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ISO 9001:2008 612078Q

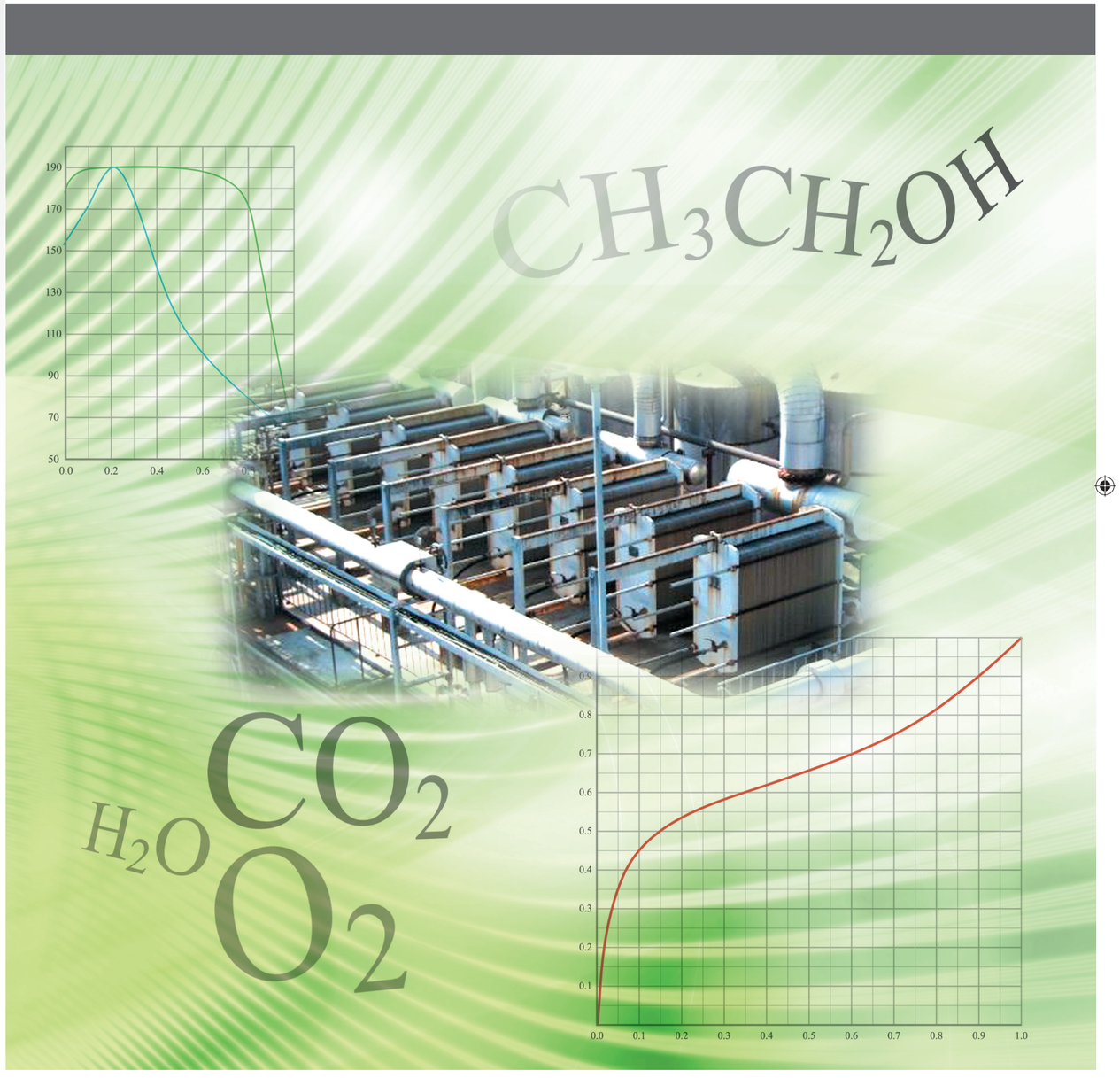
MS ISO/IEC 17021: 2011 QS 02032013 CB 13

B-ET03082015

challenge for innovation

Fermentation and Distillation

Plate Heat Exchanger



HISAKA

High Efficiency HISAKA PHE in Bioethanol Plants – A Leading Solution in Preventing Global Warming

Approaches to CO_2 reduction has been a great industrial focus since the enforcement of Kyoto protocol due to acceleration of global warming. With the surging of petrol prices, environmental friendly bioethanol fuel is renowned as an alternative to gasoline, reason adopted from photosynthesis whereby consumption of oxygen in fuel combustion will not accelerates atmospheric CO_2 levels.

Japanese government aimed to reduce 80% of dependencies on petroleum in the transportation sector by year 2030, beginning with effort such as blending 3% bioethanol with gasoline as fuel. One limitation to this vision is lack of supply source wherein ethanol has to be derived from cellulose derivatives found in wood waste, weeds and timber from deforestation. Consequently, focus has been placed on developing crops with high bioethanol yield.

To efficiently increase product yield, the heat exchangers used throughout the processes require excellent heat transfer performance. HISAKA PHE delivers various advantages, especially its outstanding heat transfer performance, leading to great innovation in plant engineering.

PHE facilitates higher efficiency of fermentation and distillation process

Bioethanol is a global trend, especially with cellulose. With economical constrains, industries emphasize on reducing the production cost of ethanol, a factor determined by the efficiencies of converting both cellulose and hemicellulose (approximately 60% of wood materials) into ethanol.

Wood saccharification with diluted sulfurous acid requires PHE made of corrosion resistant materials along with wide-gap plates to reduce slurries clogging from the degradation of hemicellulose and other substances. It is also crucial to ensure that the ethanol is produced from sugar generated from saccharification process, with the elimination of fermentation heat and act as preheater during pre-fermentation process.

Multi-stage distillation is used to condense the produced ethanol for commercialization. This process requires high performance condenser type PHE (HISAKA YX-Series) which emphasizes on small temperature difference and high condensing capacities.

As such, HISAKA is able to cater for various industrial needs and conditions with its wide product pipelines.

Pretreatment Process

Materials (such as starchy grains like corn; cellulose from plant fibers or sugar cane) are cleaned and cut to facilitate the subsequent liquefaction and saccharification process.

HISAKA PHE is used as water heater to provide excellent thermal efficiency during the cleaning process.

Liquefaction and Saccharification Process

HISAKA PHE is ideal as water preheater so that the steam can be harvested and used to steam the raw materials prior liquefaction and saccharification.

Liquefaction and saccharification hydrolyses polysaccharides (eg: starch and cellulose) into monosaccharides (eg: glucose), by the means of enzymatic reaction or with the use of diluted sulfurous acid.

Polysaccharide		Monosaccharide
$(C_6H_{10}O_5)n$	→	$n(C_6H_{12}O_6)$

Saccarification tank must be operated at optimal temperature to ensure high yield. Thereby, HISAKA multi-gap PHE is ideal as it minimizes clogging from the plant fibers and the plates being used have high corrosion resistance properties, which is especially important when acid is used for hydrolysis. Additionally, a compact and high performance PHE reduces the amount of raw materials, thereby able to reduce production cost.

HISAKA multi-gap PHE is also used during the cooling and heating process necessary prior to fermentation process.

Fermentation Process

Fermentation process emphasize on producing ethanol:

Monosaccharide		Ethanol + Carbon dioxide
$C_6H_{12}O_6$	→	$2(C_2H_5\text{-}OH) + 2(CO_2)$

Approximately 7-8% of ethanol (ethyl alcohol) and carbon dioxide can be produced with enzymatic saccarification of monosaccharides (eg: glucose).

However, ethanol produced by fermentation contains solid impurities and residues from saccarifications and fermentations; thereby, needing filtration.

Filtered ethanol will then be concentrated and further purified via distillation and purification process.

Distillation and Purification Process

Fermented alcohol is preheated by HISAKA PHE before it is fed into a multi-stage distillation to increase the ethanol concentration up to 95%.

Typically, condenser and reboiler are installed at the top and bottom of the distillation column respectively for ethanol distillation.

With the use of HISAKA PHE that can act as both reboiler and condenser, it is able to further facilitate the process by delivering outstanding performance and efficiency with little temperature difference.

HISAKA PHE is used in a wide range of applications, such as preheater, heat recovery, cooler, reboiler and condenser.

Dehydration Process

Ethanol needs to be processed into 99.5% dehydrated ethanol to be used as biofuel.

Commonly, membranes are used for ethanol dehydration; meanwhile, PHEs are used as preheater, heat and condenser.

HISAKA PHE in Bioethanol Plant

HISAKA PHEs are High Efficiency, Energy and Space Saving, and Maintenance Ease

Plate Heat Exchanger (PHE):

- Contains multiple press-formed heat transfer plates placed parallel to one another that are mounted with frames and bolts.
- Flow channels occur within the space created between the slits of each plate.
- By alternating the direction of the plates (same pattern) or mixing plates of two different patterns, a counter-current flow of high and low temperature fluids can be created, thus warranting efficient heat transfer.

Structure of Plate Heat Exchanger

■ Basic Structure

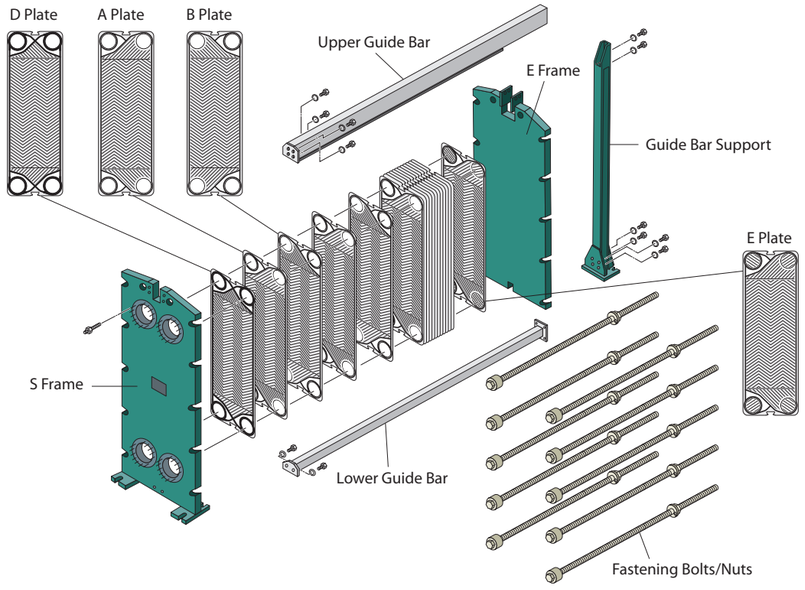
Thin sheets of press-formed corrosion resistant metals, such as stainless steel or titanium, which are sealed with gaskets. The plates are suspended between a fixed (S-frame) and moveable frame (E-frame), supported and aligned by guide bars and are lastly tightened by nuts and bolts.

■ Heat Transfer Plates

Have various corrugations to increase heat transfer area and ensuring high turbulence which ultimately achieving high heat transfer coefficient.
Each plate is tight sealed with a gasket fitted in its peripheral groove.

■ Flow Channel

Heat transfer plates are divided into A-plate and B-plate, where high and low temperature fluids flow alternatively to warrant high heat transfer efficiency.
Reversing A-plate would become B-plate; hence, only needing one type of plates for most models.



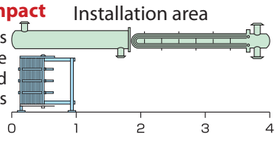
Main Features of PHE

● High performance

The press-formed patterns provide a high heat transfer coefficient by creating a turbulence flow.

● Light weight and compact

Thin heat transfer plates and small holding volume rendering cost and performance effectiveness and ease of installation.



● Quick start-up

Smaller holding volume escalates start up process.

● Easy maintenance

Assembly is by tightening with bolts and nuts; thereby making maintenance easy by just loosening it.

● Duty flexibility

Plates can be added/removed easily to adjust accordingly to the operation application.

Welded Plate Heat Exchanger (WX-Series)

FEATURES

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 stabilize the system for broader range of industrial applications, especially those involving dangerous fluids. HISAKA WX-series does not only retain the features and benefits of conventional PHE, it also further incorporated with improvement of laser welding.

Performance

Performance is warrant with the unique plate patterns to ensure even dispersion of flowing liquids at the heat transfer area.

Pressure Resistance

HISAKA WX-series is able to withstand approximately twice the pressure compared to conventional gasket type PHE.

Chemical Resistance

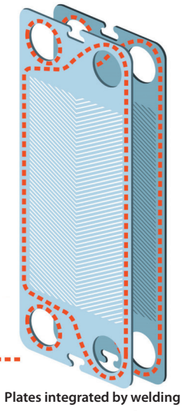
There are two available ring gaskets options - synthetic rubber gaskets and fluorine resin cushion gaskets (TCG). TCG in particular has excellent chemical resistance and are capable of providing stable degree of sealing over a long period of time.

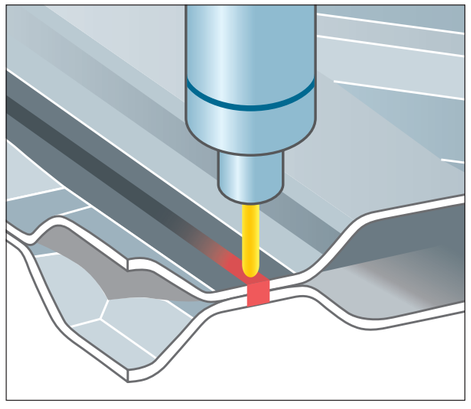
Principle of Welding by LASER Welding

Light
Amplification by
Stimulated
Emissiion 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





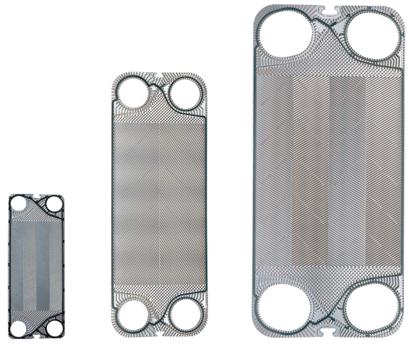


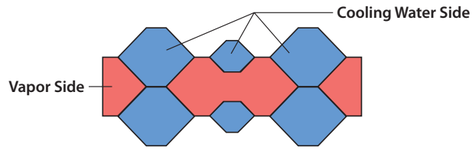
Plate Heat Exchanger for Condensation

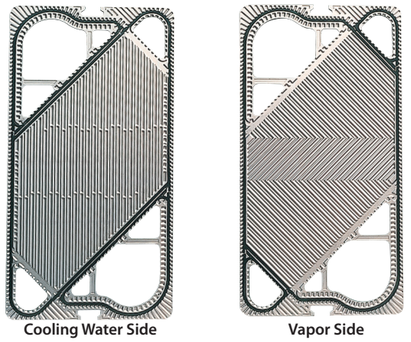
FEATURES

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 makes YX-series ideal for applications such as:

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

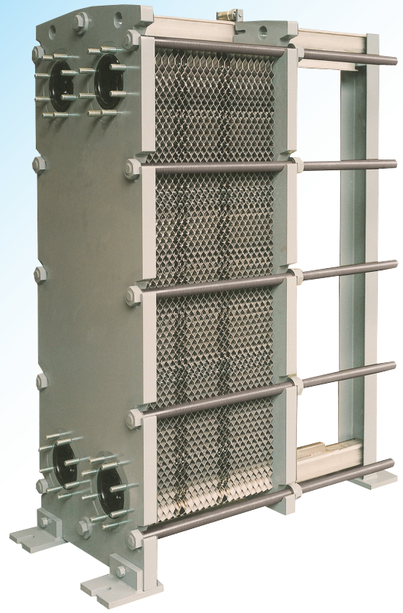
As seen from the figure, the plate pattern on the vapor side and the cooling water side have been devised to warrant higher heat conduction performance than those of shell and tube heat exchangers.





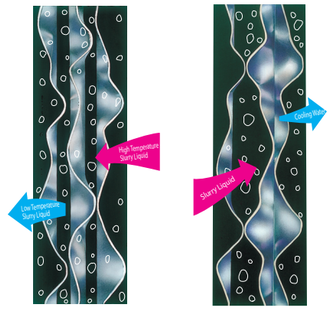
1. The coefficient of heat transfer on the vapor side is kept high whilst minimizing pressure loss. This is made possible even for cold condensation with the involvement of non-condensable and condensable vapor in vacuum.
2. The heat transfer coefficient can be increase by rising the degree of turbulence 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.
3. It is possible to create a complete counter current flow by configuring the vapor and the cooling water to flow in opposite direction.
4. 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.
5. Flexibility in altering heat duties by increasing or decreasing the number of plates.
6. Half the amount of cooling water needed as compared to conventional PHE.
7. Wide application range as TCG can be used on both vapor and coolant side.
8. Ease of maintenance.
9. Obtained manufacturing license under the Construction Code for Pressure Vessel.

Multi-Gap Plate Heat Exchanger



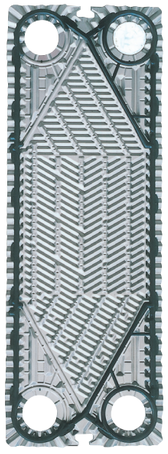
FEATURES

HISAKA GX-series has wide plate gaps of up to 20mm, made especially to allow flow of liquids containing fibers and solids (sludge) or even fluids that are prone to scaling. The gaps can be set flexibly in various combinations as accordance to industrial applications.



GX-21
Wide/Wide

GX-23
Super Wide/Normal



GX-20

1. **PHE with the largest gap, up to 20mm.**
   - Suitable for a wide range of industrial applications.
   - Cost effectiveness even when the fluids flow ratio varies greatly.
2. **Three different pairs of gaps.**
   - 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 plates.
3. **Special plate corrugation.**
   - 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.
4. **Corrosion – resistant properties.**
   - Ideal in corrosive environments as plates can be made on corrosion – resistant materials such as titanium.
5. **Slit-in gaskets are adopted.**
   - Making easy and convenient of maintenance and servicing.