

REPRINTED FROM

HYDROCARBON ENGINEERING

Volume 11 Number 9 - September 2006



Expanding the envelope

Johan Gunnarsson,
Alfa Laval

Expanding the envelope

Johan Gunnarsson,
Alfa Laval, Sweden,
surveys the alternative to
traditional heat exchanger
technology for
petrochemical plants.

Conventional wisdom has always asserted that the kinds of high temperatures and pressures common in petrochemical processing operations make it difficult to consider installing gasketed plate heat exchangers to recover heat energy.

Such high temperatures and pressures normally make it difficult to use gaskets of any kind. At the same time, many of the processes involved in petrochemical plants involve substances that are aggressive or hazardous, or both. This limits the configurations and materials that can be used.

Nevertheless, despite heat recovery being a challenge, the constant upward movement of energy costs means that it remains a key issue throughout the petrochemical industry, where energy consumption is frequently high. The recovery and reuse of costly heat energy, whether purchased or generated during processing operations, makes an increasingly big difference to bottom line results.

The tide turns on tradition

Over the years, plate heat exchangers featuring high heat transfer efficiency have steadily encroached on traditional shell and tube technology in the majority of industrial applications.

However, the high temperatures and pressures frequently encountered in petrochemical processing have long meant that the traditional approach remained the only



Figure 1. Compabloc reboiler working at the cumene distillation column at UNIPAR in Brazil.

generally accepted solution for the most demanding heat transfer operations.

Alfa Laval is one of the world's leading movers and shakers in the field of heat exchanger technology. Over the years, it has allocated substantial R&D resources to developing completely new ways of tackling this key petrochemical industry requirement.

The results of these efforts have included both exceptionally compact all welded plate heat exchangers, capable of installation to deal with capacity bottlenecks virtually anywhere in petrochemical plants, and a revolutionary heat exchanger design with the plates fusion bonded together, thus completely doing away with gaskets and paving the way for use in the petrochemical industry, where aggressive media and high temperatures are common.

The compact alternative

Many petrochemical plants are interested in increasing their production capacity and eliminating bottlenecks in the overall production flow, as well as cutting down on costly energy consumption at the same time.

Compact plate heat exchangers are an important way of dealing with this challenge; they provide substantial additional heat recovery capacity, yet only take up a minimum of space, making them relatively easy to install in existing plant configurations.

Compact plate heat exchanger designs currently provide the most advanced form of heat transfer

available. The technology is based on liquids or gases flowing through channels formed by placing corrugated plates side by side. This creates a high degree of turbulence in the media flowing through the channels, which in turn results in exceptional heat transfer coefficients. This, in turn, means that it takes a significantly smaller heat transfer area to deal with the heat load, and compact plate heat exchangers therefore take up much less space than bulky, traditional shell and tube units. Compact plate heat exchangers have thus proved to be ideal for a wide range of different duties in the petrochemical industry, with cooling, heating, condensation and evaporation prominent among them.

Alfa Laval is a leading supplier of compact plate heat exchangers. Not only does this equipment keep space requirements to a minimum, it also increases capacity and reduces capital investment and operating costs.

Compabloc is one of these heat exchangers; compact, highly efficient, all welded units designed for use in processes with high temperatures or where one or both media are aggressive or hazardous.

The fully welded plate pack significantly extends the envelope for the traditional design limits for this type of duty, and also provides improved reliability. As gaskets between the plates have been done away with, concerns about compatibility between each different medium and specific gasket types are completely eliminated, and maintenance costs are reduced. Inspection and cleaning of these units is both quick and easy, by simply removing the side panels.

Compabloc plate heat exchangers are available in six sizes, featuring heat transfer areas in the range 0.7 - 320 m² (7 - 3450 ft²). They are designed to operate at a maximum temperature of 350 °C (662 °F) and a maximum pressure of 37 bar (537 psi). The heat transfer area consists of a pack of corrugated plates welded alternately to form the media channels. The plate pack is supported by an upper and lower head and four side panels, which accommodate the connections.

The fusion bonded alternative

When conventional plate heat exchangers are considered for use in petrochemical plants, the Achilles heel is normally the gaskets, because the liquids and vapours used as heating and cooling media are often highly aggressive. However, Alfa Laval technology has now made it possible to completely do away with gaskets.

The AlfaNova range are the first plate heat exchangers in the world to be made entirely of stainless steel. They feature the same basic design as 'normal' gasketed plate heat exchangers, but the gaskets have been eliminated. Instead, the plates are bonded together using Alfa Laval's patented AlfaFusion™ technology. As AlfaNova plate heat exchangers are hermetically sealed, chemical cleaning is used.

With all the key parts made from the same material, the AlfaNova design is extremely strong, with a mechanical strength fully equivalent to its welded counterparts. The fusion bonded design holds the plates together internally with contact points, doing away with any need for external plate frames at design pressures of up to 30 bar.

Six different sizes are currently available, featuring heat transfer areas in the range 0.1 - 70 m² (1 - 750 ft²). AlfaNova plate heat exchangers can deal with temperatures ranging -196 - 550 °C (-321 - 1022 °F) at design pressures up to 30 bar (435 psi).

The AlfaNova design is an economical, low maintenance alternative for petrochemical applications where the

focus is on high efficiency, high temperature heat transfer in hermetically sealed units.

During 2005, Alfa Laval sold more than 400 AlfaNova plate heat exchangers for different process applications.

Case studies

The three following case studies demonstrate the successful installation of Compabloc and AlfaNova plate heat exchangers at petrochemical plants.

Integrated reboiler solution for energy recovery

UNIPAR, the Brazilian cumene producer, installed a Compabloc fully welded compact plate heat exchanger as an integrated reboiler mounted on the cumene distillation column. This unit is used as a combined product cooler/boiler feed water heater. It also has the advantage of not requiring a supply of steam because alkylbenzene vapour from another column further upstream is used as the heating medium.

In addition to ensuring an efficient process solution, the Compabloc compact plate heat exchanger provided UNIPAR with significant savings in operating costs by reducing overall steam consumption.

No restrictions

A Compabloc heat exchanger with AISI 316L stainless steel plates replaced a conventional shell and tube heat exchanger operating in thermosiphon mode and using steam as the heating medium.

A replacement shell and tube heat exchanger would have been extremely large, thus requiring expensive foundations and structural work. The Compabloc unit, on the other hand, provided a compact solution that imposed no restrictions regarding design.

Maximum heat recovery and benefits

The Compabloc fully welded compact plate heat exchanger enabled UNIPAR to install a high efficiency thermosiphon reboiler directly on the distillation column, with a minimum of work.

Savings in steam consumption amounted to approximately 5.3 MW (1.81 exp 7 btu/hr), corresponding to a payback time of less than one year. In addition, the alkylbenzene condenser requires no cooling water, thus reducing operating costs and payback time still further.

One single unit replaces seven shell and tubes

One single Alfa Laval Compabloc plate heat exchanger successfully replaced no fewer than seven shell and tube heat exchangers for ammonia cooler duties at the DSM Special Products plant at Rotterdam in the Netherlands, where using ammonia as a cooling medium plays an important role in the production of benzoic acids.

The cooling process used here involves two types of fluids: ammonia rich and ammonia poor. The Compabloc now serves as an interchanger to heat most of the incoming ammonia rich fluid by cooling the outgoing ammonia poor fluid. Due to the large amount of energy recovered here, exceptional interchanger reliability is crucial. Any unforeseen downtime would force the company to use alternative, more expensive, energy sources.

The right solution at the right time

The Compabloc heat exchanger is built around a pack of corrugated plates welded together. The plate pattern creates a maximum of turbulence, which in turn results in outstanding heat transfer efficiency. In a Compabloc with multipass on both sides, the overall flow pattern is countercurrent, which enables temperature crossing and close temperature approach, all within one single unit.



Figure 2. Compabloc working as ammonia cooler at DSM in the Netherlands.

The Compabloc plate heat exchanger has now been running continuously since May 2003, and has proved the ideal solution for DSM. Difficulties with control valves, which indicated malfunctioning of the tubes in the previous equipment, are now a thing of the past. The absence of vapour bubbles means the highly compact, efficient Compabloc is performing well and easily coping with the load, providing DSM Special Products with an excellent replacement for no fewer than seven bulky, inefficient shell and tube units that previously struggled to do the same job.

Epoxy production in Taiwan

An epoxy producer in Taiwan needed a heat exchanger for cooling a mixture of epichlorhydrine and bisphenol A. Alfa Laval suggested a gasket free solution consisting of one AlfaNova 76 unit, with a heat transfer area of 9.8 m² (105 ft²). By comparison, the company had also considered a shell and tube unit with a heat transfer area amounting to 44.7 m² (481 ft²).

The combined price of purchasing and installing the AlfaNova plate heat exchangers, and the rapid delivery time (only four weeks) convinced the company that AlfaNova units would be a better, and cheaper, solution than bulky shell and tube heat exchangers. The customer actually bought two AlfaNova 76 units, one for operation and one in reserve.

These units have been performing with no trouble since September 2005. Although AlfaNova heat exchangers are much more compact and take up considerably less space than shell and tube units, they also provide highly efficient, reliable performance at this Taiwanese epoxy plant.

Conclusion

Innovative Alfa Laval plate heat exchanger designs such as the compact, all welded Compabloc and the fusion bonded AlfaNova have paved the way for petrochemical plants the world over to achieve exceptional processing results and financial performance that break new ground. The resilience of these designs make them ideal for use with the kinds of aggressive media that are common in petrochemical processing, and to deal effectively with heat recovery in a market where energy prices are constantly rising.

With these innovative approaches, high temperatures and pressures are clearly no longer a limitation to introducing the exceptional heat transfer efficiency that plate heat exchanger technology makes possible. ■