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10th Anniversary HISAKA SOUTH EAST ASIA

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challenge for innovation

Petroleum Refining and Petrochemistry

Plate Heat Exchanger

HISAKA

HISAKA Plate Heat Exchanger in petroleum refining and petrochemical processes

Petroleum refining and petrochemical processes are going through drastic changes with inflation of petroleum price and global warming. Consequently, functional advancement of chemistry products have been modified to be on par with society, industries and environmental progress.

As such, focuses have been set in producing facilities and machineries that can:

- Energy and cost effectiveness
- Reduce carbon footprint
- Process precision and flexibility

HISAKA PHEs are ideal because:

i. It is extremely safe to be used and manipulate
ii. Reduced carbon footprint
iii. Excellent heat performance
iv. Minimal thermal energy consumption
v. Simple and quick machinery assembly
vi. Ease of modifying heat performances (by increasing or reducing the number of plates)
vii. Reduced installation space

ABOUT HISAKA PLATE HEAT EXCHANGER (PHE)

Advantages of Plate Heat Exchangers (PHE)

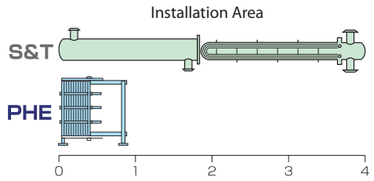
Plate heat exchangers (PHE) plates:
- Pressed thin metal plates that have convex and concave wave patterns (herringbone patterns)
- Made of corrosion resistant materials, such as stainless steel or titanium
- Perimeter of the plates is sealed with synthetic rubber gaskets (slit in or glue on method)
- Suspended perfectly on both upper and lower guide bars
- Fastened and compressed by a fixed and moving frame

Mechanisms:
* Counter current flow of high temperature fluid and low temperature fluid flowing against each plates. This phenomenon ensures heat transfer to take place.
* Gaskets ensure that the flowing fluids do not intermix.

PHE Main Unit

1. High Performance
- Pressed-moulded herringbone patterns enhance heat conduction performance (heat transfer coefficient), hence able to reduce heat conduction surface area.

2. Lightweight and Compact
- Compressed thin heat transferring plates
- Limited fluid capacity
- Smaller heat transferring surface area
  → This realizes reduction in installation space, making installation and maintenance easier



3. LMTD (Log Mean Temperature Difference)
- Complete counter current flow ensure full utilization of LMTD to warrant good thermal efficiency and heat transfer coefficient.
- Temperature difference can be brought to as close as 1°C between the outlet temperature and the inlet temperature fluid

4. Quick Start - Up
- Limited fluid capacity per unit allows quick operation start up, and also possible to correspond to changes in operating conditions with high precision.

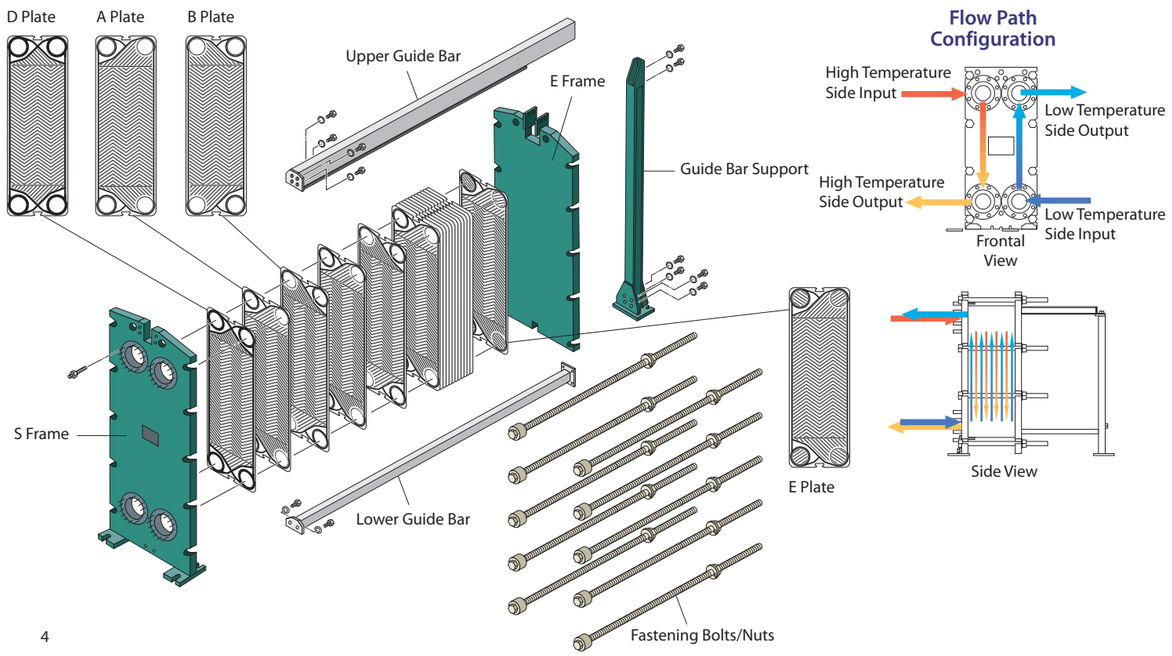
5. Excellent Maintainability
- Assembly and disassembly are made convenient by simply removing the fastening bolts
- Maintenance are thereby made easy, even for visual inspections and cleaning

6. Easy Modification of Capabilities
- Flexibility in modifying the heat transferring surface area by simply increasing or decreasing the number of plates

●The film heat transfer coefficient h is high.
●It is difficult for impurities to attach to the heat transferring surface.
●The thickness of the heat transferring walls (plates) is thin.
●It is possible to increase or decrease the heat transferring surface area.

→ High Performance and Compact → Cost Reduction

Structure of Plate Heat Exchanger (PHE)



Flow Path Configuration

Side View

HISAKA Plate Heat Exchanger are Lightweight, Compact and High Performance

Heat exchangers are thermal machineries that transfer thermal energy from a high temperature fluid to a low temperature fluid. This is done by creating a counter current flow of two different temperature fluids that are separated by metal plates to avoid intermixing. Heat exchangers can be used as:

i. Heaters
ii. Coolers
iii. Vaporizers
iv. Condensers

A variety of different types of heat exchangers have been developed to support various industrial applications, depending on its purpose, installation conditions, and the type of fluids being used. In comparison of shell and tube heat exchanger vs Plate Heat Exchanger:

About Shell and Tube Heat Exchangers
- As seen in figure 1, it is made of a bundle of heat transferring tubes that is contained inside a cylindrical shell
- Heat transfer occurs when one of the fluids flow through the tubes while the other fluid flows through the shell at the same time
- Despite for its simple configurations, it requires a large installation space due to its large mass
- Cleaning and maintenance are also much complicated as the tubes are intertwined inside the shell
- The cost of installation is also much higher especially when high quality metals (eg: titanium) are needed

About Plate Heat Exchangers
- As seen in figure 2, it is made of layers of high-pressure compressed plates, secured by two solid metal frames
- The complex plate corrugation patterns warrants a high heat transfer rate whilst creating a high turbulence to prevent adhesion of impurities on the plates
- The arrangement and corrugations of the plates which cross and supporting each other to give the system a high pressure resistance, hence ensuring a 3 to 5 times higher performance as compared to shell and tube heat exchangers
- Flexibility in modifying the heat transferring area by increasing or decreasing the number of plates, therefore making it more cost effective for initial investment and respond to process modifications

Fig. 1

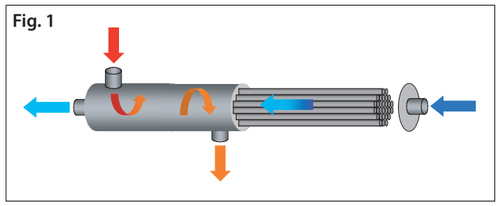
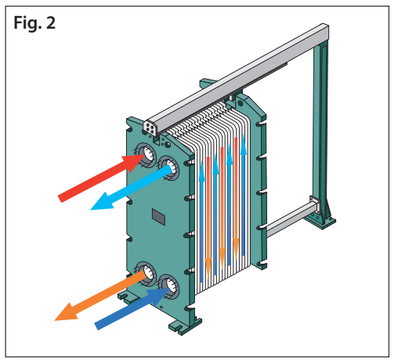


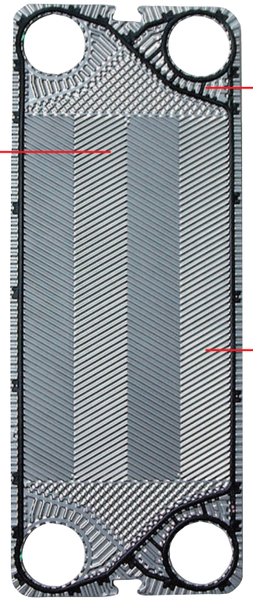
Fig. 2



CONFIGURATION OF HEAT TRANSFERRING PLATES AND THE NAMES OF THE COMPONENTS

Heat transfer area
Cold-pressed unique waveforms that contributes to the high heat transfer performances

i. Plate gaps formed on the plates create fluid turbulence flow, hence contributing to the high heat transfer coefficient
ii. High turbulence also creates a passive self-cleaning effect by reducing the chances of scaling
iii. Heat transfer area can be altered as long as it is within the dimensions of the model design
iv. Thin layers of metal plates are compacted together, thereby creating a high pressure resistance



Heat Transferring Plate

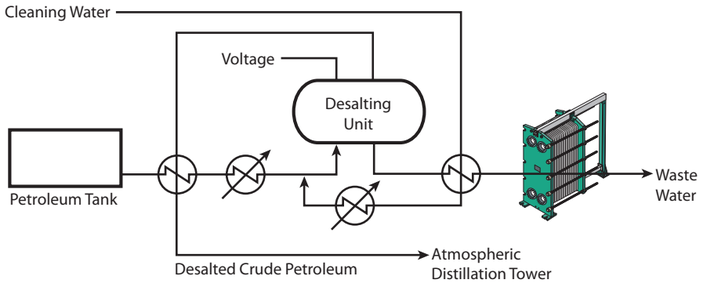
Double Layered Seal
- The vital area at which fluids of high and low temperature come closest to each other
- The gaskets are sealed (and maintained with air pressure) at the gasket seal lines presented on the plates
- This prevent mixture of two flowing liquids even when there is a leakage at the plate caused by gasket deterioration
- Such configuration also enables easy maintenance to identify gasket deterioration at an early stage

Gasket
- High quality synthetic rubbers which are accurately formed to match the gasket seal lines presented on the plates
- Plays and important role by directing the flow of fluids at outlet and inlet of high and low temperature fluid by sealing either the right or left port holes

Concerning Applicable Laws
Construction Code for First Class Pressure Vessels, High Pressure Gas Safety Act, Electricity Business Act, Overseas Standards
✻ Please make an inquiry upfront on details regarding applicable laws.

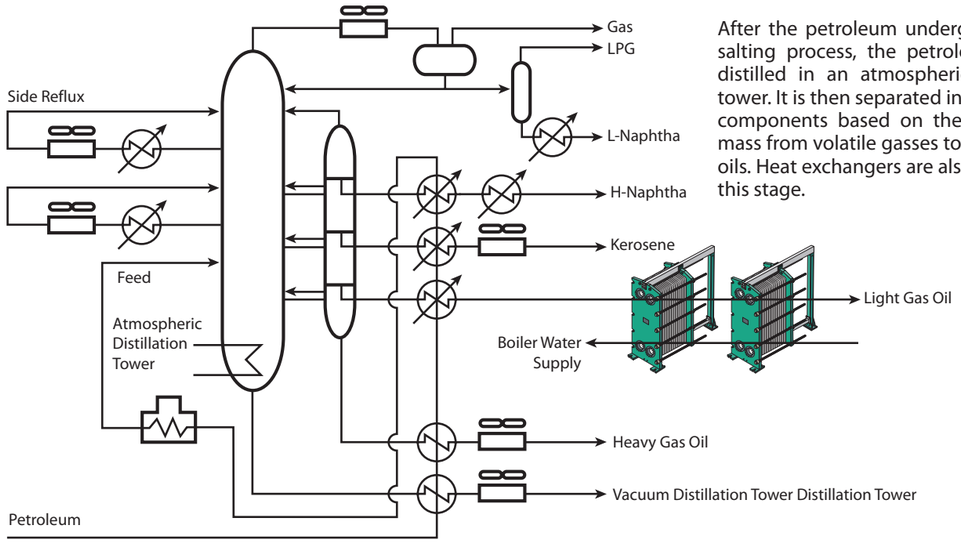
HISAKA Plate Heat Exchanger in petroleum refining and petrochemical processes

DESALTING PROCESS



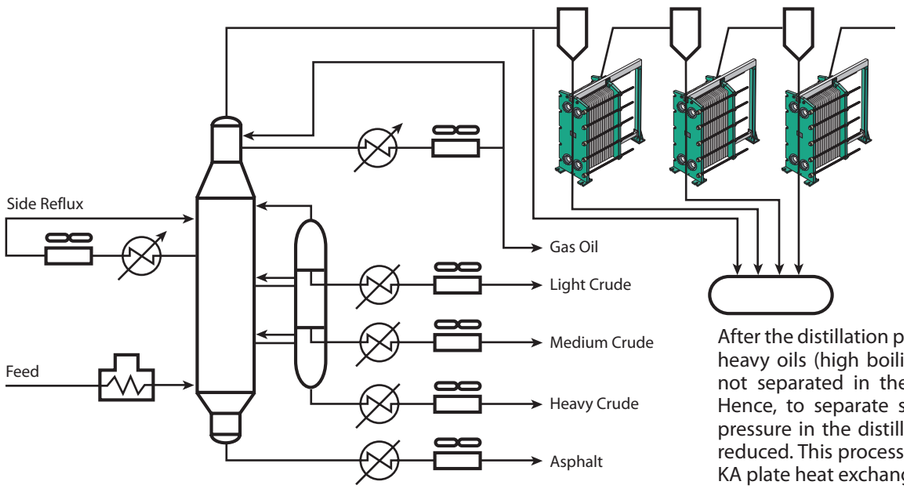
Before crude petroleum is sent for atmospheric distillation process, it undergoes a desalting treatment at the desalting tank. Cleaning water is pumped into the desalting tank. At this process, HISAKA plate heat exchangers are used. In the desalting tank, an electric charge supplied by a high voltage device is used to separate the salts from the petroleum. The separated salts are then discharged by the cleaning water as waste water.

ATMOSPHERIC DISTILLATION PROCESS



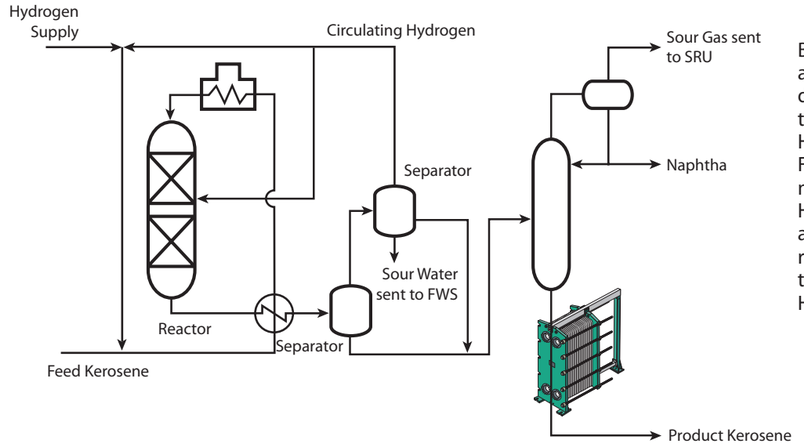
After the petroleum undergoes the desalting process, the petroleum is then distilled in an atmospheric distillation tower. It is then separated into each of its components based on their respective mass from volatile gasses to heavy liquid oils. Heat exchangers are also involved in this stage.

VACUUM DISTILLATION PROCESS



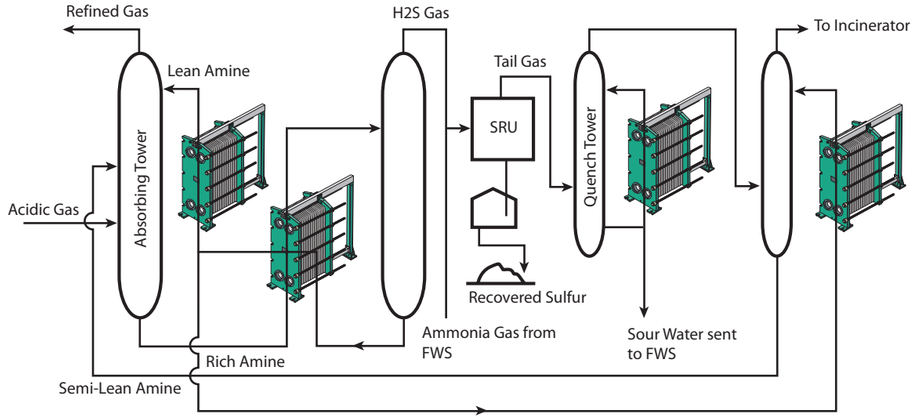
After the distillation process, there will be heavy oils (high boiling points) that are not separated in the distillation tower. Hence, to separate such heavy oil, the pressure in the distillation tower will be reduced. This process also involves HISAKA plate heat exchangers.

HYDROGEN DESULFURIZATION UNIT (HDS)



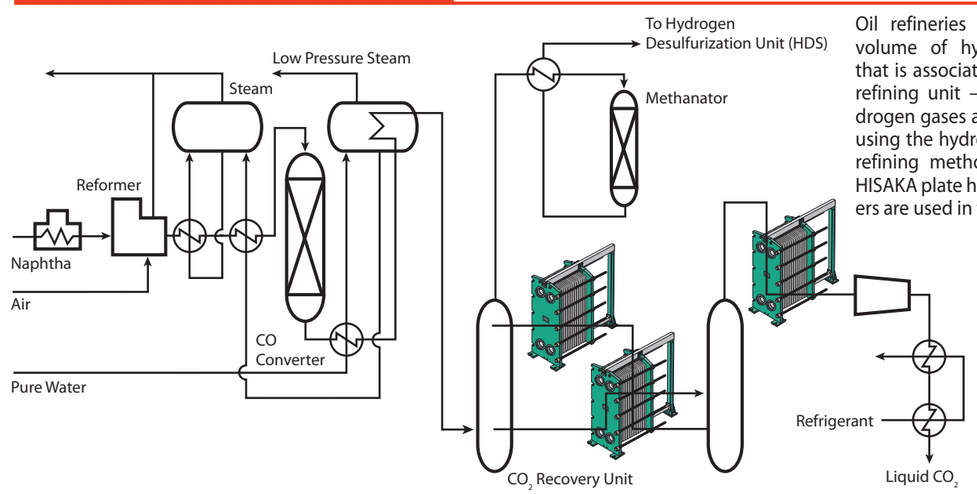
Before feed oil is sent to the reactor, it will be mixed with hydrogen gas. Before the mixture, the raw oil will be preheated by HISAKA plate heat exchangers. Feed oil contains sulfur and ammonia contents. Prior to that, HISAKA plate heat exchangers are also used in the process of removing acidic gas (water) from the feed oil with the use of an HDS unit.

SULPHUR RECOVERY UNIT (SRU)



HISAKA plate heat exchangers are used in the process where acidic gases removed are treated with amine circulating in the Sour Gas Treater (SGT) and the Tail Gas Treater (TGT) . From this process, H_2S (hydrogen sulphide) gas is separated out and collected as crystalized sulfur.

HYDROGEN PRODUCTION UNIT



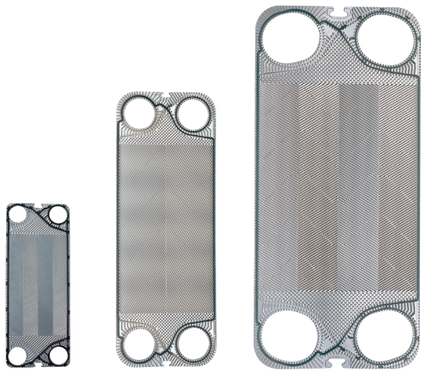
Oil refineries use a large volume of hydrogen gas that is associated to hydro-refining unit – a HDS. Hydrogen gases are produced using the hydrogen vapour refining method of which HISAKA plate heat exchangers are used in the process.

Welded Plate Heat Exchanger

HISAKA WX-series involves laser welding a couples of plates as an O-ring at the port holes between the plates in order to further stabilise the system for broader range of industrial applications, such as those involving dangerous fluids.

Conventional gasket sealing method at the port holes might not be sufficient, especially when dangerous fluids are involved. HISAKA WX-series does not only omit this worry, it also retains the benefits of conventional PHEs:

i. High performance assurance with the unique plate patterns to ensure even dispersion of the flowing liquids to the heat transfer area
ii. WX-series PHEs are capable of withstanding approximately twice the pressure compared to conventional gasket type PHE
iii. There are two available ring gaskets options - synthetic rubber gaskets and fluorine resin cushion gaskets (TCG). TCG in particular has excellent chemical resistance and are capable of providing stable degree of sealing over a long period of time.



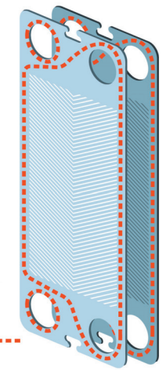
WX-10 WX-53 WX-90

Principle of Welding by LASER Welding

Light
Amplification by
Stimulated
Emission of
Radiation

Melting and solidifying plates locally by collecting and projecting laser light as a heat source

① Rapid and deep weld penetration
② Minimal heat affected zones
③ Small welding distortion



Plates integrated by welding

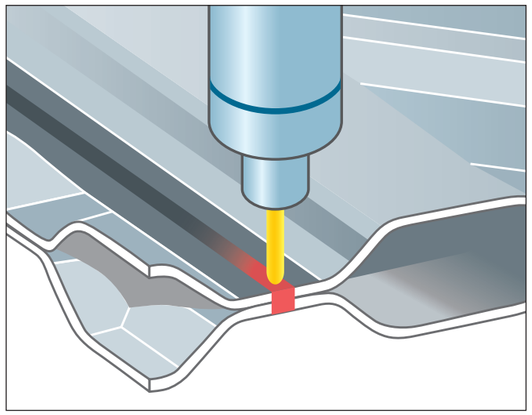


Plate Heat Exchanger for Condensation

Vapor Side

Cooling Water Side

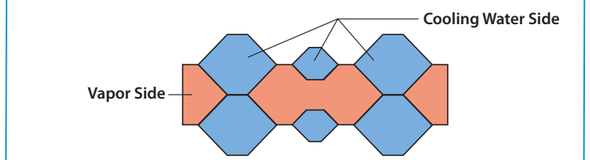
HISAKA YX-series is specially made to be used as condensers, especially for heat exchange duties of large volumes of gas in vacuum systems or under low pressure.

Since fluorine resin cushion gaskets (TCG) can be used, this make YX-series ideal for applications such as:

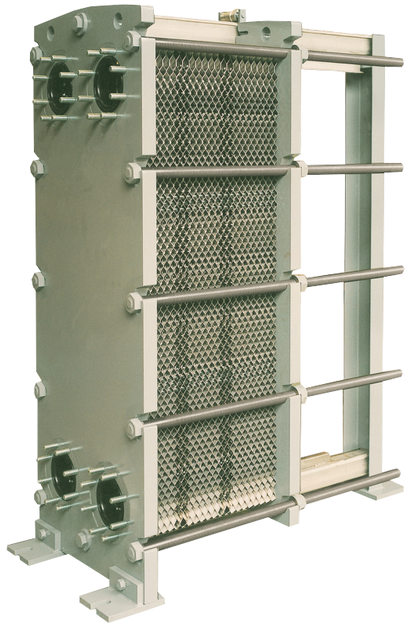
- Overhead condenser of a distillation tower
- Vapor condenser of a reaction vessel

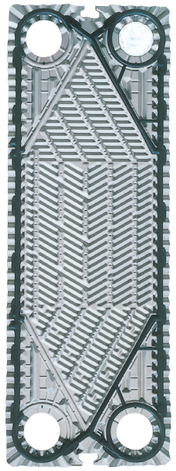
As seen from the figure, the plate pattern on the vapor side and the cooling water side have been devised to warrant higher heat conduction performance than those of shell and tube heat exchangers.

- The coefficient of heat transfer on the vapor side is kept high whilst minimizing pressure loss. This is made possible even for cold condensation with the involvement of non-condensable and condensable vapor in vacuum
- The heat transfer coefficient can be increased by rising the degree of turbulence in the cooling water (coolant) side, hence, enabling a self-cleaning effect as dirt and/or other solids are difficult to adhere onto the plates
- It is possible to create a complete counter current flow by configuring the vapor and the cooling water to flow in opposite direction
- The inlet/outlet passage of the vapor plate are identical, hence, making it possible to use YX-series as a total condenser, but also as a cooling condenser for vapor containing non-condensable gases
- Flexibility in altering heat duties by increasing or decreasing the number of plates
- Half the amount of cooling water needed as compared to conventional PHE
- Wide application range as TCG can be used on both vapor and coolant side
- Ease of maintenance



Multi-Gap Plate Heat Exchanger GX Series





GX-20

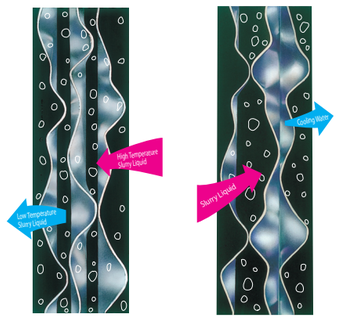
Advantages

HISAKA GX-series has wide plate gaps of up to 20 mm, made especially to allow flow of liquids containing fibres and solids (sludge) or even fluids that are prone to scaling. Furthermore, HISAKA GX-series is compliant with the Construction Code for First Class Pressure Vessels.

Apart from having a wide gap, HISAKA GX-series has several other advantages such as:

1. Special plate corrugation pattern to ensure that the flowing medium from the plate channels to the plate gaps are flat, hence reducing the chances of clogging by the fibres or solids
   - An ideal combination of plates with different types of gaps (GX-23: super wide/normal; GX-21: wide/wide) can be done by altering the direction of the plates being assembled in order to minimize the contact points on each plate to make it best suit for a wide range of applications
2. Great versatility to combine 3 different types of gaps onto 1 plate, hence giving extensively flexibility for a wide range of fluids.
   - Furthermore, the gaps for both fluid flows can be made identical with few contact points to make ideal for heat collection between two solids containing fluids
3. Ideal in corrosive environments as the plates are made on corrosion - resistant materials such as titanium
4. Maintenance is made ease and convenient with the usage of slit-in gaskets

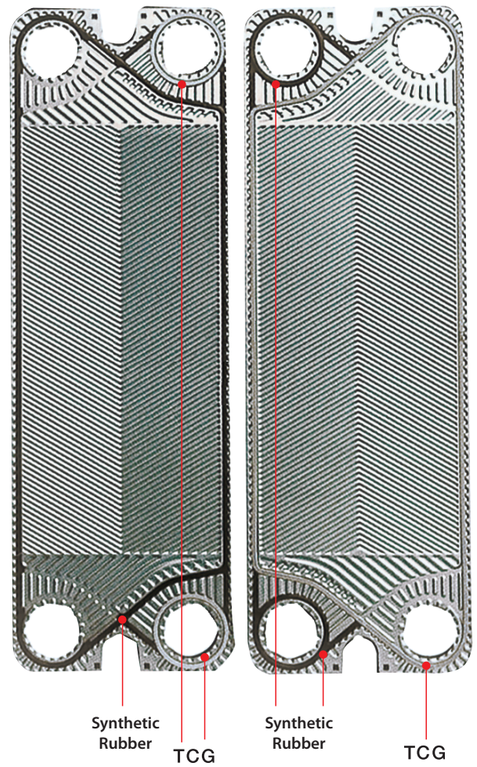
Principle of Multi-Gap



GX-21
Wide/Wide

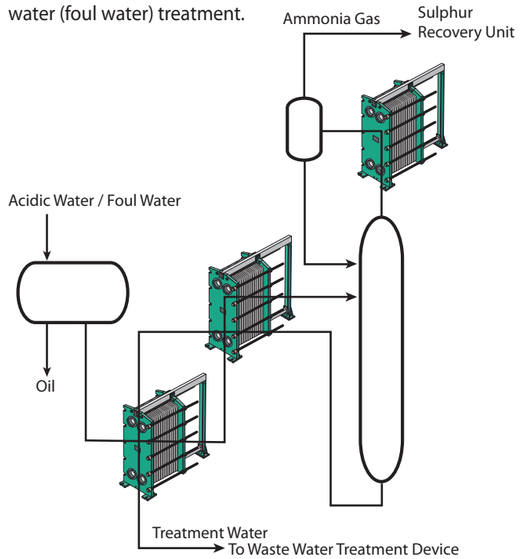
GX-23
Super Wide/Normal

Fluorine Resin Cushion Gaskets TCG



Waste Water Treatment Process

These are also used for waste water (foul water) treatment.



Advantages

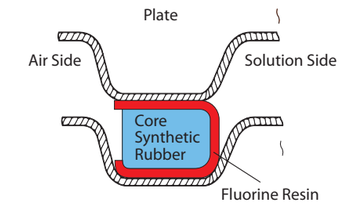
Despite having a compact structure, PHE can be easily assembled and disassembled for maintenance ease. However, conventional synthetic rubber gaskets might not be suitable and/or compatible for certain industrial applications. Hence, HISAKA conducted extensive year of research to produce fluorine resin cushion gaskets (TCG) that does not only have all the advantages of conventional synthetic rubber gaskets, but is also highly chemical resistance.

Mechanisms:

i. TCG uses an elastic synthetic rubber core that is covered with a thin sheet of fluorine resin, making ease for assembly and disassembly during maintenance work

ii. Since TCG can be used in combination with synthetic rubber, it is possible to use it in processes that specifically require TCG

iii. TCG can also be used in locations applicable to First Class Pressure Vessel



Configuration

An elastic synthetic rubber is used in the core which is covered with a thin sheet of fluorine resin.

Liquids for which Performance has been confirmed

Benzene Vapor, Trichlene, Normal Hexane, Mono-Crawl Benzene, Toluene, Gas Liquids, Aniline, Acetone, Kerosene, Isopropyl Alcohol, Ethanol, Latex, Other Organic Solutions, Pure Water, Caustic Soda, Chemical Solutions, Ammonium Sulfate Mother Liquor, Reaction Solutions, and more