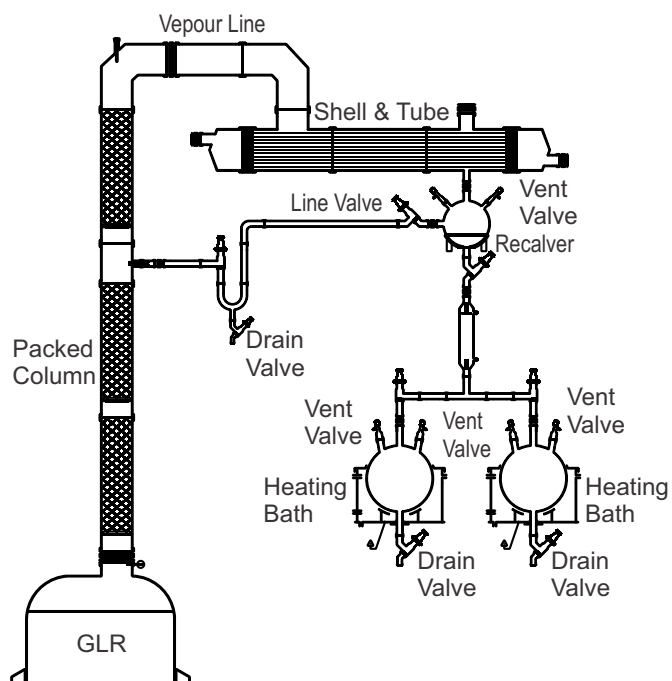
Dean and stark type distillation top with coil heat exchanger, Product cooler and internal reflux with receiver for vessels.



Distillation top with coil heat exchanger, product cooler and internal reflux with receivers for vessels.

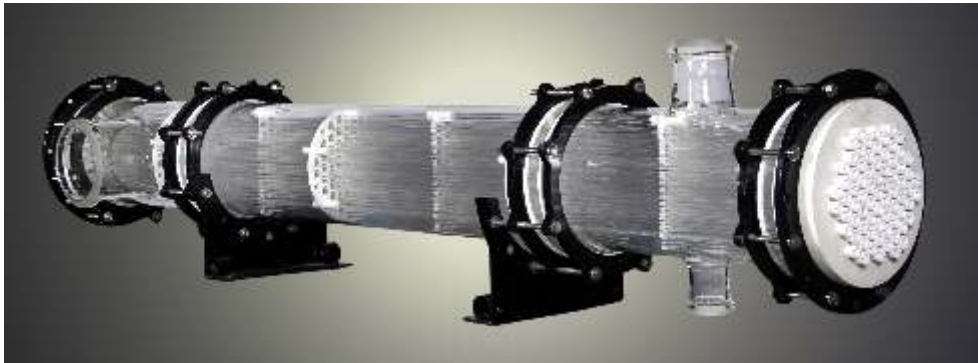


Distillation top with coil heat exchanger vent condenser and external reflux with receiver for vessels.



Distillation top with shell and tube heat exchanger and external reflux separator with receiver for vessels.

# SHELL & TUBE HEAT EXCHANGERS



## Improved Shell & Tube Heat Exchangers :

Shell and tube Heat Exchanger are for large heat transfer area, efficiency of heat transfer and compactness.

Shell and Tube Heat Exchanger are widely used as coolers, Condensers, Heaters and Evaporators.

Glass Shell and Tube Heat Exchangers are reliable only when leak free sealing is available between shell & Tube sides.

There are two types of Ferrule Sealing in Sigma shell and tube Heat exchangers. Such as:

1. **PTFE Ferrule with Gland Packing.**
2. **PTFE Ferrule without Gland packing.**

In case of Ferrule seal with gland packing PTFE 'O' Ring & PTFE Rope is used to fill the space between tube and tube sheet and PTFE Ferrule acts as a Gland Follower to make sealing perfect and leak free.

And Ferrule without gland packing is a sealing system where the design of ferrule is such that while tightening. The ferrule gets folded at the seal point of Tube – Sheet in such a way that it does not require 'O' Ring or the gland rope and gives as good leak free sealing as in the first case.

This unique ferrule type sealing arrangement permits easy replacement and cleaning of tubes.

Sigma has further improvised on shell and Tube Evaporators and Re-Boilers with replacement of Glass Tube by Graphite Tubes and GFT Tube – Sheets. These types are good for high temperature and high pressure application.



# GLASS ABSORBER SYSTEMS

## HCL GAS ADIABATIC ABSORBERS

Hydrogen Chloride gas produced as a by product can be economically processed into Hydro – Chloric Acid by simple Absorption

Adiabatic Absorption is the most effective means of production of Hydro – Chloric Acid solution. Under normal operating conditions Hydro Chloric Acid Solution of 30% - 31% strength can be obtained

These absorbers operate, as the name implies, without any heat input into the reaction zone.

The gas loading should in no case fall below 50% of the design maximum for adiabatic absorption column to be most effective means of absorption.

In this process HCL – Gas is absorbed by fresh water flowing down the column . The heat generated by this reaction vapourises approximately 30% of the water that rises to the head of the column with non – soluble components of the gas stream.

Hydrogen Chloride streams containing air, water vapour & non - condensable are condensed / absorbed within the column and are returned together with the make up water to the bottom of the column through several packed sections and are passed through heat exchangers for dissipating the heat of absorption before storage. The acid out let temperature is 45° C to 50°.



## FALLING FILM ABSORBER

The Falling Film Absorber are typical Heat Exchangers with weir tube arrangement at the top – which is always Vertically Mounted.

A co – current flow of gas & absorbent liquid flows down through the tubes – each tube functioning as an individual heat exchanger. The Heat of absorption released is removed by the cooling water flowing in the shell side of the falling film unit. There by affecting gas absorption at lower temperatures and enabling a higher absorption rate.

### Objectives :

- To separate gas Mixtures as required by the process
- To purify a component of a gas Mixture
- To remove harmful gases from waste Gases
- To recover valuable components from waste gases



## MOBILE GAS SCRUBBER :

### Salient Features:

- Simple in design
- Ideal for scrubbing exhaust from small scale chemical plants
- Suitable for air and exhaust clean up tasks.
- Ideal for studies and Scale – up of gas scrubber systems.

Sigma offers Mobile Scrubber in all glass and PTFE Construction for use in laboratories. The system is Mounted on stainless steel skid structure for maneuverability.



## GLASS VENTURI SCRUBBER

Venturi Scrubber is a device which helps in mixing of Liquid and gas to achieve the purpose of scrubbing and Absorption.

### Advantages / Salient Features:

- No moving parts
- No Maintenance
- Ease of Operation
- Can handle Large Gas Flow Rates
- Intimate Mixing
- No space requirement, can be installed on a tank
- Can be used as Vacuuming / Dust collection Device.
- Venturi scrubbers can be used as single or as Multi-stage equipment for higher efficiencies of absorption.
- Can be used as tail – gas absorber

### Applications :

- Gas Absorption
- Vacuum Generation
- Fume Scrubbing
- Dust Collection / Air Pollution
- Gas Liquid Reaction
- Feeding of solids to reactors is made easy by negative draft developed by Venturi on the system



# HCL GAS GENERATOR SYSTEMS

## DRY HCL GAS GENERATOR SYSTEMS

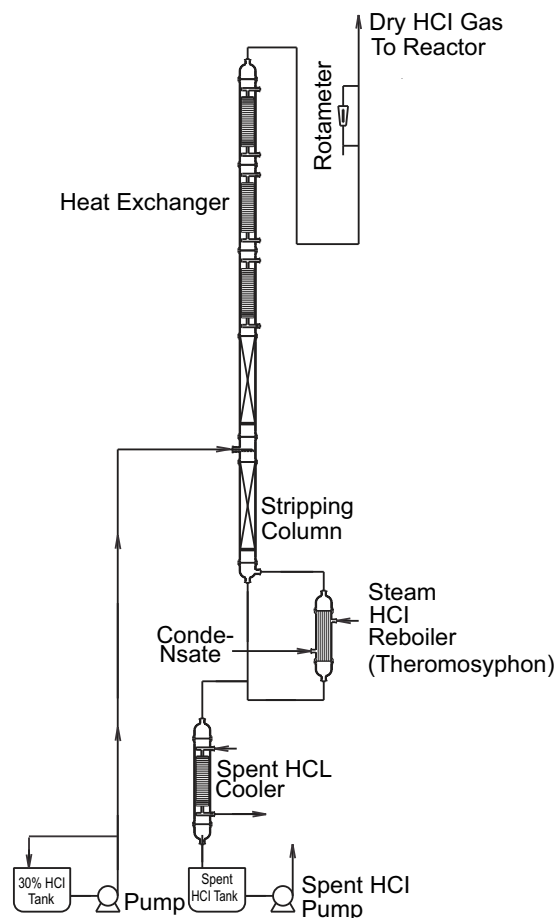
There are three types of HCL – gas generation plants designed and supplied by us. These are the processes prevalent in the chemical process industry today. Our glass plants are designed and manufactured as per current international standards and codes which guarantee product durability, quality, smooth and trouble free operations.

### Process No : I] (Boiling Route)

30% HCL Solution is boiled thermo-syphonically in an azeotropic distillation column still where the heat energy to the re-boiler is supplied by steam. This plant is for continuous operation under monitored feed rate 30% HCL solution. The vapour from re-boiler strips the available gas from the feed in the column. The bottom product is 20% HCL solution which is cooled, stored for treatment & disposal.

#### The Salient Features of this process :

1. Low capital cost
2. Simple process
3. Compact Design
4. Low operating cost
5. Pure 20% HCL as bottom Product
6. No sulfuric acid handling



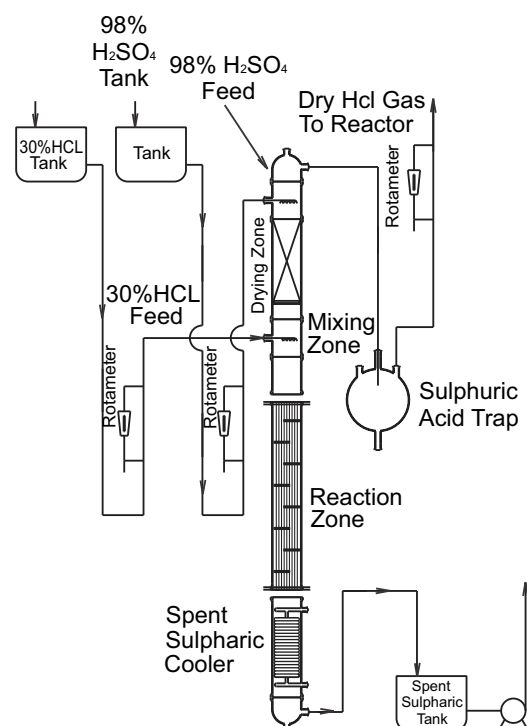
HCL GAS GENERATOR (Azeotropic Boiling Route)

### Process No : II] (Sulphuric Acid Route)

Plant is designed to produce dry HCL-gas by the process of dehydration of 30% Hcl solution with concentrated Sulfuric Acid. SA is fed from the top of the packed column as a co-current feed to 30% HCL sol. from the middle of the column. HCL gas is generated when the two acids come in contact in the bottom portion of the column. Bottom product from this plant is spent F A (70%) solution with some percentage of HCL. This again has to be cooled and stored for final treatment & disposal.

#### The Salient Features of this process are :

1. Low capital cost
2. Simple process
3. No drying required
4. Compact design
5. Effluent with HCL impurity
6. Large quantity of 98% sulfuric acid handled
7. High operating cost



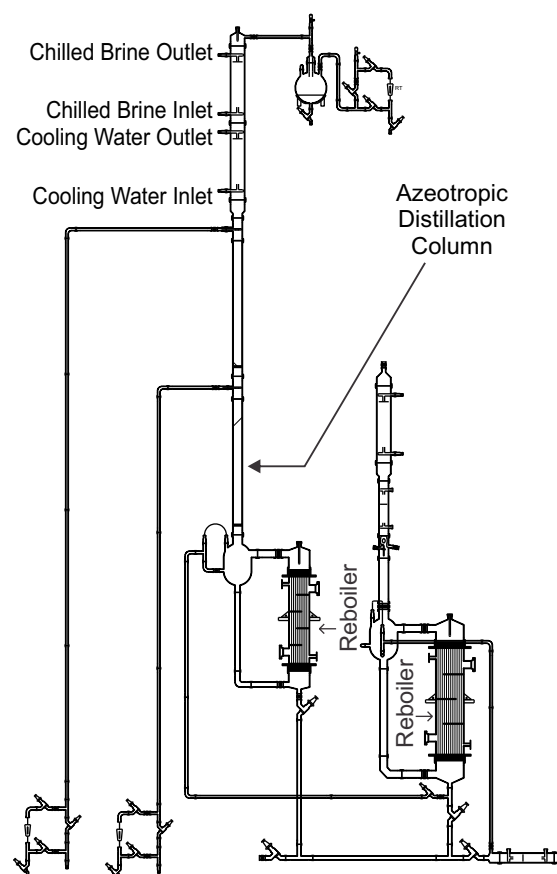
HCL GAS GENERATOR (Sulphuric Acid Route)

### Process No : III](Calcium Chloride Route)

The process produces HCL gas continuously by azeotropic distillation of 30% HCL solution along with a co-current stream of Calcium Chloride Solution. The calcium chloride breaks the azeotrope formed between HCL and water and as a result all the HCL available in the solution is released as gas. The bottom product from column is dilute calcium chloride solution with some HCL content. This Calcium Chloride solution is concentrated in the evaporator and recycled to the distillation column. The vapour from evaporation process consists of water and 1% (max) HCL by weight. This vapour is condensed & pH adjustment prior to discharge to the drain.

#### The Salient Features of this process are :

1. No effluent
2. Zero discharge
3. Lowest operation cost
4. High capital cost



HCL GAS GENERATION (CaCl<sub>2</sub>)

## GLASS NUTSCHE FILTERS

Chemical and Active pharmaceutical Ingredients are frequently processed as powders, so that, after the reaction crystallization of the solution and separation of solid and liquid materials becomes necessary.

Sigma has developed Nutsche Filters made from borosilicate Glass for application in the Kilo – Lab.

The contact parts being Borosilicate Glass and PTFE and can easily handle corrosive materials.

The base with the filter cloth can be lowered for filter cloth change. Dissipative PTFE can be used to ensure that no static charge accumulation takes place.

Conforms to GMP regulation and FDA certification standards

#### Application :

1. Acidic Media Filtration and Light Sensitive Products
2. Vacuum Filtration
3. Mobile/skid Mounted





# BROMINE RECOVERY PLANTS FROM BROMIDES AND SEA BITTERNS

Bromine being a highly reactive material, finds wide application in many chemical industries like: Organic Intermediates, Dyestuffs, Agro chemicals, Fire Retardants etc.

During Bromination not more than half the bromine added ends up in the reaction. The rest being rejected / discarded as bromides

Bromides generally are

- NaBr (Sodium Bromide)
- KBr (Potassium Bromide)
- HBr (Hydrogen Bromide)
- Sea Bitterns (Magnesium Bromide)

We can get Bromine in crude form from any of the Bromides above in our Bromine Recovery Plants. This crude Bromine is then distilled to get Bromine of purity 99.50%.

We manufacture Bromine Recovery Plants having the capacity of handling large amounts of Bromides. We can also give system for Bromine Recovery from Sea - Bitterns.

## Salient Features :

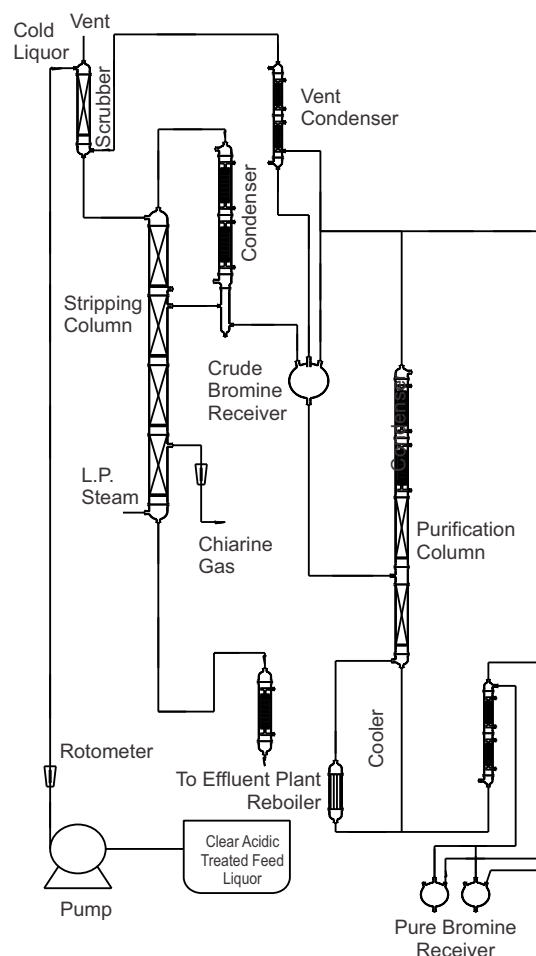
Zero Bromine Vapour loss to atmosphere.

Yield: Pure Bromine of 99.50% assay.

Pure Bromine of  $\geq 90\%$  Recovery

Chlorine consumption is 0.3 – 0.6 Kgs (w/w) per kg of Bromine Recovered.

Bromine Recovery Plants are available in 1 TPD to / 3 TPD etc. capacities



# BENCH SCALE REACTION UNITS (with Hand Lift)

Reactor Volume : 5L , 10L  
Reactor Type : Double Walled & Triple Walled  
Operating Pressure : Full Vacuum to 0.4 bar (g)  
Operating Temperature : -80°C to +200°C  
Thermal Shock Resistance : ( $\Delta T$ ) : 60°C for Triple Walled and 110°C for Double Walled Reactors

The triple walled Reactors are suited for operations in the range of -80°C to +200°C, however due to thermal stress, the temperature difference ( $\Delta T$ ) should not exceed 60°C, as a preventive measure.

## Salient Features :

All Reactors are designed without dead space to ensure complete drainage.  
Reactors equipped with flush bottom valve of special type to ensure a leak free sealing over entire temperature range.  
All reactors are designed to keep L/ID Ratio within 1.5(max) for security of fabrication limits, performance and easy scale up.  
All These Reactors are designed GMP compliant



# Bench Scale Reactor + Filter (with Hand Lift)

Reactor Volume: 5L , 10L  
Reactor Type : Double Walled  
operating Pressure : Full Vacuum to 0.4 bar (g)  
Operating Tempt : -80°C to +200°C  
Thermal Shock Resistance ( $\Delta T$ ) : 110°C

## Salient Features

Ease of Operation  
GMP compliant  
Suitable to handle acidic media  
Suitable for both cloth / paper filter media  
skid mounted assembly



The System does not include overhead Stirrer and thermostat.

# THIN-FILM EVAPORATOR

\_Thin - film Evaporators are vertical, Mechanically Operated Continuous Film Evaporator designed for difficult concentration, extremely heat sensitive materials wherein the unit operations like Distillation, Evaporation and Stripping can be conducted.

This technology gives the ability to remove volatile components from less volatile materials that are heat – sensitive, viscous, foaming, or contain solids. It offers short residence time, thin film formation by the centrifugal force of the rotating wiper system, the speed of which, can be adjusted to the viscosity of the product to be evaporated, which increase the evaporation efficiency. This is possible by creation of uniform film on the smooth heated surface of glass body.

Of late, the demand for test and pilot plants for gentle distillation has considerably increased in Fine Chemicals, Pharmaceuticals, Foods & Beverages industry. The Constantly rising number of new products and rising world market price of raw materials are responsible for this demand.



## Salient Features :

- Maximum Evaporation in Single Pass

- The Roller – wiper system (fully corrosion resistant construction) makes possible to attain a homogenous mass of liquid mixture and high wiping speed maximize evaporation efficiency.

- Minimal to no-degradation of thermally unstable materials.

- Capability of Handling High Viscosities.

- High surface to volume ratio

- Higher Heat Flux due to uniform film formation

- No dry spots and no fouling.

- Easy to clean, install and maintain

- Thin- Film – Evaporators are available in DN-80 X 0.15m<sup>2</sup> to DN-150 X 0.5m<sup>2</sup> Evaporation surface Area.

- Thin – Film – Evaporators can be run upto 200°C Product side and 230°C Jacket Side.

- Thin – Film- Evaporators can be run under Jacket Pressure of 2.0 bar (g) and evaporator can be operated at vacuum of 5mm Hg to 0.005mm Hg.

- All wetted – parts that make contact with liquids or gases are made from high precision Borosilicate Glass Tube and PTFE

# MIXER SETTLERS



These are a Class of mineral process equipment used in Extraction Processes.

Industrial Mixer- Settlers are commonly used in the Copper, Nickel, Uranium, and cobalt Hydro – Metallurg Industries where Solvent Extraction Processes or Liquid – Liquid Extraction Processes are applied.

Mixer Settler consists of a first stage that mixes the phases together followed by a non-active settling stage that allows the phases to separate and a gravity separator where the liquids are separately removed as Heavy Phase and Light Phase.

For continuous operation, mixing and settling zones are spatially separated from each other. This can be achieved by connecting a series of several such mixing & settling chambers through which the phases are fed in counter – current flow, the system can be designed as per the requirements of a particular problem.

The Critical factor in the design of the horizontal mixer- settler is the coalescence ( to come together to form a mass or whole) rate of the dispersed phases .

## **Mixer – Settler Uses :**

- Extraction Process
- Washing Process
- Stripping Process

## **Salient Features Uses :**

- Separation of components in solution
- Chemical Dispersion or Dissolution
- Cooling or Heating of liquid by direct contact with another
- Creating Permanent Emulsions



# GLASS PROCESS EQUIPMENT

## PIPELINE COMPONENTS

Sigma borosilicate glass 3.3 pipeline components are widely used in chemical, pharmaceutical, dyes & allied industries and food & drink production where the advantages of using glass as a basis for the construction of complete process systems have long been recognized. The main reasons for wide acceptance of Sigma borosilicate glass 3.3 are because of (a) Universal resistance to almost all chemicals resulting in reduced contamination risk, (b) Transparency for ease of visual monitoring of the process (c) Smooth surface allows easy cleaning & sterilization of systems. This guarantees long service life & minimum maintenance requirements.



## COUPLINGS & GASKETS

SIGMA couplings are a strong & heavy-duty system that provides maximum reliability with minimum need for maintenance. This is achieved by use of easy to install corrosion resistant gaskets and carefully dimensioned individual parts of the coupling. The material of construction is selected based on the type of products being handled & the atmospheric conditions of installation area. For GMP application SS coupling with SS nuts & bolts are used. PTFE bellows are used to compensate for different thermal movement between glass and associated equipment, absorb vibrations from associated equipment or foundation. PTFE 'O' Rings are the most widely used gaskets. They are manufactured from pure, high quality PTFE and offer almost identical properties corrosion resistance to borosilicate glass.



## HEAT EXCHANGERS

SIGMA heat exchangers provide optimum solution for all requirements encountered because of the wide range of heat exchangers available. Heat exchangers are used for condensation of vapours or cooling of gas or cooling of liquids. Two basic types of glass heat exchangers are available, Coil type and Shell and tube type. Glass coil type heat exchangers are available as condensers, boilers and immersion heat exchangers with heat transfer areas up to 8m<sup>2</sup>. Shell & tube type heat exchangers are designed for use with tubes in widest possible range of corrosion resistant materials. Shell & tube type heat exchangers are available with glass or Mild Steel (MS) Shells in combination with glass tubes as standard. The advantage of using Shell & Tube type heat exchanger are larger heat transfer area in single unit, Low pressure drop, Easy tube replacement.



## VALVES & FILTERS

SIGMA valves & filters can be relied upon to require minimum maintenance & to provide maximum reliability. They provide relatively easy on off function to control flow & pressure relief. All wetted parts of valves & filters are made of borosilicate glass 3.3 & PTFE, which ensures maximum resistance to corrosion. Complete valve consists of Glass Valve Body, PTFE Bellow with nut, Bakelite Valve Bonnet with MS Spindle etc. Different types of valves like Line valve, Drain valve, Bottom outlet valve, Vent valve, Adjustable overflow valve, Non return valve (flap type), Non return valve (ball type), Pressure relief valve, Sampling valves are available.

Pipeline filters are recommended to remove impurities from gas & liquid streams in glass pipelines. The assembly is designed such that the filter can be easily removed for cleaning or replacement.



## COLUMN COMPONENTS

SIGMA column components provide the optimum solution for every requirement such as distillation, absorption, reaction, rectification & extraction because of wide range of different components available. This applies not only to various types of column & pipe sections available but also to the wide selection of internals & packing that can be supplied. The transparency factor of glass column is a particular advantage in visual monitoring of the process at all times. Column section is available up to 600 mm in diameter and max. length of 1500 mm.



## VESSELS & STIRRERS

SIGMA vessels & stirrers provide best solution for all requirements encountered in production processes because of wide range of vessels available. Vessels in either unjacketed or jacketed form are essential components of many units & plants. The vessels can be combined with various components as stirrer drive, vessel covers & heat exchangers to construct wide variety of stirred units & reaction systems. These vessels find universal application as reactors, receivers, reboilers, separators, measuring, feed vessels & storage vessels in chemical industry. The complete range of standard vessels are available up to 300lit cap.



## TUBULAR SUPPORTING STRUCTURE

SIGMA structure are designed to support plant and other equipments in borosilicate glass 3.3 These structures are available in the form of modular system that not only meet standard requirement but also facilitate solutions for problems of unique nature. These structures consist of steel tubings, which are connected using the appropriate fittings. As a result these structure can be assembled, dismantled, expanded or modified very easily & quickly. Standard support is made of G.I. tubes with C.I. fittings. For GMP application SS pipes with SS fittings are used.



## OUR VALUABLE CUSTOMER

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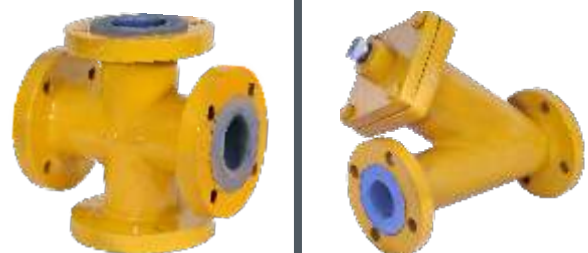
## OUR GROUP COMPANY



### Sigma Hi-Tech Lining LLP



[www.liningcoating.com](http://www.liningcoating.com)



[www.sigmapte.com](http://www.sigmapte.com)

## Our Network

We have agents, dealers, distributors, associates promoting our products overseas.  
Contact [marketing@sigmaglassindia.com](mailto:marketing@sigmaglassindia.com) for local assistance.



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**Bangalore Office:** Mr. G. Ravindran

**Hyderabad Office:** Mr. Jacob Punnose

**Surat Office:** Mr. Ravi Fumakiya

**Ahmadabad Office:** Mr. Bharat Patel

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