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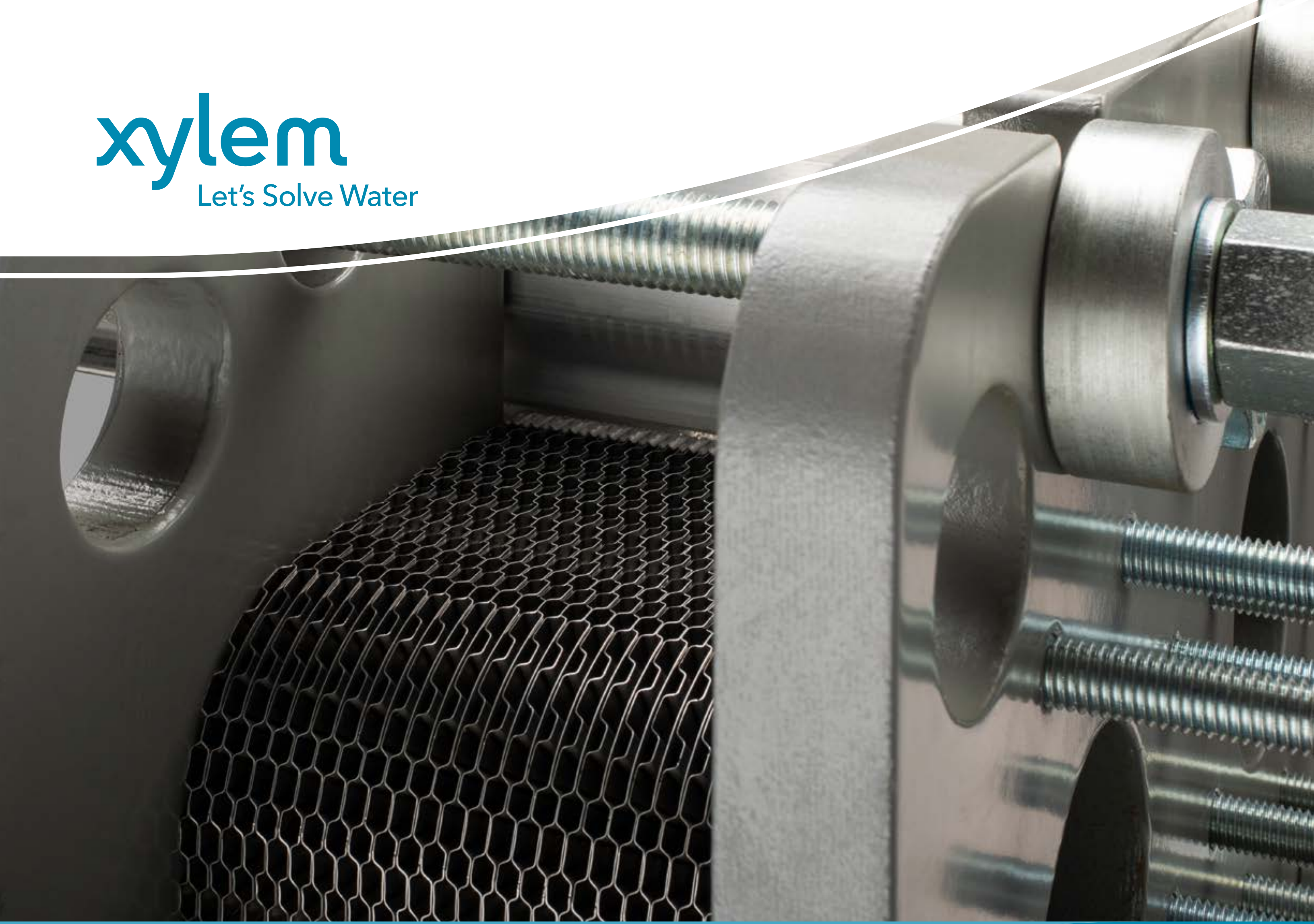

Specification Tips to Maximize Heat Transfer

PLATE AND FRAME EXCHANGERS

Standard Xchange
a xylem brand

Choosing the right plate and frame heat exchanger for your application

Heat exchangers are widely used in various industries including chemical, oil & gas, power generation, food & beverage, HVAC & refrigeration, pulp & paper to name a few, and are expecting strong growth over the coming years driven in part by a rising focus on environmental impact and improving efficiency standards.

Although used for varied applications, a heat exchanger's primary role is to transfer heat from one fluid or gas to another in order to control the temperature of a system and manage waste heat. Growing environmental concerns and regulations are motivating energy-intensive industries to look at ways to improve heat exchanger performance and maximize energy efficiency use.

Choosing the right heat exchanger to fit the needs of specific applications and systems is critical in achieving optimal efficiency.

Operating conditions, ease of access for inspection and maintenance, and compatibility with process fluids are just some of the variables to be considered when assessing heat exchanger options. Other factors include:

- Maximum design pressure and temperature
- Heating or cooling applications
- Maintenance requirements
- Material compatibility with process fluids
- Gasket compatibility with process fluids
- Cleanliness of the streams
- Temperature approach

A properly selected, installed, and maintained heat exchanger can help enhance the reliability and efficiency of a fluid system by optimizing energy consumption and reducing associated operating costs.

In this whitepaper we look at the specification tips to maximize heat transfer in plate and frame and air-cooled style heat exchangers in order to boost heat exchanger performance and increase efficiency.

Plate and frame exchangers

The plate and frame heat exchanger has emerged as a viable alternative to shell and tube exchangers for many applications. Such units are comprised of a series of plates, mounted in a frame and bolted together. Space between adjacent plates form flow channels, and the system is arranged so that hot and cold fluids enter and exit through ports at the four corners (Figures 4 and 5).

Figure 4. Plate and frame exchanger

When the plates of a plate and frame exchanger are assembled, the holes in the corners form a continuous channel. Alternating gasket patterns direct the hot and cold fluids into alternating passes. Heat transfer then takes place across the plates.

Within the exchanger, an alternating gasket arrangement diverts the hot and cold fluids from each inlet into an alternating sequence of flow channels. In this arrangement, each cell of heat transfer media is separated by a thin metal wall, allowing heat to transfer easily from one media to the other.

A corrugated chevron or herringbone pattern is pressed into each plate to give the exchanger strength and rigidity, to extend the effective surface area of plates and to increase turbulence in the flow channels, which combined, boost heat transfer.

The plate and frame's highly efficient countercurrent flow typically yields heat transfer coefficients three to five times greater than other types of exchangers. As a result, a more-compact design is possible.

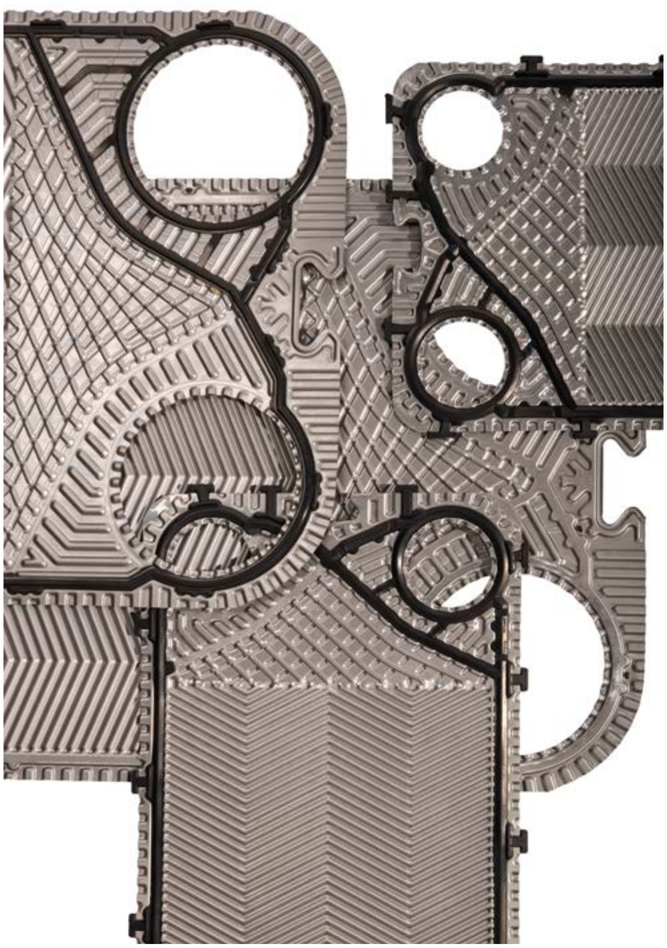

Figure 5. Plate and frame exchanger

Depending on the applications, plate selection is optimized to yield the fewest total number of channel plates. Because the plates can be easily removed, service and maintenance costs are typically lower than that of shell and tube exchangers.

Although the plate and frame heat exchanger can be used in a broad range of applications, the following selection criteria may be used as a guideline:

- Maximum design or working pressure is limited to 450 psi.
- Temperature limits and fluids must be compatible with gasket materials, typically limited to 300°F.
- Plate materials must be compatible with process media.
- The narrow passageways in the plate and frame can result in high pressure drops, making the exchanger incompatible with low-pressure, high volume gas applications.
- Rapid fluctuations in steam pressures and temperatures can be detrimental to gasket life. For this reason, applications that use steam favor shell and tube exchangers.
- In applications where process media contain particulate matter, careful consideration should be given to the free channel space between adjacent plates. Maximum weight percentage of 20% solids with particle size not exceeding 50% of the free channel space are typical limits.
- The plate and frame design is best suited for applications with a large temperature cross or small temperature approach. A temperature approach of 2°F is often achievable.

Early designs of plate and frame heat exchangers used glue to attach gaskets to plates. The glue was often applied unevenly, greatly increasing the chance of process fluid leaking through the gasket groove of the plate and either contaminating other fluids or escaping to the atmosphere. Additionally, the replacement of glued gaskets can be challenging.

Many plate and frame heat exchangers are now offered with a glueless gasket system. The plate construction uses clips and studs to secure gaskets to the plates. This method eliminates irregularities in the gasket groove and results in better sealing of the plate pack.

The glueless system also cuts service and maintenance costs, since the plates can be cleaned or regasketed without removing them from the frame.

Double-wall plate exchangers

Double-wall plate heat exchangers offer even greater protection against gasket failure. In traditional plate and frame exchangers, the process fluids are contained by gaskets and thin, metal plates. In double-wall exchangers, two plates are welded together at the port holes to form one assembly, with an air space between the plates. In the event that one of the two plates should develop a hole or perforation the fluid will leak into the space between the two plates and then to the atmosphere, instead of entering an adjacent fluid passageway and contaminating the other process stream.

Typical applications include:

- Domestic water heaters
- Hydraulic oil cooling
- Any service where cross contamination of process fluids cannot be tolerated

Welded plate exchangers

In this design, the field gasket that normally contains the process fluid is replaced by a welded joint, greatly minimizing the amount of fluid exposed to the gasket material and making this design suitable for hazardous or aggressive fluids.

The welded plates form a closed compartment or "cassette." Similar to gasketed designs, alternating flow channels are created to divert the flow of hot and cold fluids into adjacent channels. Aggressive fluids pass from one cassette to the next through an elastomer or Teflon ring gasket, while non-aggressive fluids are contained by standard elastomer gaskets. The use of welded joints can reduce total gasket area by 90% on the aggressive-fluid side.

Typical applications include exchangers handling:

- Vaporizing and condensing refrigerants
- Corrosive solvents
- Amine solutions

Wide-gap plate exchangers

Compared with traditional plate and frame exchangers, this design relies on a plate pattern with significantly larger free channel spacing, which provides improved resistance to clogging. The plates are designed with few, if any, contact points between adjacent plates to allow fibers or solids to pass. Some styles of this exchanger use wide-gap plates on the process side and conventional chevron patterns on the coolant side, to enhance heat transfer.

Typical applications include exchangers handling:

- White water in pulp and paper operations
- Slurries

Brazed plate exchangers

In this design the elastomer gaskets found in most plate and frame exchangers are replaced with a brazed joint, which greatly reduces the possibility of leakage. The corrugated heat transfer plates, which are typically available in stainless steel, are brazed together using either a copper or nickel brazing material.

The brazed plate exchangers are typically rated to 435 psi, but could be rated in excess of 2000 psi. Temperature ratings vary from 450°F for copper brazing to 750°F for nickel brazing. As with other plate and frame exchangers, high heat transfer rates translate to compact designs. Because of the rigid brazed alloy construction, temperature differential between the two fluids should be considered and is typically limited to 200°F.

Typical applications include:

- Units that vaporize and condense refrigerants
- Oil heating or cooling
- Applications requiring high alloys
- Heat-recovery applications
- Brine exchangers
- Applications involving liquid ammonia, chlorine solutions, alcohols or acids

Tube and continous fin air-cooled exchangers

In the tube and fin air-cooled exchanger, a motor and fan assembly forces ambient air over a series of tubes, to cool or condense the process fluids carried within. The tubes are typically assembled in a coiled configuration (Figure 6).

Air is readily available, but it is a relatively poor heat transfer medium. Use of air-cooled heat exchangers can greatly help eliminate the use of valuable cooling water supplies. To increase the heat transfer rates of the system, the tubes in air-cooled exchangers are typically given fins, which extend the surface area and increase heat transfer.

The diameter and materials specified for the tubes and fins depend on system requirements. The fins are commonly made from aluminum or copper but may be fabricated of stainless or carbon steel. Tubes are generally copper, but can be made from almost any material, and they typically range in size from 3/8- to 1-inch outer diameter.

Typical applications include:

- Oil cooling
- Compressed-air cooling
- Water or glycol cooling
- Heating and air conditioning
- Process heating and cooling
- Air-cooled process equipment
- Energy and solvent recovery
- Combustion air preheating
- Flue gas reheating

Figure 6. Tube and continuous fin air-cooled exchanger

In tube and fin air-cooled exchangers, a motor and fan assembly forces ambient air over a series of tubes, to cool or condense the process fluids carried within. Tapered fins are typically added to the tubes to extend the surface area and maximize heat transfer.

Aluminum bar and plate air-cooled exchangers

Similar to the tube and continuous fin design, this design also utilizes a motor and fan assembly, but instead of tubes, corrugated plates and fins are added to a brazed-composite core, to create alternating air and fluid passages. (Figure 7) This compact, lightweight design is considered the most cost-effective air cooled unit available. Turbulence created in the fluid channels boosts efficiency and reduces required size and surface area.

Typical applications include:

- Cooling lube oil for power equipment
- Cooling fluids for hydraulic equipment
- Cooling gear box fluids

There are a multitude of plate and frame and air-cooled heat exchanger options available; these guidelines should provide a basis for comparison to help you choose the correct design for your specific application.

No matter what configuration is ultimately implemented, the emphasis on clean, efficient heat recovery ensures that the heat exchanger will remain one of the most critical components in the manufacturing process.

Figure 7. Aluminum bar and plate air-cooled exchanger

About Standard Xchange

Standard Xchange has been developing heat transfer solutions for more than 100 years. Our top-notch technical expertise ensures our products run efficiently and perform well. It also means you're assured of technical guidance throughout the process of evaluating, selecting, and installing the right heat exchanger. Our experts can help you define your needs, determine specifications, and answer questions; and they can even provide precise technical drawings and mechanical details, if needed.

With our in-house, state-of-the-art lab, we can test equipment to your precise application before anything is shipped to you. In short, we'll work with you every step of the way to make sure you get the exact solution you need for your heat transfer problems.

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