5 Effective Heat Recovery Scenarios

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ARTICLE TOOLS

Plate heat exchangers designed for heat recovery can be configured specifically to meet the duty. Consider some real-life examples and how your process might achieve similar results.

Plate heat exchangers have been used for heating process streams with steam or hot water and for cooling product streams with tower, city or seawater. The plate heat exchanger provides an excellent means of achieving high efficiency in heat recovery. Full countercurrent flow and the ability to produce high heat transfer coefficients enable the plate heat exchanger to produce a close end-temperature difference. Some plate heat exchangers can achieve 97 percent heat recovery, even at temperatures approaching as low at 2°F (1.1°C). This is highly important in plants with sources of low-grade or poor quality heat.

There is nothing new about heat recovery. In the past, many processors regarded it as not worth the capital expenditure. With today's high energy costs however, it is not merely considered a desirable: It is a necessity.

In many applications, an immediate savings can be accomplished with an existing system by adding a plate heat exchanger. Other processes can be made more economical by replacing a shell-and-tube with a plate heat exchanger. In all new process systems, provision for heat recovery should be considered from the start. The result is a system optimized for maximum economy savings.

Single-wall gasketed plate heat exchangers designed for heat recovery are configured specifically to meet the duty, taking into account the specific product characteristics. Hot and cold fluids are directed between thin metal plates that are corrugated to induce turbulence. The hot fluid transfers the heat to the cold stream, which is heated to a point where it requires little additional energy expenditure after the heat exchanger to reach the desired final temperature. In many applications, the fluids are of the same product. Examples are raw and pasteurized milk, wet and dry crude oil, lean and rich amine. In other cases, one stream is product and the secondary stream is process water being preheated for use elsewhere in the plant, or cooled to be sent down the drain. Heat recovery is also possible with two different products or with uneven flows. Capturing the heat before it is lost is the key to major energy savings.

Heat recovery can be accomplished with various types of exchangers. Experience has shown that plate heat exchangers can handle the requirements efficiently while providing compact size, minimal weight, design versatility and operational durability. When the application is within the pressure and temperature limits of the plate heat exchanger design, it often is the best choice.

Many single-wall gasketed plate heat exchangers are available in a range of models and port diameters. Although the most common plate materials are 304 stainless steel, 316 stainless steel, titanium and Hastelloy exotic materials can be used to meet application requirements. Common gasket materials are nitrile butadiene rubber (NBR) and ethylene propylene diene monomer (EPDM) rubber although other specialty materials can be used. Welded plate pairs, a welded channel path with limited exposure to gasket material, can be ordered for fluid streams that have gasket compatibility problems.

Here are five examples of how a plate heat exchanger can provide benefits for process heating applications.

1. Power House Recovery Payback

In a comparable operation in the Northeast, a leading chemical producer installed two units to handle power house heat recovery duties. Running 300 gal/min of 224°F (106°C) condensate against 400 gal/min of process water, slightly more than 5.5 million BTUs of heat are recovered per hour as the process water temperature is increased to 209°F (98°C).

It was estimated that the payback for this plate heat exchanger installation was achieved in 483 hours. By passing the 187°F (86°C) condensate to a second plate heat exchanger against 700 gal/min of 65°F (18°C) feedwater, an additional 16.3 million BTUs per hour of heat were recovered as the feedwater was heated to nearly 112°F (44°C), resulting in payback in only 162 hours.

2. Whiskey Processing

At an East Coast import whiskey plant, the spirit is first chilled to precipitate insolubles, then filtered and warmed to avoid bottling difficulties. It is processed at 2,500 gal/hr, seven hours a day, in a three-section single-wall gasketed plate heat exchanger, which replaced batch processing in five large tanks. By using 80 percent heat recovery, chilling time was cut by more than 75 percent, reducing required refrigeration loads by 84 ton/hr and boosted production by 70 percent.

As the 90°F (32°C) product enters the regeneration section of the heat exchanger, it exchanges heat with the outgoing cold stream. The 90°F (32°C) product is cooled to 42°F (5°C). After chilling to 30°F (-1°C) in the second section of the plate heat exchanger, it leaves the plate heat exchanger for filtration. Following filtration, it is passed back through the plate heat exchanger for recuperative heating and final trimming, using hot water in section three, to room temperature for bottling. This is achieved in a plate heat exchanger with little more than 10 ft^2 of floor space. Only minimal maintenance is necessary: the heat exchanger is opened and cleaned once a year. The increase in productivity of approximately 7,000 gal per day is accomplished without an additional increase in manpower.

3. Can Cooling

A single plate heat exchanger in a food plant is creating substantial savings through the use of incoming cold process water to reduce the temperature of used can cooling water. Spent can water at 2,350 gal/min is cooled from 95 to 83°F (35 to 28°C) using 600 gal/min of cold process water at 60°F (15°C). The cold process water leaves the plate heat exchanger at 85°F (29°C), ready to use without requiring any further heating.

Heat savings by recuperation is 9 million BTU/hr and the plant is in use 17 hours a day, five days a week and 48 weeks a year. Other benefits include a reduced BTU requirement for the cooling fan and lower evaporative water losses. The system paid for itself in three months.

4. Geothermal System Recovery

In the upper Midwest, a single-wall gasketed plate heat exchanger was installed in a geothermal heating system for municipal buildings. Because geothermal well water often is corrosive (and was in this installation), its heat was transferred via the plate heat exchanger to the closed-circuit system for space heating. The geothermal water pipes are cast iron, so the corrosion problem is confined to the heat exchanger. There, it is eliminated by the use of 316 stainless steel plates.

Geothermal water is boosted to a pressure of 60 psig and enters the heat exchanger at 165°F (73°C). At its maximum flow of 500 gal/min, it heats 320 gal/min of closed-circuit water from 100 to 130°F (37 to 54°C). The outlet temperature of the closed-circuit water is maintained by a pneumatic valve in the geothermal loop, which regulates the amount of incoming hot water. The plate heat exchanger's response is almost instantaneous, and temperatures can be controlled to an accuracy of 2°F (1.1°C). Under normal conditions, geothermal energy provides all the heat required for space heating: 8 million BTUs per hour. If necessary, a boiler also can be employed in extreme conditions.

5. Conserving Water as an Energy-Saving Tactic

Although known as the ideal means for heating and cooling process streams, the plate heat exchanger works equally well as a water conservation tool. The close temperature approach characteristic of the plate heat exchanger permits the use of the cooling tower water for longer periods of the year.

Modern engineering capabilities along with the plate heat exchanger performance typify the reduced water consumption enjoyed by a chemical acid producer. In the past, the cost of process water was considered a minor part of the operation. Constantly increasing charges for city water and sewer services have altered that perspective.

The process required 340 gal/min of 70°F (21°C) water used to reduce the temperature of 625 gal/min of product from 190 to 180°F (87 to 82°C). The company purchased close to a million gallons of water weekly, a significant expenditure. Engineers calculated that a small plate heat exchanger could replace the tubular unit being used.

The solution was to remove about 3 million BTU/hr from 20 percent of the product flow, cooling this amount to 138°F (58°C), instead of cooling the entire 625 gal/min to 180°F (82°C). After the plate heat exchanger, the 138°F (58°C) slip-stream was mixed with the remaining hot product to arrive at the desired overall temperature of 180°F (82°C). Under this design, the cooling water requirement was reduced to 149 gal/min. This resulted in a 56 percent reduction in cooling water consumption. Payback of the exchanger was calculated in just a few hours of operation.

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