Compact heat exchanger improves the process for BASF

Condensing and sub-cooling in one Compabloc

Case story

The Compabloc and the shell-and-tube units are installed in series. The Compabloc has a higher heat load, and allows for both condensation and sub-cooling, but is much smaller in size.

An Alfa Laval Compabloc heat exchanger has successfully replaced a shell-and-tube heat exchanger at BASF's amine plant in Ludwigshafen, Germany. The main reason for purchasing the Compabloc was the compactness of the unit and the low capital investment cost.

Amines are produced through a reaction between ammonia and alcohol. Un-reacted ammonia is stripped off in a distillation tower and fed back into the process. Originally, BASF had purchased two shell-and-tube heat exchangers for use as top condensers on the distillation towers. After some time, however, these were damaged due to several process shutdowns and start-ups. The decision was therefore made to replace these shell-and-tube units and, at this point, BASF contacted Alfa Laval.

A feasibility study was conducted, and it was discovered that Alfa Laval could provide a unit that was much smaller than the existing installation. The lower capital investment costs of the Compabloc also made it possible to select a corrosion-resistant plate material, without exceeding the budget. This meant that BASF was able to upgrade the material from carbon steel to UB6.

In addition, the Compabloc combines condensing and sub-cooling in a unique way that is impossible to achieve in a shell-and-tube. This is made possible by a baffle system that devides the Compabloc into several passes. The first 2 passes condense the ammonia and the last 2 passes sub-cool the condensed liquid. This results in a lower outlet temperature on the process side which boosts the capacity of the distillation tower – an additional benefit to the process. BASF decided to install the Compabloc in series. An existing spare shell-and-tube heat exchanger first condenses the gas, which is then further condensed and sub-cooled in the Compabloc. The heat load is equal in both units.

Compabloc replaces shell-and-tube

The Compabloc heat exchanger is built around a pack of corrugated plates, without gaskets between them. 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 counter-current, which enables both condensation and sub-cooling – all within one single unit.

For BASF, this resulted in a very low outlet temperature in the ammonia stream exiting the Compabloc. Direct comparison of the two units – with the same heat load – shows that the Compabloc weighs 30% less than the shell-and-tube heat exchanger, and takes up 70% less space.

The process

Amines are used to manufacture products such as rubber, surfactants, detergents, coatings and gas treatment chemicals. The amine chemicals are produced through a reaction between ammonia and alcohol. Un-reacted ammonia is stripped off in a distillation tower and fed back into the process. This separation step is vital for the economics of the plant, as the stripped off ammonia can be reused.

The Compabloc heat exchanger serves as a top-condenser on the distillation tower. Ammonia gas exits the tower and is condensed and sub-cooled in the Compabloc and then returned to the process in liquid form. The Compabloc is able to sub-cool the ammonia to a much lower temperature than original shell-and-tube installation, which results in an increased capacity in the distillation tower.

Experience

The Compabloc unit was installed in September 2004 and has operated since then without any problems whatsoever. No cleaning has been needed since start-up.

“We are very happy with the performance of the Compabloc, and have since successfully replaced several other shell-and-tube units with Compablocs. The Compabloc is the clear alternative to bulky shell-and-tubes,” says Mr Wambsganss, plant manager at BASF.

Key facts about Compabloc

The Compabloc is a high-efficiency, all-welded compact heat exchanger designed for aggressive or hazardous process services. It is available in six sizes, with heat transfer areas in the range 0.7–320 m2 (7–3450 sq ft). The heat transfer area is made up 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 fully welded plate pack extends design limits and provides improved reliability. Because there are no inter-plate gaskets, compatibility concerns are eliminated, and maintenance and operating costs are reduced. Access for inspection and cleaning is fast and easy.

Plate materials

- 316L, 304L, 317L, 904L, 254 SMO and AL6XN stainless steels
- Titanium, Pd-stabilized titanium
- C-2000, C-276, C-22 and B3 alloy.

Specifications

Design pressure:
min. vacuum/max. 35 barg (500 psig)
Design temperature:
min. –30°C/max. 350°C (-20/660°F)
Connections:
PED and ASME (with or without U-stamp)