ablaze®
Since 1985

# SHELL & TUBE HEAT EXCHANGERS

- Large Heat Transfer Surfaces
- High Heat Transfer Coefficient
- Both Sides Corrosion Resistant

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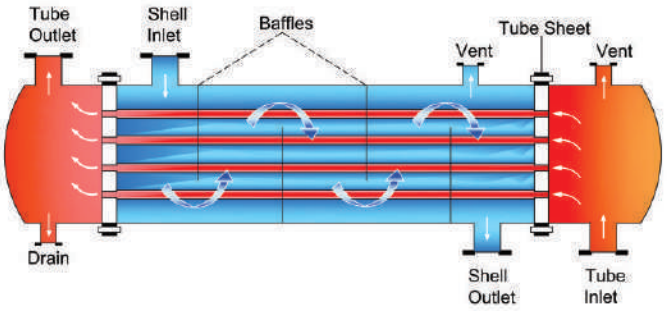
# SHELL AND TUBE HEAT EXCHANGERS

Shell & Tube Heat Exchangers are one of the most common and versatile type of exchangers used in heat transfer applications. They allow transfer of larger amounts of heat in a more compact construction, than is possible with conventional coil type heat exchangers. Shell and Tube type Heat Exchangers find application as heaters, coolers, condensers, vaporizers, reboilers etc.

## Design Features & Benefits

- Same diameter of tube used for all versions
- Same design of tube sealing fitting used across all versions
- Modular design, making maintenance simple and spare part stocking easy
- Suitable for wide range of heat transfer processes
- Only inert materials i.e. borosilicate glass 3.3, and PTFE coming in contact with process vapours
- Extremely low pressure drop across the equipment
- Smooth internal surfaces, extending the lifecycle time of the product
- Shells and headers can be made of Borosilicate Glass 3.3, Mild steel, stainless steel, MS-PTFE lined, Glass lined, PP-FRP
- Tubes can be made of Borosilicate Glass 3.3, SiC, Graphite, Hastelloy




## Advantages

- Larger heat transfer surfaces
- High heat transfer coefficients
- Both Shell and Tubes sides can be corrosion and diffusion resistant
- Pressure resistant up to +6 bar G
- Suitable for pharma GMP applications with ultra-pure products
- Available across a broad range of heat transfer areas from 0.6m$^2$ to 50m$^2$
- High resistance to corrosion, oxidation and erosion across the operating temperature range

## Applications

Because of the universal design, Shell & Tube Heat Exchanger find application in a lot of heat transfer processes such as

- Condensation
- Heat transfer
- Cooling
- Reboiler

And are designed to operate between

Temperature: -40°C to +150°C

Pressure: -1 Bar G to +3.5 Bar G

Maximum allowable temperature difference between media: 70°C Customized solutions can be offered for process parameters other than these.

# PERFORMANCE AND DESIGN DATA

The Shell & Tube Heat Exchanger can be optimally designed based on operating data from the user. However, an indicative performance data is tabulated below for several typical applications.

| Application | Fluid / Medium | k-Value Kcal / $m^2$ hrK | |
|---|---|---|---|
| | | Glass / Glass | SiC |
| Liquid/ Liquid | Water - Water | 275 - 475 | 550 - 1500 |
| | Water - Organics | 250 - 400 | 400 - 1200 |
| | Water - Heat transfer oil | 175 - 350 | 350 - 700 |
| Liquid/ Gas | Water - Air | 10 - 75 | 10 - 75 |
| Liquid/ Vapour | Water - Water | 450 - 550 | 1200 - 2500 |
| | Water - Organics | 350 -500 | 750 - 1800 |

Typical heat transfer coefficicents for various applications

## Construction Details

### Partial section view shell and tube heat exchanger (Glass/ steel)

**1** Glass shell tube

**2** Glass inner tube

**3** Glass spacer rod

**4** PTFE threaded bushes for guiding spacer rod

**5** PTFE baffle

**6** Stainless steel cover

**7** PTFE closed bushes

**8** PTFE/viton envelope gasket

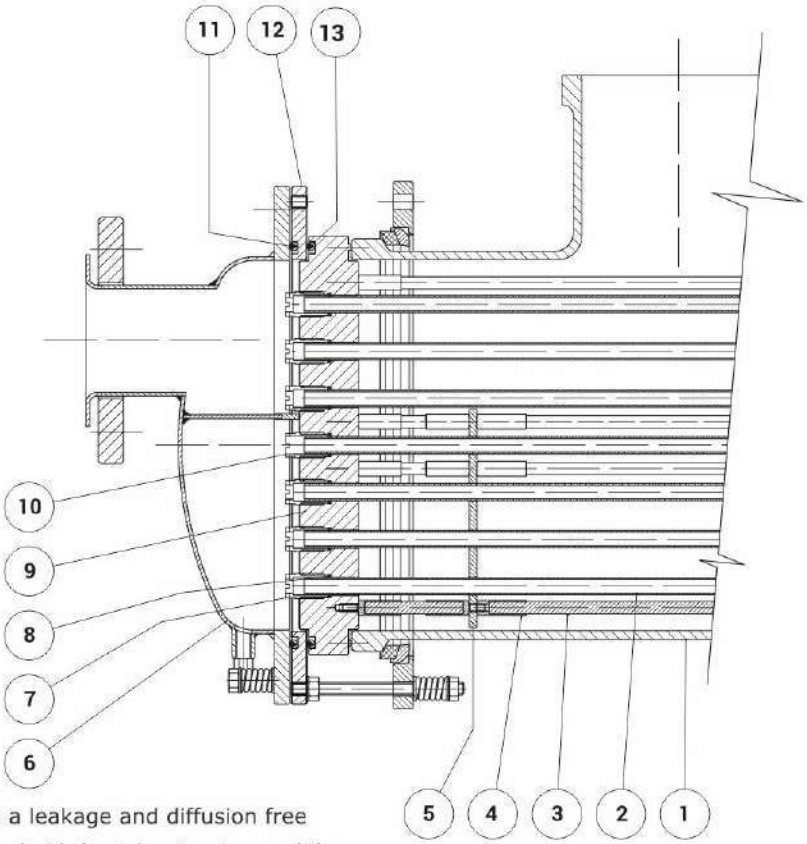
**9** PTFE tube plate

**10** PTFE open bushes

**11** PTFE/envelope gasket (tube side)

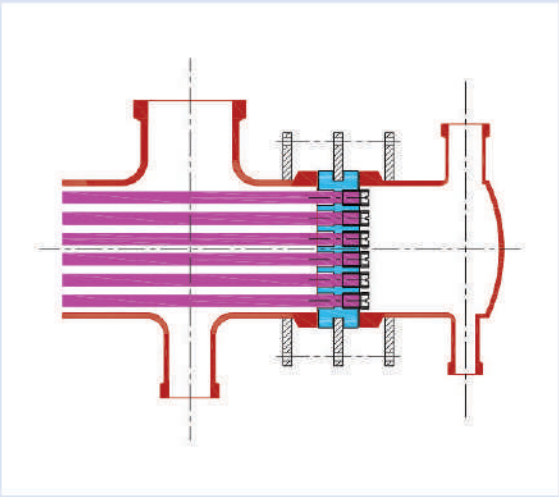
**12** Stainless steel intermediate flange

**13** PTFE/envelope gasket (shell side)




The tube sheet is the sealing part where all tubes fit, and a leakage and diffusion free partition is made between shell side and tube side. Baffles hold the tubes in place, while allowing for a more turbulent flow through the shell. Each tube has its individual sealing fitting, and hence the construction is modular and any tube can be changed without disturbing the entire heat exchanger fitting.

# TYPES OF SHELL & TUBE HEAT EXCHANGERS



## TYPE-I: Both Sides Corrosion Resistant

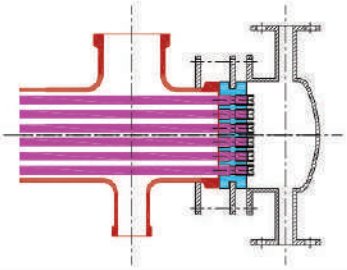
This is the universal and most common design of shell and tube heat exchanger where both shell side and tube side are resistant to corrosion. It finds usage in applications such as condensation in shell side, heat recovery, and cooling in shell or in tubes. With minor modifications, it can also be used as a falling film absorber and falling film evaporator.

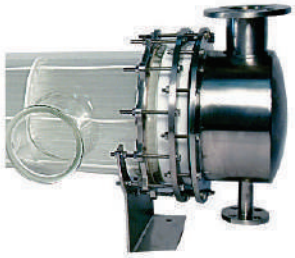
The traditional MoC in this case was of Glass Headers, Glass tubes and Glass shell. In this case, the maximum permissible pressure was limited and depending on the diameter of the glass shell and the header.

We can now also offer Shell and headers made of Teflon lined metal or Glass lined metal, for higher pressure application, where usage of glass is not possible.

This type of Shell & Tube type heat exchanger can be installed either horizontally or vertically and is easy to maintain and service since all tubes are fitted independently.

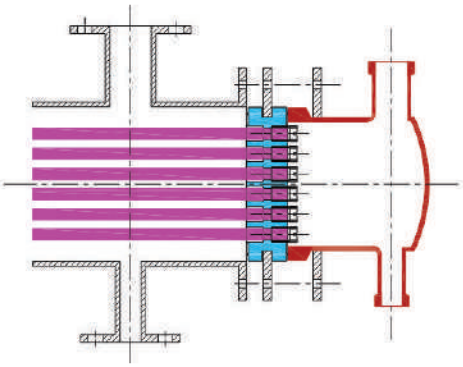
## TYPE-II: Shell Side Corrosion Resistant





Type-II Heat exchangers are very similar to Type-I but have Metal (Mild steel or Stainless Steel) Headers instead of glass headers. These are used in applications where there is no risk of corrosion at the service/utility side. The process side comes in contact only with the glass shell or PTFE components, and hence can be corrosive. Thus, this design is generally used for condensation and tempering of corrosive liquids.

With Metal headers, we can have optional segments / partitions of the same MoC, which allow for multi-channel flow of the service/utility medium through the tubes. This design of 2 or 3 pass Shell & Tube Heat Exchangers provides more efficient heat transfer for a given heat transfer area.



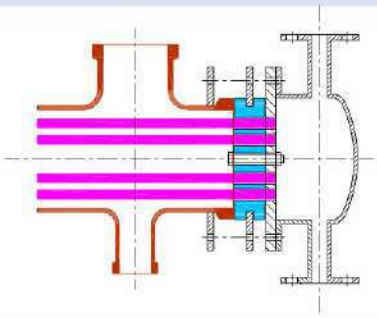
## TYPE-III: Tube Side Corrosion Resistant

Type-II Heat exchangers are very similar to Type-I but have Metal (Mild steel or Stainless Steel) Headers instead of glass headers. These are used in applications where there is no risk of corrosion at the service/utility side. The process side comes in contact only with the glass shell or PTFE components, and hence can be corrosive. Thus, this design is generally used for condensation and tempering of corrosive liquids.

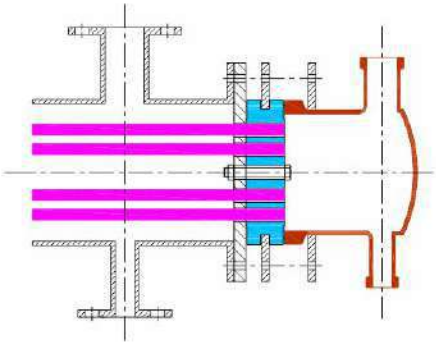
With Metal headers, we can have optional segments / partitions of the same MoC, which allow for multi-channel flow of the service/utility medium through the tubes. This design of 2 or 3 pass Shell & Tube Heat exchangers provide more efficient heat transfer for a given heat transfer area.

# TYPES OF SHELL & TUBE HEAT EXCHANGERS

## TYPE-IV: Shell Side Corrosion Resistant, High Tube Side Pressure



A key factor due to which maximum permissible pressure is limited in Shell & Tube Heat Exchangers is the Tube sheet, which cannot withstand a high pressure since it is made of pure PTFE. In applications where corrosion is not an issue at the utility side, a reinforcing plate can be installed at the header side of the PTFE Tube Sheet. This increases the maximum pressure limit up to 6 Bar. It is essentially a utility side high-pressure modification of Type-II and can be used in similar applications.



## TYPE-V: Tube Side Corrosion Resistant, High Shell Side Pressure

This design of Shell and Tube Heat exchanger again uses the reinforcing metal plate to increase maximum permissible operating pressure. However, in this type, the pressure is increases on the shell side since the plate is installed on the shell side of the Tube Sheet and not the header side.

This is possible only when corrosion is not an issue for the shell side medium. Hence, the shell is also usually made of Metal (mild steel or stainless steel). The utility lines are connected to the shell and can withstand a pressure of up to 6 Bar.

This type of shell and tube finds application in rapid cooling of a corrosive media at low temperatures, or as falling film evaporators.

## OTHER VARIANTS

- Translucent reinforced protective coating to prevent
  from accidents from breakage of glass
- Multi-Pass headers in Metal for more efficient heat transfer
- Vertical installation possible with minor modifications
- GMP, clean room models available in all types
- Tubes of exotic materials such as Hastelloy etc available on request in the same design
- Other process connection sizes can be modified as per application and user requirement
- Tubes of SiC and graphite also available offering higher thermal conductivity

# MATERIALS OF CONSTRUCTIONS

## Ablaze Offers A Huge Variety Of MOCs To Choose From, Depending On Process Requirements

| Component | Material | Pressure + barg | Type1 | Type2 | Type3 | Type4 | Type5 |
|---|---|---|---|---|---|---|---|
| **Shell** | Glass | 1(2) | • | • | | • | |
| | Mild Steel | 6 | | | • | | • |
| | Stainless Steel | 6 | | | • | | • |
| | Enamel Lined | 6 | • | • | | • | |
| | PTFE Lined | 6 | • | • | | • | |
| **Header** | Glass | 1(2) | • | | • | | • |
| | Mild Steel | 6 | | • | | • | |
| | Stainless Steel | 6 | | • | | • | |
| | Enamel Lined | 6 | • | | • | | • |
| | PTFE Lined | 6 | • | | • | | • |
| **Tubes** | Glass | 3.5(6) | • | • | • | • | • |
| | Silicon Carbide | 3.5(10) | • | • | • | • | • |
| | Graphite | 3.5(6) | • | • | • | • | • |

Tubes of Hastelloy, tantalum, and other exotic metals can be provided on request.

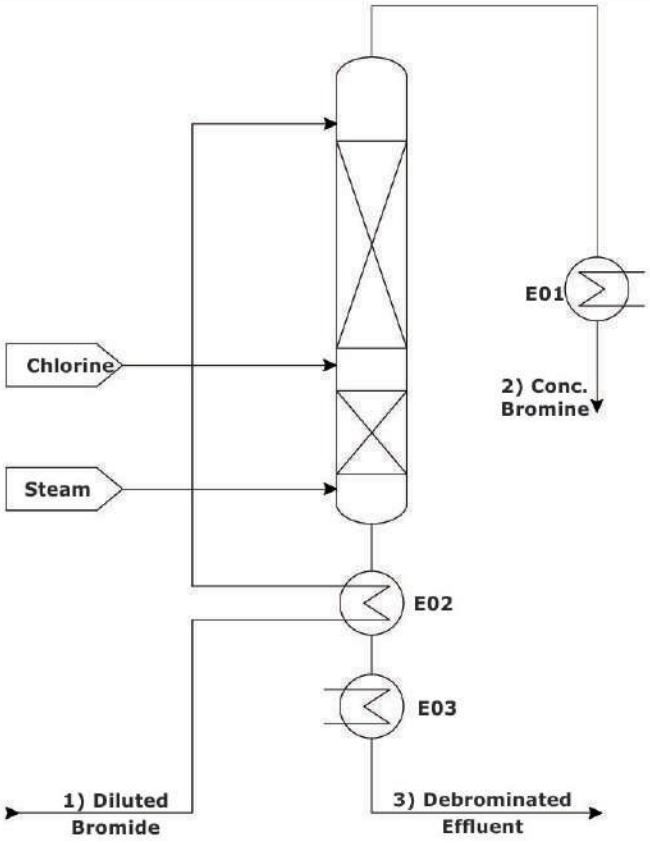
## Sample Applications

Owing to the wide varietys of MOCs available and versatility of the equipment, Ablaze's Shell & Tube Type Heat Exchangers can be used for a wide range of processing stages in a Process Plant. The sample here shows a Simplified Flow diagram of a Bromine Recovery Process Plant to illustrate this.

**E1: Condensation**
Shell Side Corrosion Resistant (Type - 2, 4)

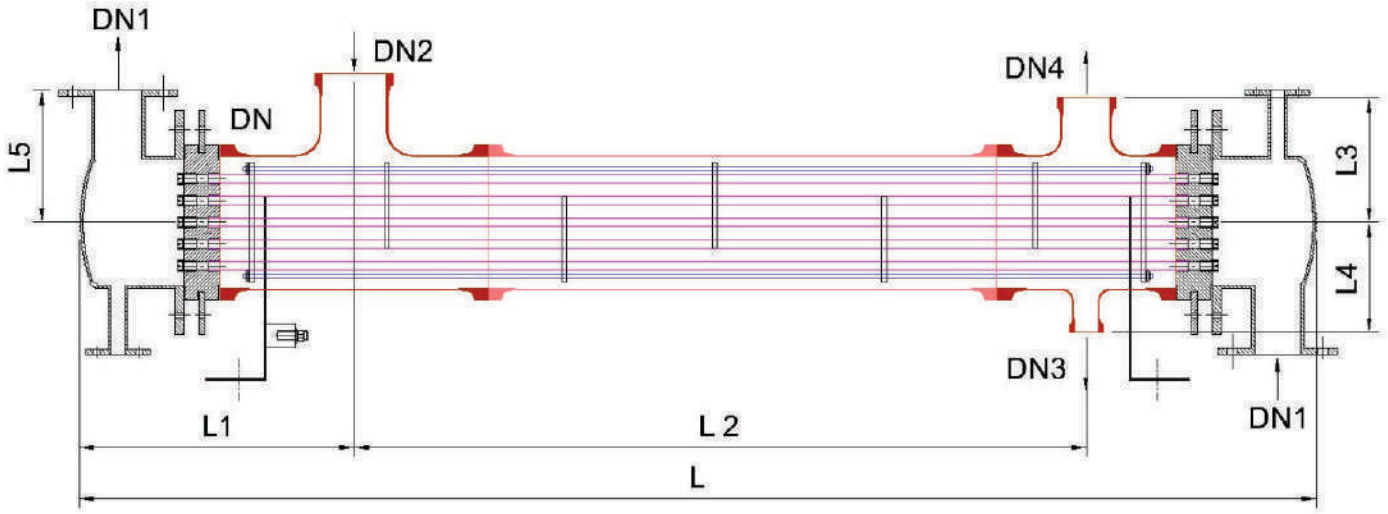
**E2: Heat Transfer**
Both Sides are Corrosion Resistant (Type - 1)

**E3: Cooling**
Tube Side Corrosion Resistant (Type - 3, 5)



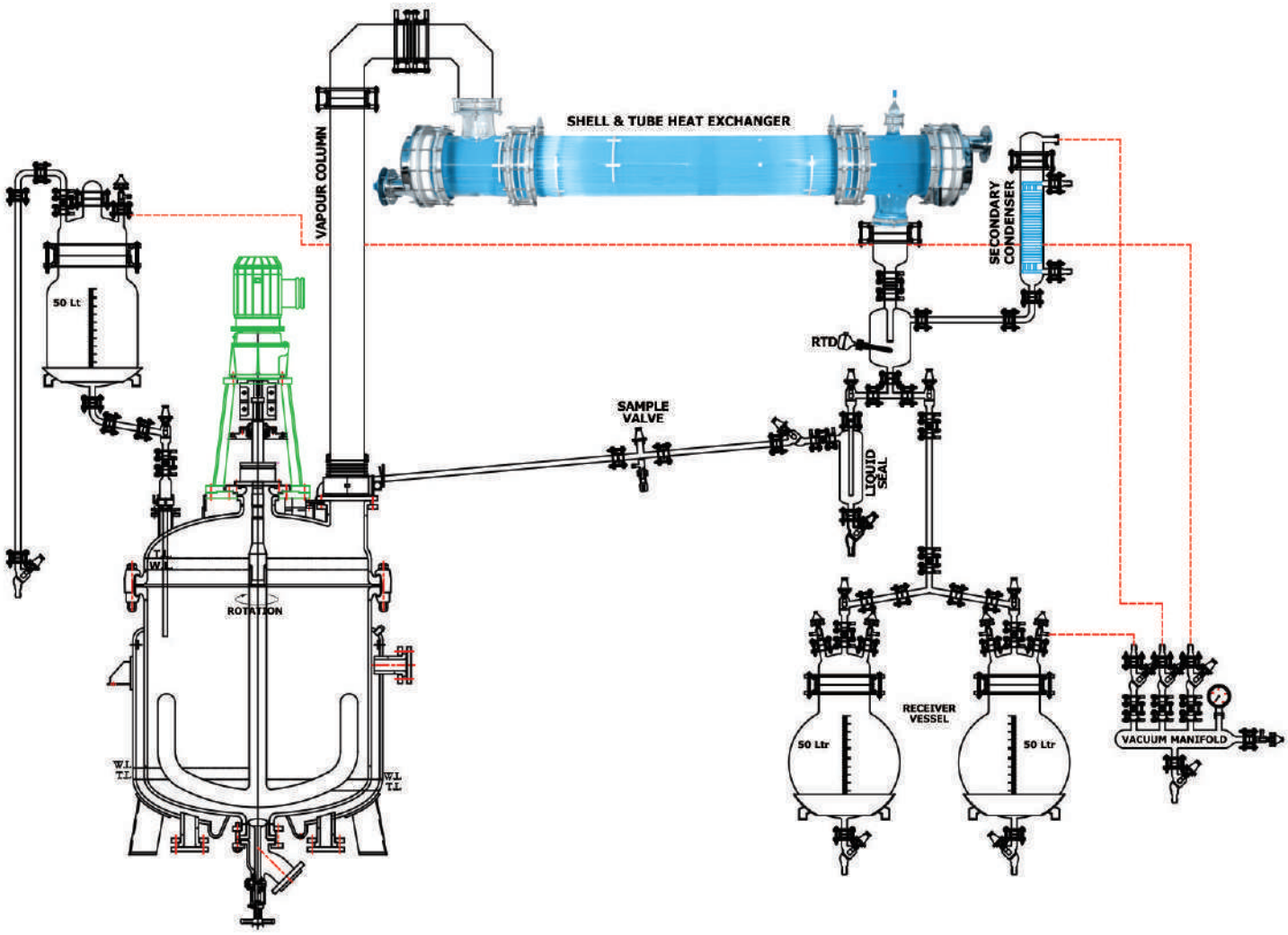
## Shell And Tube Heat Exchangers Single Pass (Glass / Glass)

| Sr. No. | Area $M^2$ | DN (Shell Dia) | DN 1 (Utility Inlet) | DN 2 (Vapour Inlet) | DN3 (Liquid Drain) | DN4 (Vent) | L | L1 | L2 | L3 | L4 | L5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.6 | 100 | 40 | 50 | 25 | 50 | 1150 | 340 | 255 | 125 | 110 | 135 |
| 2 | 1.0 | 100 | 40 | 50 | 25 | 50 | 1665 | 340 | 770 | 125 | 110 | 135 |
| 3 | 1.5 | 100 | 40 | 80 | 25 | 50 | 2365 | 365 | 1145 | 125 | 110 | 135 |
| 4 | 2.5 | 150 | 50 | 100 | 25 | 50 | 2065 | 375 | 1115 | 150 | 150 | 185 |
| 5 | 3.0 | 150 | 50 | 100 | 25 | 50 | 2365 | 375 | 1415 | 150 | 150 | 185 |
| 6 | 4.0 | 150 | 50 | 100 | 25 | 50 | 2965 | 375 | 2015 | 150 | 150 | 185 |
| 7 | 5.0 | 150 | 50 | 100 | 25 | 50 | 3665 | 375 | 2715 | 150 | 150 | 185 |
| 8 | 5.0 | 225 | 80 | 150 | 40 | 80 | 2065 | 460 | 985 | 210 | 180 | 220 |
| 9 | 6.3 | 225 | 80 | 150 | 40 | 80 | 2365 | 460 | 1285 | 210 | 185 | 220 |
| 10 | 8.0 | 225 | 80 | 150 | 40 | 80 | 2965 | 460 | 1885 | 210 | 185 | 220 |
| 11 | 10.0 | 225 | 80 | 150 | 40 | 80 | 3665 | 460 | 2585 | 210 | 185 | 220 |
| 12 | 10.0 | 300 | 80 | 225 | 50 | 100 | 2065 | 550 | 815 | 275 | 230 | 270 |
| 13 | 12.5 | 300 | 80 | 225 | 50 | 100 | 2365 | 550 | 1115 | 275 | 230 | 270 |
| 14 | 16.0 | 300 | 80 | 225 | 50 | 100 | 2965 | 550 | 1715 | 275 | 230 | 270 |
| 15 | 20.0 | 300 | 80 | 225 | 50 | 100 | 3665 | 550 | 2415 | 275 | 230 | 270 |
| 16 | 25.0 | 300 | 80 | 225 | 50 | 100 | 4365 | 550 | 3115 | 275 | 230 | 270 |
| 17 | 35.0 | 400 | 100 | 225 | 50 | 150 | 3415 | 700 | 1865 | 350 | 275 | 325 |
| 18 | 40.0 | 400 | 100 | 225 | 50 | 150 | 3715 | 700 | 2165 | 350 | 275 | 325 |
| 19 | 40.0 | 450 | 100 | 225 | 50 | 150 | 3015 | 700 | 1415 | 380 | 300 | 355 |
| 20 | 45.0 | 400 | 100 | 225 | 50 | 150 | 4415 | 700 | 2865 | 350 | 275 | 325 |
| 21 | 45.0 | 450 | 100 | 225 | 50 | 150 | 3415 | 700 | 1815 | 380 | 300 | 355 |
| 22 | 50.0 | 400 | 100 | 225 | 50 | 150 | 4415 | 700 | 2865 | 350 | 275 | 325 |
| 23 | 50.0 | 450 | 100 | 225 | 50 | 150 | 3715 | 700 | 2115 | 380 | 300 | 355 |



# Distillation Plant with Glass Lined Reactor

For production scale chemical synthesis , distillation , solvent recovery , rectification processes, Glass Shell & Tube Condensers are used along with Glass Lined Reactors. Complete process piping is also made of borosilicate glass 3.3 These plants usually operate under vacuum.




## Salient Features

- Suitable for operation under high vacuum and low pressure
- Setup can be configured up to 600 DN for large size reactors
- Visual monitoring of process, improving safety and reliability of production
- Customized compact design as per available space
- Measure and control devices can be easily equipped
- High corrosion resistant Coupling and Fasteners
- Shell and Tube type Heat Exchanger available up to 50m$^2$ for improved heat transfer efficiency

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