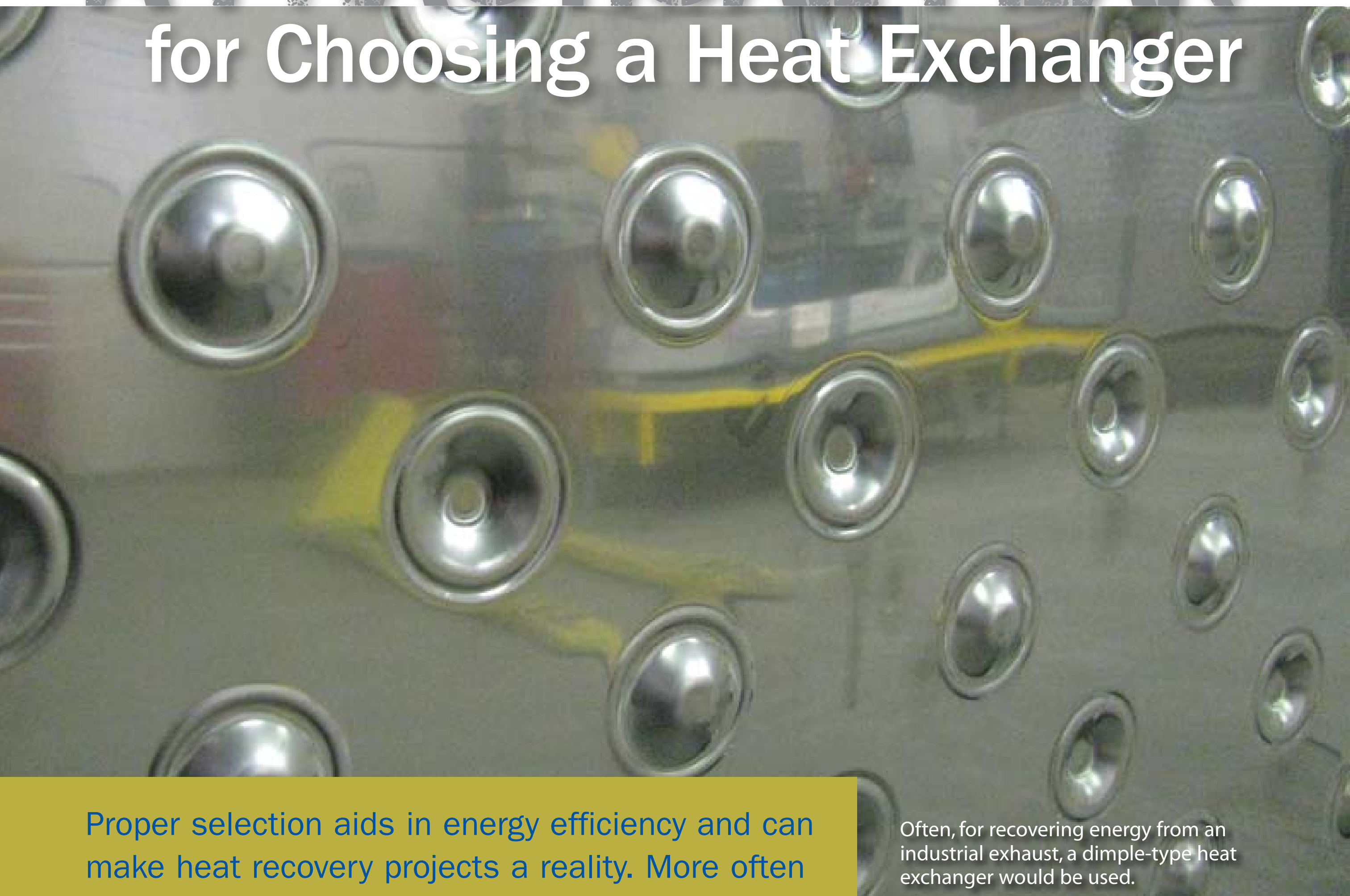
A PRACTICAL PLAN for Choosing a Heat Exchanger



Often, for recovering energy from an industrial exhaust, a dimple-type heat exchanger would be used.

Proper selection aids in energy efficiency and can make heat recovery projects a reality. More often than not, the exchanger user and the heat exchanger supplier need to partner to reach the most optimum solution for each process application.

By Paul Wild, Exothermics Inc.

Energy efficiency is becoming more important in the process industries due to the pressures of worldwide competition and the economic environment in which companies operate. There is growing recognition of a need for profitability measurements — not only for the company as a whole but also for particular products, customers, branches and so forth. Reducing energy costs is still one of the best methods for improving profitability.

Depending on which source consulted, some would say that the cost of certain fuels, over a longer period, is relatively flat. Forecasts of increasing fuel costs, however, are more credible. And while the fluctuations in fuel costs are an economic concern, other challenges — efficiency improvements, reducing carbon emissions — must be met. Fortunately, financial support is becoming more available. Governments and related agencies have released a number of grants and tax credit systems to support companies in their quest for efficiency while protecting the environment.

Today, production and plant managers worldwide are realizing that heat recovery — through the use of industrial-grade heat exchangers — is a cost-effective investment that can address the challenges of many industrial manufacturing companies. But when selecting a heat exchanger, many companies often do not get the optimum solution. In fact, good heat recovery opportunities often lose financial backing because the optimum solution is not found.

To start your search for the optimal solution for your process needs, talk to the heat exchanger manufacturer or manufacturer's representative about your application — where and how the exchanger will be used. Prudent purchasers take interest in each step to find the optimum solution. They realize that, once installed, the heat exchanger will be recovering energy for 15 to 20 years, so time spent reviewing the design procedure is time well spent. Remember not to sacrifice quality or engineering design by letting cost be your only consideration.

To arrive at the optimum heat exchanger solution, take your exchanger search in stages. Consider:

- The problem specifications.
- Surface characteristics.
- Physical properties.
- Design theory procedure.
- Optimal solutions.
- Evaluation criteria.
- Evaluation procedure.

These steps may seem familiar, as they are known as the "methodology of heat exchanger design" in many reference books. Take that collected knowledge and put it to work for your process application. Let's look at each of the first three steps with a practical approach. And remember, your heat exchanger manufacturer can provide guidance along the way if you need help.

Problem Specifications

This step is all about the application and targets. It is important to generate the best and most accurate specification of what you want the heat exchanger to do. Always keep your targets in mind. Why are you looking for a heat exchanger? You may wish to write a simple supporting statement to focus your reasoning. Include the goals that you feel are most important. You could include an illustrative view of your data (figure 1).

Start with the targets and limits of the application and then describe the flow conditions into the heat exchanger. Take time to gain accurate data. Remember that your heat exchanger solution relies entirely on the accuracy of the design data provided for inlet conditions of hot and cold sides. The data will be applied to a model that can accurately predict heat transfer performance. However, if the input data are wrong, then the performance predictions will be wrong. A reputable heat exchanger manufacturer will provide additional support to find and validate the data if required.

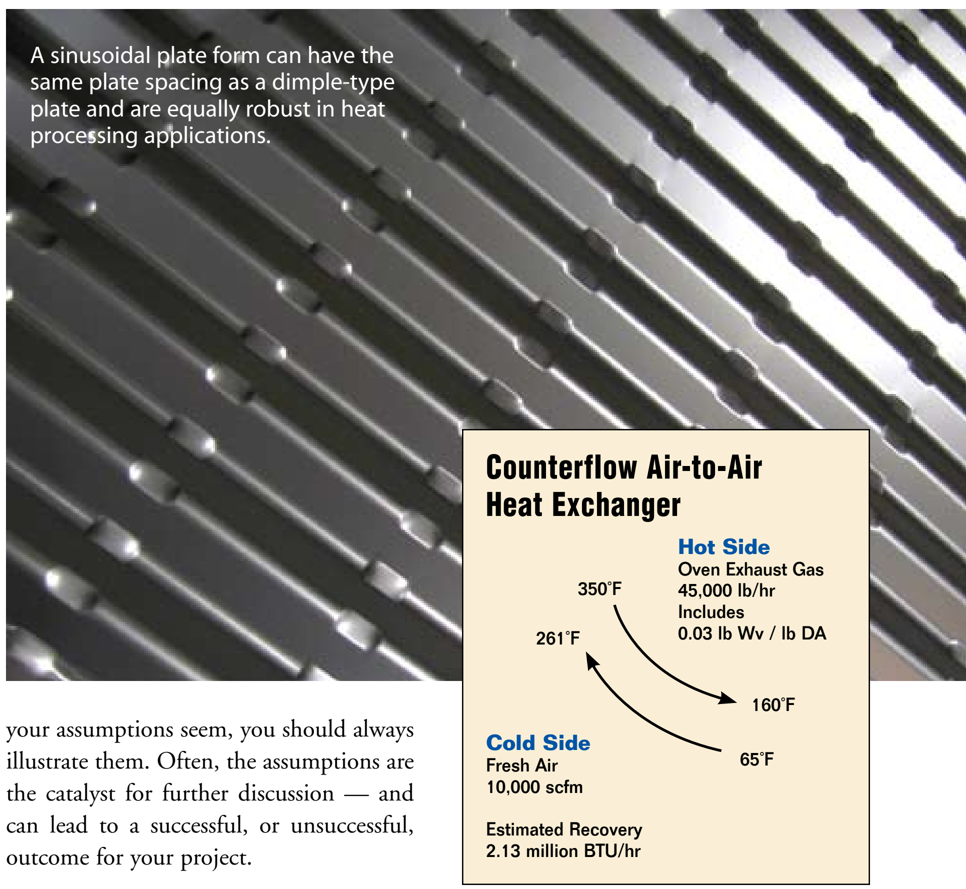
There are a number of ways to quantify the data requirements of fluid flow description, temperature, static pressure and pressure drop. If the fluid is a gas, for instance, you should be sure to consider volume while keeping in mind the influences of temperature, pressure and vapor. If the fluid is an exhaust from an oven or a dryer, what is the gas composition? You can make assumptions at any point, but be sure to tell the heat exchanger manufacturer what and where those assumptions are. Separate and specify the factual data first, then add any assumptions made about the process. However small and insignificant your assumptions seem, you should always illustrate them. Often, the assumptions are the catalyst for further discussion — and can lead to a successful, or unsuccessful, outcome for your project.

Surface Characteristics

The heat exchanger surface normally is designed to make the cold and hot flows turbulent. This will increase fluid friction through the exchanger. Increasing turbulence will improve the performance of the heat exchanger surface, but remember, it will affect the cost of the power expended to overcome the pressure drop. The reputable heat exchanger manufacturer needs to balance heat exchanger effectiveness with the ultimate cost of pressure drop.

Often, for recovering energy from an industrial exhaust, a dimple-type heat exchanger would be used. A typical design, for example, has 0.5" plate spacing and can be used for air-to-air or gas-to-air applications where the flows may include some particulate. In the same application though, you could consider using a sinusoidal plate form, which can have the same plate spacing and are equally robust.

In general, sinusoidal air-to-air heat exchangers are more effective at transferring energy than dimple exchanger designs.



A sinusoidal plate form can have the same plate spacing as a dimple-type plate and are equally robust in heat processing applications.

With a diagram of your proposed heat exchanger application, you can easily see what the duty is, and you can highlight important aspects or targets. You also could highlight pressure drops and static pressures as required.

Other heat exchangers that can be used for heat recovery include a fully welded crossflow plate-type and a fully welded two-shell-pass tubular primary fume preheater.

A counterflow air-to-air heat exchanger with a sinusoidal plate form (figure 2) is smaller than a dimple air-to-air heat exchanger on a "like for like" basis. The sinusoidal plate form may be applied to exhaust flows that include particulate.

Fouling potential can influence the design of surface characteristics, but mostly this aspect should be considered as part of the next stage: physical properties.

Physical Properties

The heat exchanger manufacturer will consider the physical properties of the materials and methods of construction. The design should allow for a balance of strength and yet not be too rigid, and it should be resistant to corrosion and even erosion for some applications. For instance, a heat exchanger made of plastic will not last long when applied to a thermal oxidizer as a primary fume preheater.

Your application limits of pressure and temperature and the cycles of operation should combine harmoniously with the capability limits of the heat exchanger proposed. Any gray areas should be identified and should be grouped as compromises and highlighted in the design theory procedure. You and the manufacturer need to avoid conditions that could hurt the exchanger. Try to balance the benefits of material, size, configuration or other exchanger characteristics against the application to find the best overall fit of factors. If you have enough experience with the process to know what can and cannot be used, look for examples of potential risks and be open with your experience. The heat exchanger manufacturer will listen to your recommendations. If your recommendations can be countered with a lower cost solution that will not compromise longevity, there may be an optional solution to consider.

From here, the ride should be smoother and, by now, you and the manufacturer should be heading in the same direction. If the first three steps are considered appropriately, you will be taken on a guided tour of the "design theory procedure."

Here, the heat exchanger manufacturer takes control. You will see all of the first three stages come together when the manufacturer ultimately presents a number of optimal solutions for you to consider. These solutions, or selections, may differ in any combination of thermal performance, pressure drop or material cost, but they should all concur with steps one, two and three. You may be presented with only one heat exchanger solution or perhaps several. At this point, you will be presented with some middle ground selections, and you will be asked to consider the alternatives equally and methodically by entering into the "evaluation procedure."

Together with the heat exchanger manufacturer, you should pool your reasons for choosing one solution or selection, over another. These reasons should be clearly identified as your "evaluation criteria," and remaining pure to these reasons is key to gaining the best solution. You may not be fully satisfied the first time around. You may even wish to go through the whole procedure again, or you may just choose to return to stage three. But following this methodology will help you get to the optimum solution. PH

A fully welded counterflow sinusoidal plate-type heat exchanger will be smaller than a dimple air-to-air heat exchanger on a "like for like" basis.

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