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RESEARCH CONCERNING DESIGN OF HIGH EFFICIENCY BRAZED PLATE HEAT EXCHANGERS

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ABSTRACT
Brazed plate heat exchangers are carving a big chunk out of the heat transfer industry with their compact size and high efficiency design. Brazed plate units are up to six times smaller than alternative methods of heat exchange with the same capacity. This is because of their unique construction: more then hundred corrugated stainless steel plates are brazed together with every second plate turned 180 degrees. This design creates two highly turbulent fluid channels that flow in opposite directions over a massive surface area. The result of this construction is a significantly higher heat transfer coefficient with less required surface area and outstanding performance characteristics.
Keywords: brazed plates, heat, exchanger

1. INTRODUCTION
Brazed plate heat exchangers are assembled from a very small number of machine formed parts, resulting in significantly less manufacturing time and reduced costs to the end user. Machine formed parts also mean product quality and performance parameters are easily met. And every brazed plate heat exchanger must pass careful checks on quality, as well as compliance with specifications and dimension tolerances.

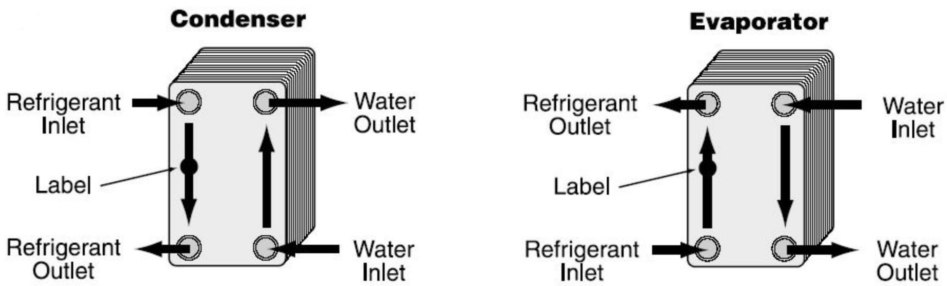


Figure 1. Condenser and evaporator

Brazed-plate heat exchangers consist of up to 200 pattern-embossed plates of acid-resistant stainless steel (see Figure 1). Every other plate is reversed so the ridges of the herringbone pattern intersect one another on adjacent plates forming a lattice of contact points.

When these points are vacuum brazed together, a compact and pressure-resistant heat exchanger is formed in which virtually all material is utilized for heat transfer. After brazing, the impressions in the plates form two separate systems of channels where the two media flow in true countercurrent. This complex channel system causes vigorous turbulence, ensuring maximum heat transfer.

The result is a highly efficient heat exchanger with heat transfer coefficients having no counterpart. The largest unit can handle a maximum flow capacity of 600 gpm. The standard unit is designed for UL and CUL to meet 435 psig at 365°F. CSA ratings are 450 psig at 383°F.

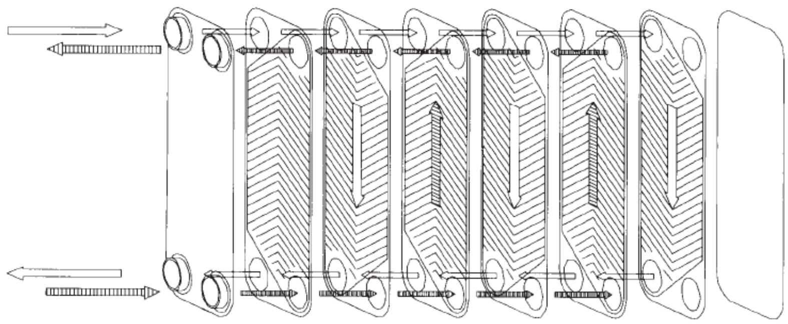


Figure 2. Working principle

2. BRAZED PLATE HEAT EXCHANGERS APPLICATIONS

The field of applications for brazed plate heat exchangers is very large. Examples of applications where a brazed-plate heat exchanger can be used:

- Heat pumps
- Industrial chillers: plastic machines, welding machines, hydraulic presses (oil), compressor-oil cooling
- Air conditioning
- Refrigeration
- Water coolers; drinking water or process water for various industries
- Temperature holding for storage tanks (for example, milk tanks)
- Heat recovery from waste water or other processes
- Climatization (computer room and other similar applications)

Brazed-plate heat exchangers can also be used for various media:

- All types of refrigerants except ammonia
- Organic solvents
- Water
- Various brine solutions (glycol mixtures, $CaCl_2$, alcohols, and others)
- Oil and other similar fluids

In heat pumps, air conditioning, and chiller applications, a brazed plate heat exchanger can be used for several tasks—primarily as an evaporator and condenser, but also as an economizer, subcooler, oil cooler, or desuperheater. The flow sheet in Figure 2 is a combination of different system variants.

In refrigerant applications brazed-plate heat exchangers function as: condensers; evaporators; superheaters for gas; desuperheaters for gas; subcoolers for condensate; economizers; intercoolers; heat recovery with or without partial condensation; oil coolers (Figure 3).

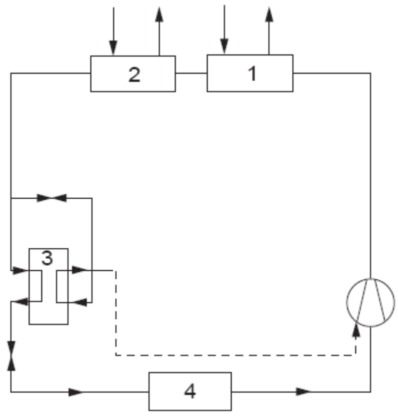
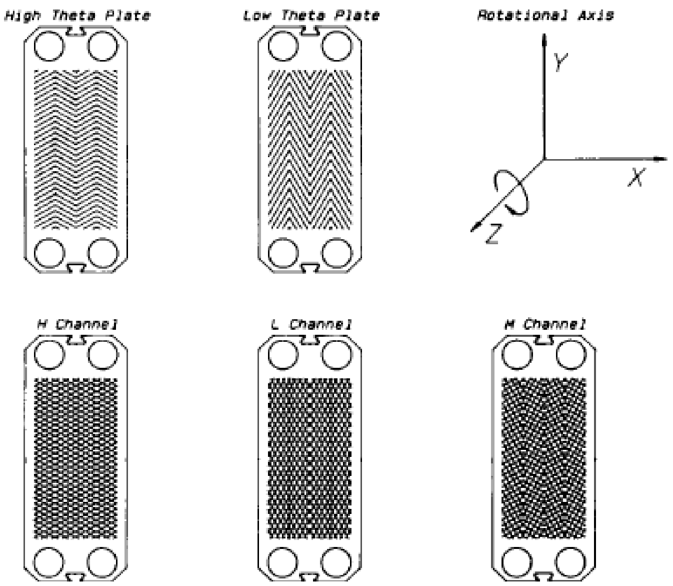


Figure 3. Possible application of brazed plate heat exchangers in refrigerant systems
1 – Condenser, 2 – Subcooler, 3 – Economizer, 4 – Evaporator

3. BRAZED PLATE HEAT EXCHANGER DESIGN

Today's conventional heat transfer plate designs are classified as chevron or herringbone type, with the corrugations forming a series of patterns. Each plate size is pressed with two different chevron angles, Figure 4, the low theta plate and high theta plate, and has acute and obtuse apex angles, respectively.



a. b. c.

Figure 4. Heat transfer plates and channel combinations.

The gasket groove on these conventional-style plates is recessed 100%, so that there is always a front and back to each plate. By having the gasket groove recessed 100%, the plates can only be rotated about the Z axis. The channels are formed by alternately rotating adjacent plates 180° about their Z axis so that the arrow heads of the chevron angles point in the opposite direction.

When two plates are adjacent to each other, the thermal and pressure drop characteristics of that channel depend strongly on the angle at which corrugations cross each other. With two different patterns, low and high theta, three distinctly different channels can be formed, each having their own hydrodynamic characteristics.

• H Channel. Two plates with obtuse angles and high theta are placed together forming a high-theta channel, characterized by high pressure drop and high temperature changes across the plate, Figure 4. a.

• L Channel. Two plates with acute angles and low theta are placed together forming a low-theta channel, characterized by low pressure drop and modest temperature changes across the plate, Figure 4. b.

• M Channel. Combining one high-theta plate and one low-theta plate to form a medium-theta channel, having characteristics that fall somewhere between those of an H and L channel, Figure 4. c.

Within a conventional plate pack, there can also be a mixing of high-and low-theta channels for pressure drop optimization. Despite the ability to mix channels, conventional plate heat exchangers have the major shortcoming that both fluids are subject to identical channel geometries since the channels are symmetrical. This symmetrical geometry is very effective when both fluids have the same thermal length requirement and pressure drop, but this is rarely the case today. Typical applications in today's marketplace involve unequal flow rates with varying thermal length requirements for the hot and cold fluids. When the duties are such, both fluids can never be totally optimized with symmetrical channels, and the exchanger will not be the most economical possible.

While the conventional heat transfer plate has a homogeneous corrugation pattern, the asymmetrical plate has heat transfer section divided into four quadrants, with two different angles. The asymmetrical plate utilizes a patented invention that permits the gasket groove to be positioned in the neutral plane of the plate, recessed 50%. With the gasket groove in the neutral plane, now the distance between adjacent plates' gasket surface and the gasket groove will always be the same regardless of the rotation of the plate. Conventional plates, with gasket groove 100% recessed, can only rotate about one axis, the *Z* axis.

4. CONCLUSIONS

The brazed plate heat exchangers, no compromises are made on strength, as the brazing process welds the plates together at thousands of contact points in each unit. The benefits are easily recognized, exceptional durability along with higher operating pressures and temperatures.

Most brazed-plate exchangers are very compact in size and are light-weight. A brazed plate heat exchanger is about 20-30% of the weight of a shell and tube heat exchanger for the same duty.

The major limitation is the size of the plates that can be successfully and reliably brazed. Currently, 350 gpm is about the maximum flow attainable. In addition, the brazed plate is a sealed unit and not serviceable in the event of fouling or failure.

5. REFERENCES

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