HYDROCARBON WORLD EXTRACT

Compabloc – The Right Choice for Energy Saving in Refineries

a report by
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Marketing Manager, Market Unit Refinery, Alfa Laval

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Many processes in oil refineries are facing heavy problems with fouling and corrosion, but also problems related to the thermal efficiency of heat exchangers. Very often, on many processes, thermal efficiency affects the dimensions of the heat exchangers, with a negative impact on installation and layout definition, and maintenance costs.

That is why on de-bottleneckings and revamps, refineries are looking more and more to welded compact heat exchangers as a reliable and convenient alternative to traditional shell and tubes (S&T).

Compabloc Heat Exchanger – The Alternative to Shell and Tubes

Among welded heat exchangers, the Compabloc is today widely used by oil refineries on many processes. The main advantages offered by the Compabloc are:

- better thermal efficiency;
- reduced dimensions and footprints;
- reduced maintenance costs;
- improved energy savings when used as an interchanger or pre-heater; and
- reduced emissions (CO2, SOx, NOx) from the heater.

The 'inner secret' of the Compabloc for achieving these advantages is the flow behaviour induced by the plates pattern. The thermal efficiency, the possibility of crossing temperatures in heat recoveries and the reduced fouling are all aspects managed by the turbulence in combination with the counter-current and the short channels.

In practice, Compabloc's efficiency is not based on fluid velocities, as is the case for S&T, but on the shear rate induced in the medias.

Shear Rate Comparison – A Good Example

Normally, an S&T operating on crude oil, allowing a good velocity, would probably not reach a shear rate equalling 15Pa. In the same circumstances, but at a lower velocity and a higher friction factor, the Compabloc achieves shear rates between 40 and 50 Pa. The ratio between the two values gives a good idea of the duration of service, before a shutdown for cleaning is necessary. The higher the shear rate, the longer the unit will resist to fouling during time.

A Good Example – Primary Refinery in Canada

A primary importance refinery in Canada is processing up to 72,000bpd of crude oil. This refinery produces different distillates, such as diesel fuel, furnace oil and jet fuels, plus some heavy oils. In 1999, the Canadian Government instituted regulations that required Canadian refineries to reduce dramatically the sulphur content in the gasoline by 1 January 2005, to 30ppm. This represented a real challenge, as a complex optimisation of the energy efficiency had to be managed by all the locam oil refiners.

Low Sulphur – A Tough Task

A new hydrotreater to remove sulphur from gasoline required large amounts of energy to operate. To supply this additional energy, the refinery had two alternatives: building a new furnace boiler in the steam plant, or increasing the feed water temperature to the existing boilers by recovering heat from the existing processes.

They decided to focus on the fluid catalytic cracking (FCC) overhead vapours, coming from the head of the fractionation column. Traditionally, S&T would have been the choice of a refinery for such a large duty. In this case, S&T would have had an important disadvantage: an increased risk of fouling and corrosion. Moreover, it has been impossible for the refinery to solve the duty with an S&T practical design able to deliver the required heat transfer, staying within a narrow pressure drop range typically required in a cat cracker.

The Compabloc Solution – Good Management of Thermal Constraints and Corrosion

The challenge for Alfa Laval was thermal; being able to deliver the required heat in respect of the pressure drops, and mechanical, facing the corrosion mainly coming from bisulphites, chlorides and cyanides present in the overhead vapours.

It was necessary to use eight big Compablocs, working as vertical condensers, made of Alloy C276. These eight units condense the vapours coming from the FCC and put this energy into the boiler feed water (BFW); this energy is approximately 13.5MW. They are arranged in two trains of four units in parallel per train: the first four Compablocs cool down and condense the vapours, pre-heating the BFW, while the second row of four units performs the final trim cooling, using process cooling water.

These eight big Compablocs work as vertical multipass condensers: this layout has been necessary to work with a huge thermal cross. The units have been in continuous successful operation since they were commissioned in mid-2002. They represent an excellent example of energy saving, providing the most economical solution for using high-grade alloys to avoid corrosion.

Energy Saving – Compabloc Helps to Optimise Heat Recoveries in Refineries

In today's refinery business there is an increasing emphasis on improving capacity while reducing energy consumption and environmental impact. Compablocs are much more efficient than S&T, and can achieve increased performance using fewer heat exchangers. The bigger heat recoveries result in reduced fuel consumptions in the fired heaters, as well as reductions in emissions, leading to very attractive investment pay-back times.

The main feature behind this different performance is the fluid behaviour induced by the use of corrugated plates. These corrugations induce very high turbulence in the media: this means that for the same velocity through the channels, a Compabloc achieves higher turbulence than a S&T, allowing a three- to five-fold higher thermal efficiency.

This greater turbulence also leads to higher shear stress, allowing the Compabloc to operate for a longer time between two maintenance shutdowns. The reason for this is simple: the shear stress has got a cleaning effect, reducing the deposits and the fouling in the heat exchangers.

Another feature typically present in the Compabloc is the counter current flow, which enables the units to handle huge temperatures crossings in a single heat exchanger. This is very important in heat recoveries, and a typical example may be represented by energy savings in crude pre-heat trains.

Energy Savings – A Key Issue for Refineries

In an oil refinery, the atmospheric distillation unit (ADU) and in particular the crude pre-heat especially, is the process requiring the largest amount of energy.

Therefore, this is one of the most interesting areas wheer compabloc can be used for a 100,000bpd refinery, about 120MW of energy is needed to pre-heat the crude from 25 to 350°C. An important part of this energy is recovered from the hot fractions available, or from the atmospheric residue; the last part of the crude heating is done in a fired heater. It is therefore clear that if more energy can be obtained by heat recovery, less actual heating will be needed. For each 1MW less energy in the heater, there is a fuel saving corresponding to 970 tons of natural gas. Using a fuel cost of US$40 bbl, around US$300,000 can be saved for every year of operation.

Important savings can also be achieved on emissions: for each ton of natural gas burned in the heater, 2.6 tons of CO_2 are released. According to the Kyoto Protocol, one CO_2 emission allowance gives the right to release one metric ton of CO_2. Companies can buy and sell CO_2 credit, for a price of US$20 per credit has been forecasted before 2008 in the US; this is around 50% of the shortfall fines (US$40 per credit) proposed in Europe. Considering US$20 per credit, an additional US$50,000 can be saved on reduced CO_2 emissions for 1MW of energy reduction in the heater.

The same trading can be done on other emissions: SOx and NOx. Companies with emissions below the limits can sell their surplus permits. The normal trading price for SOx and NOx is around US$1,000 per ton. For each ton of natural gas burned, 15kg of SOx (at 0.6% S in the fuel) and 12kg of NOx (at 0,25% N in the fuel) are released. In particlar, this means an additional US$30,000 saved, every year, for 1MW of energy reduction in the heater. ■

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