The New Kid on the Block

by Matt Oswald and Michael Allen, GEA PHE Systems NA Inc.
September 1, 2008

Making the switch from shell-and-tube heat exchangers to plate-and-frame units can have many benefits.

The list of tools required for typical maintenance work is a short one: a wrench, tape measure, and a set of gloves to protect your hands while handling the plates.

Making the switch from traditional shell-and-tube heat exchangers to plate heat exchangers can sometimes be a hard decision. Even with dozens of years' evidence of proven reliability, many companies are still reluctant to transition away from a technology that has worked well for decades. Here are 10 tips that can help you become more familiar with this technology and its potential for your application.

1. It's Older Than You Think

While plate heat exchangers may seem like a relatively new technology to some, they actually have been in use for more than 70 years. The first plate heat exchangers were developed for use in the food industry, where their ability to be opened and fully cleaned has been essential to maintaining sanitary conditions. Companies in the process industries as well as power and marine applications are beginning to transition to plate heat exchangers after discovering their three key features: versatile design, ease of maintenance and small footprint.

2. Incorporate Its Flexibility

One of the advantages of the design of the plate-and-frame heat exchanger is its versatility. With proper planning during the design stage, a plate heat exchanger can be adapted to handle changes in heat capacity, flow rate or pressure drop in the event of a change to the process. This is accomplished either by varying the number of plates or installing plates with a different corrugation pattern. Typically, these changes can be made with minimal downtime, without requiring re-piping and at a lower cost than a new heat exchanger.

3. Get the Gaskets You Need

Due to the range of gasket and plate materials available, plate heat exchangers also demonstrate versatility regarding the type of fluids they can handle safely. Gasket materials typically range from the standard NBR (Nitrile) and EPDM to specialty rubbers such as Viton, Hypalon, Teflon and Neoprene. Many plate materials also are available, typically ranging from standard stainless steel grades 304 and 316 to specialty alloys and materials such as 254-SMO, C-276, titanium and titanium-palladium.

4. Master Simple Maintenance

This newly assembled plate-and-frame heat exchanger can be unbolted, knocked down into individual pieces and reassembled on site.

For those unfamiliar with plate-type heat exchangers, maintenance can seem a daunting task. However, once familiarized, most find general plate exchanger maintenance a simple task. The list of tools required for typical maintenance work is a short one: a wrench, tape measure, and a set of gloves to protect your hands while handling the plates. Often, the plates can be cleaned with a pressure washer and a soft brush; however, if fouling is particularly hard to remove, chemical cleaners can be used.

If needed, gaskets can be replaced. Over the past few years, the most manufacturers of gasketed-type plate heat exchangers have stopped gluing the gaskets into place; instead, they use mechanical fixing via lock-in clips or tabs on the gaskets. Because it is no longer necessary to remove old glue residue and reapply fresh glue, replacing gaskets is greatly simplified.

5. Consider Lifecycle Costs

Plate heat exchangers are relatively small when compared to shell-and-tube heat exchangers. Plate heat exchangers have higher heat transfer efficiency and therefore require a smaller footprint than a comparable shell-and-tube unit. This simplifies installations in both new and existing facilities.

In large projects such as power plants, the buildings are often built around the shell-and-tube units. When the existing unit eventually must be replaced, it may be necessary to cut it up and remove it in pieces. If the exchanger is large enough, it can be necessary to remove or cut holes into walls or ceilings. For these reasons as well as others, replacing a large shell-and-tube heat exchanger can be a costly, laborious task.

6. Add or Remove Plates

A plate-and-frame heat exchanger can be unbolted, knocked down into individual pieces and reassembled on site. This simplifies replacement and reduces labor costs. This difference is especially important for installations in cramped areas such as mechanical rooms where space is at a premium and where it often is unrealistic to bring in a complete unit fully assembled. In newly built facilities, using plate-and-frame exchangers

allows a smaller footprint, thereby freeing up space for other equipment or other uses.

7. Fathom Fouling Factor

One of the most commonly misunderstood areas when sizing a plate heat exchanger as a replacement for a shell-and-tube unit pertains to the terms “fouling factor” and “surface margin.”

While mathematically both terms apply to the overall heat transfer coefficient, the term “fouling factor” commonly is used only in tubular-type heat exchangers. Because of the comparatively low internal velocities for shell-and-tube heat exchangers, they tend to be more prone to fouling than plate heat exchangers. The solution for fouled or damaged tubes often is to use mechanical bungs or weld them to seal off the individual holes in the tubesheet. Over the life of the exchanger, more and more holes can be sealed off until the exchanger’s performance degrades to an unacceptable level. Some designs incorporate a large number of extra tubes in an effort to extend the life of the heat exchanger.

8. Value Fluid Velocity

Just as a fast-moving river deposits less sediment than a slow-moving one, a heat exchanger with higher internal velocities will have less fouling than one with lower internal velocities. Plate heat exchangers that are sized properly will have much higher flow velocities in the heat transfer area than a shell-and tube-heat exchanger; consequently, they will have a lower fouling rate when compared to shell-and-tube heat exchangers. This principle is called the “self-cleaning effect.”

This plate heat exchanger will be used for process cooling in a power plant. Plate-and-frame heat exchangers will perform well while requiring less floor space and maintenance in many process applications.

Specifying fouling factors on a plate heat exchanger will cause it to be oversized significantly and may reduce the internal velocities to a point where there is no longer any self-cleaning effect. This needlessly reduces the performance and increases the price of a plate heat exchanger. For example, a TEMA-specified fouling factor of 0.001 for shell-and-tube heat exchanger would result in a plate-and-frame unit that is approximately 75 percent oversized. This causes very low fluid velocities between the individual plates and can result in a greater fouling tendency. Because the individual plates can be replaced or cleaned as needed, the excess surface area is unnecessary and contributes to a more expensive unit that will need to be serviced more frequently than if it had been sized properly.

9. Factor in Safety

So, if specifying a fouling factor for a plate-and-frame exchanger results in an oversized unit, how can you ensure a proper safety factor? The

answer for plate-and-frame units is “surface margin.” Simply put, surface margin is the excess area present in a plate heat exchanger. It is given as a percentage of the area required to exchange a certain amount of heat. For example, if an application requires 100 ft^2 of surface area, a surface margin of 10 percent would reflect an actual heat transfer area of 110 ft^2. Typical surface margins vary based on the industry and the type of fluid used, but in every case, specifying a reasonable surface margin value helps to prevent fouling and will ensure a functional and “right-sized” plate heat exchanger.

10. For Success, Study Your Site

While there are heating and cooling applications -- those marked by high temperatures or high pressure, for example -- for which shell-and-tube heat exchangers will always be required, there are many applications for which plate-and-frame heat exchangers will perform well while requiring less floor space and maintenance. Just as you would spend time evaluating your options when purchasing a new car, so you should evaluate your options when choosing a new heat exchanger. The space and cost savings involved as well as their overall reliability and ease of maintenance can make plate-and-frame heat exchangers an attractive option. The range of sizes, materials and configurations available can suit almost any purpose or application. The only limitation is your willingness to consider them as another option to the traditional shell and tube.

Matt Oswald and Michael Allen, GEA PHE Systems NA Inc.
Matt Oswald is an application engineer specializing in the power industry, and Michael Allen is an application manager specializing in the HVAC industry, both with GEA PHE Systems North America, York, Pa., a manufacturer of gasketed, brazed and welded plate heat exchangers and other heat transfer equipment. For more information from GEA PHE, call (717) 268-6200 or visit www.geaphena.com.