Spiral heat exchanger in desalter service solves fouling issues

Technology offers problem-free operation along with considerable maintenance savings

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A major US refinery was experiencing severe fouling and plugging problems in two shell-and-tube (S&T) heat exchangers installed to cool desalter effluent using cooling water. In 2008, the refinery replaced the two S&Ts with a fouling-resistant spiral heat exchanger (SHE). The SHE gives continuous problem-free operation, higher process reliability and more consistent wastewater treatment temperatures than the S&Ts. Best of all, there has been no plugging and, based on savings in maintenance and cleaning costs alone, the payback time was less than 18 months.

In the desalting process, crude oil is contacted with hot water to remove impurities such as chloride salts and particulate matter before continuing through the crude preheat train into the refinery. The solids and salts collect in the process and must be flushed out with the effluent water. In a process called "mudwashing," solids are mixed with the effluent water and removed. The effluent water—now contaminated with oil, suspended solids and dissolved solids—needs to be cooled before traveling downstream to wastewater treatment.

As shown in Fig. 1, Refineries typically use two stages of cooling before wastewater treatment: 1) effluent cooling by preheating feed water, and 2) effluent cooling with cooling water. The first application is a heat recovery service; so maximizing the efficiency of this heat exchanger is important. The second heat exchanger is a trim cooler and is designed to protect the wastewater treatment plant from excessively hot effluent. Unfortunately, due to severe fouling in both applications, refiners will bypass the heat-recovery service and foul the cooling-water exchanger so rapidly that it damages the wastewater treatment system. The consequences of the damage include unplanned downtime and environmental penalties for noncompliance. Fortunately, there is a solution to this widespread problem of desalter effluent fouling with the SHE. These facts are very evident in a specific US refinery that has operated a SHE in desalter service since 2008.

The process of cooling the effluent water has caused fouling headaches in refineries for years, as was the case with the major refinery covered in this article. Due to continuous, costly fouling and plugging problems, it was necessary to shut down the S&Ts cooling the desalter effluent water once a month on average. The unplanned downtime caused problems for the wastewater treatment plant, since the effluent temperature was poorly regulated and frequently out of specification.

SHE recommended. SHEs have a well-proven technology for fouling applications. Its single-channel design resists plugging while the fully counter-current flow paths allow for effective heat recovery in a compact space.[1] SHE is the only technology that copes easily with the solids in the stream and can handle process upsets with high solid concentrations. Due to the design efficiency, it was possible to install just one SHE. This only had 50% of the surface area of the S&Ts, yet it still outperformed them in the long term.

Problem-free operation. Shortly after the SHE startup, the refinery had satisfactorily noticed that the pressure drop through the unit remained stable. Increasing pressure drop had frequently been one of the reasons the refinery needed to shut the S&Ts down for cleaning. The SHE continued to provide trouble-free operation and, over an extended period, only a moderate reduction in thermal performance was measured.

Cleaned once since startup. In June 2009, after 14 months of operation, the refinery opened the SHE for the first time

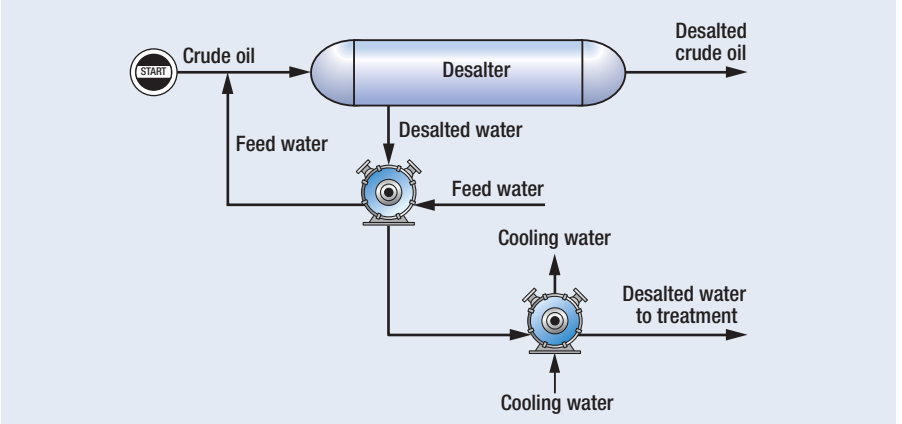

FIG. 1 Simplified desalter system configuration.

FIG. 2 Single-channel geometry resists plugging while counter current flow efficiently recovers heat.

to check for fouling—an operation made easy by the option of integral davits on each cover. To their surprise, the engineers found only a thin greasy coating on the effluent side and minor scale on the cooling water side. With the S&T exchangers, they witnessed many plugged tubes after only one month. The spiral was mechanically hydroblasted and placed back in service the next day. By December 2010, it was noted that the SHE had only been cleaned once since startup and was still operating efficiently. An onsite engineer stated that it's doing well and there have been no complaints.

TABLE 1. Cost savings when using SHE

Unit	Service	Cleaning frequency (amount/year)	Cost per cleaning*	Total cleaning costs/year
2 shell-and-tubes	Desalter effluent cooling	12	$6,000	$72,000
1 spiral heat exchanger	Desalter effluent cooling	0.86	$3,250	$2,786

* S and T cleaning costs calulated as $2,500 (disassembly/assembly tube side, two units) and $2,500 (cleaning rig: day one and $1,000 cleaning rig: day two). Spiral cleaning costs calculated as $1,250 (disassembly/assembly one unit) and $2,000 (cleaning rig: 5.5 hrs).

Savings. The cost to clean the tube side of the two S&T exchangers was estimated by the refinery in Table 1. Given the frequency of cleaning, the investment cost for the SHE was returned in less than 1.5 years on savings in maintenance alone (Table 1).

Summary. The SHE technology includes these benefits:

- Fouling problems in refinery desalter effluent services can be greatly reduced or eliminated.
- The single-channel design and robust construction make the spiral an ideal product for this challenging refinery service (Fig. 2).
- Often, the capital cost of the spiral equipment can be justified with the savings in maintenance/cleaning costs alone, not to mention the added reliability of the process and more consistent wastewater treatment temperatures. **HP**

LITERATURE CITED

[1] Anderson, E., "Minimizing refinery costs using spiral heat exchangers, *PTQ Q2* 2008.

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