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Zhenhai Petrochemical Jianan Engineering Co.,Ltd.
镇海石化建安工程股份有限公司

MULTIFLUID STHE technology

Spiral tube heat exchangers have been used for many years , in fact, since the beginning of cryogenic liquefaction industry. For more than 30 years, ZPJE has developed a unique state of the art know how of heat exchange calculation, hydraulic simulation and mechanical modeling of spiral tubes design to enable this technology to be used in refinery, petrochemical and Oil&Gas businesses.

In pursuit of advancing heat integration, footprint optimization and energy efficiency, ZPJE has invested significant resources into R&D to enhance its two fluid counter-current design to be able to accommodate multiple fluids within a single equipment. This highly adaptable and versatile design is tailored to address customer requirements, including intricate flow schemes.

Design

The distribution of fluids can occur either on the tube side or the shell side of the heat exchanger. Our innovative design can accommodate up to 6 or 8 different fluids, which can be configured in series or parallel arrangements to enhance equipment efficiency.

This design gives significant advantages for both new grassroot or debottlenecking revamping projects by offering :

Lower CAPEX :

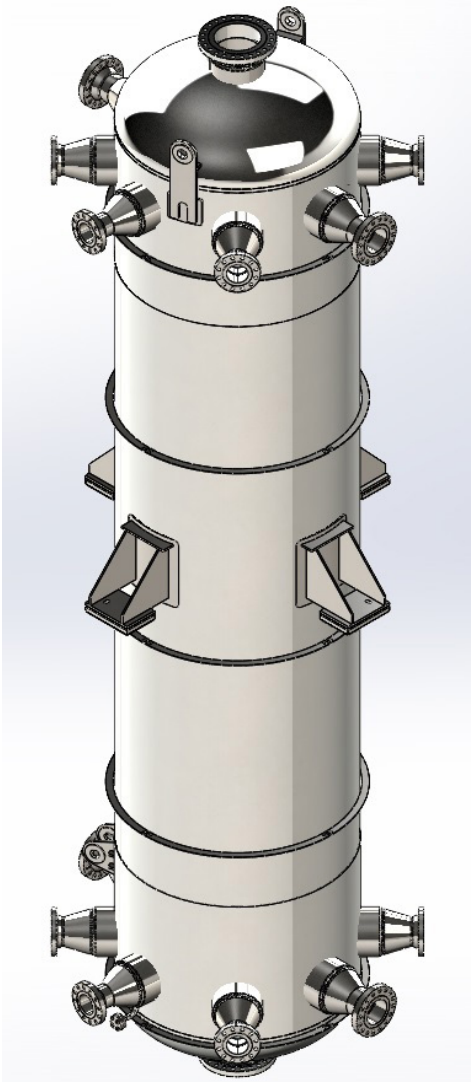
Limited number of equipment can replace 10s of conventional shell&tubes exchanger thereby reducing equipment cost, piping, instrumentation and installation structures.

Reduced OPEX :

High STHE efficiency design allows for lower fluids approach temperatures and pinch point consequently improving overall unit efficiency. This optimization creates opportunities for debottlenecking with minimal investment.

Enhanced Safety:

By reducing the number of flanges and gaskets, our design significantly mitigates the risk of leaks and necessitates less maintenance.



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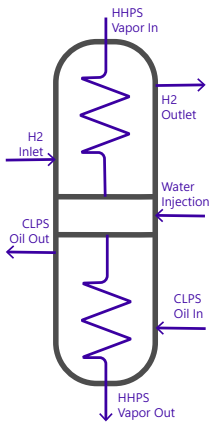
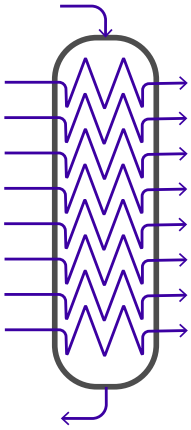
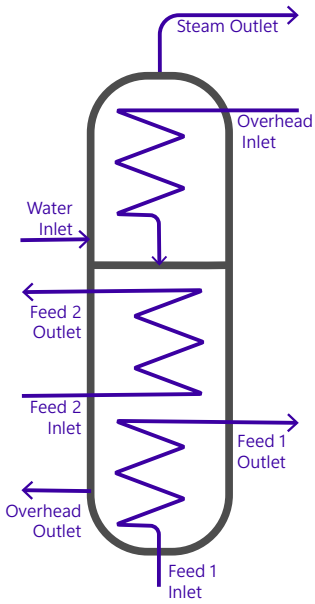
Here are some examples of multifluid configuration :



2 fluids in series on tube side



8 parallel fluids on tube side



4 fluids fitted on tube and shell side
to optimize heat recovery

Case study 1

Overhead Lower-Grade Heat Recovery

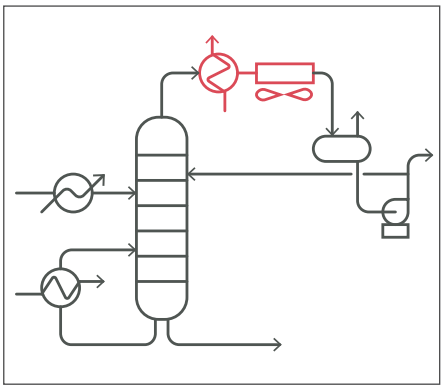


Figure 1

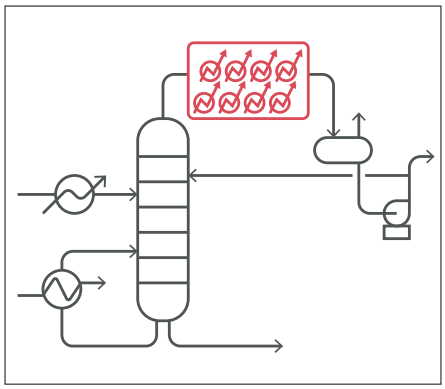


Figure 2

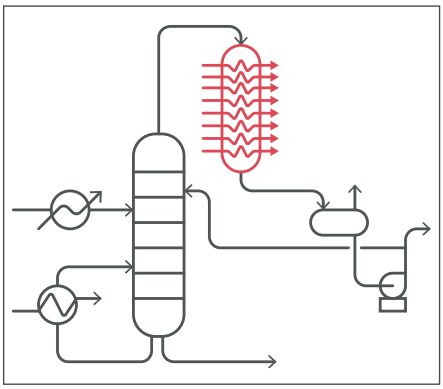


Figure 3

The heavy aromatics separation unit employs a vacuum tower for separating heavy aromatics feed.
In the initial design *(figure 1)*, the feed is heated by a heat transfer oil before entering the vacuum separation tower. The overhead gas then goes through a first exchanger for heat recovery, followed by a cool down in an air cooler before entering the reflux drum. A portion of the light components is extracted, while the remaining components are recycled for reflux.

To fully utilize the abundant low-temperature heat resources present in the separation overhead gas, the original design utilized 8 conventional shell-and-tube (S&T) exchangers in parallel *(see Figure 2)*, resulting in several drawbacks:

- Complex heat transfer network
- Large plot area requirement
- Numerous control valves to control fluid distribution, leading to a high pressure drop at the tower overhead and reduced operating vacuum efficiency in the separation process.

To address these challenges, ZPJE's multi-stream Spiral Tube Heat Exchanger (STHE) technology was adopted. This solution involves a single STHE handling heat exchange between 8 cold feeds on the tube sides and 1 overhead gas stream within the pressure vessel *(see Figure 3)*.

This solution eliminates the need for the original air cooler and maximizes the recovery of low-temperature heat from the tower overhead. Additionally, the overhead gas now flows downwards in the STHE without any dead zones or liquid accumulation. This configuration results in a **pressure drop** of less than **2kPa**, thereby improving separation efficiency and reducing distillation temperature.

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Case study 2

Diesel Hydrotreater Revamping

In this 2.0 MMTA DHT unit licensed by Axens, the original process diagram for the reactor loop included 5 BEU TEMA type heat exchangers (figure 1). Instead, one vertical STHE (stacked type) is chosen.
Reducing the number of exchangers give the following investment advantages :

Plot Area	-70%
Piping Workload	-50%
Flange Sealing Face Quantity	-70%
Heat Duty	+10.14 Gcal/h *(Summer)*, +10.73 Gcal/h *(Winter)*

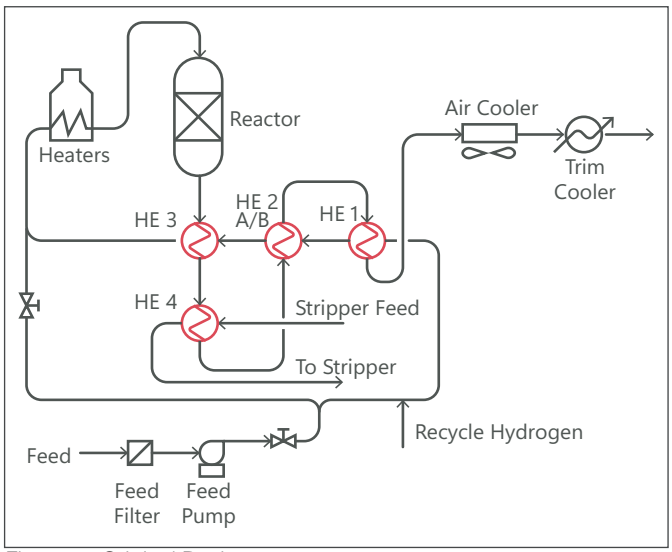

Figure 1 : Original Design

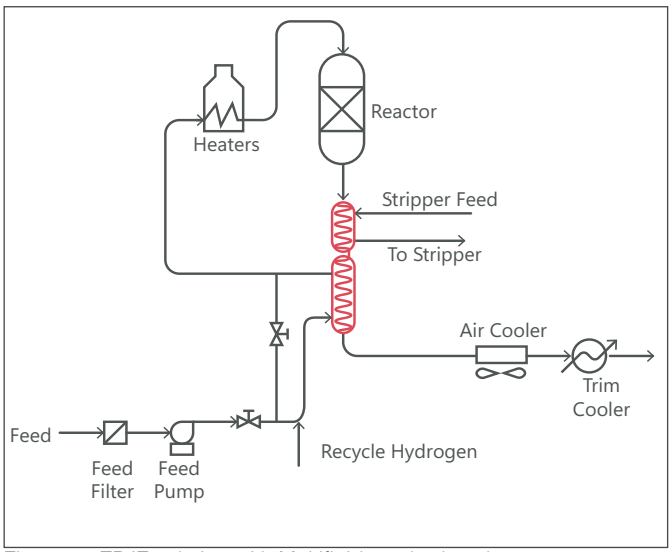

Figure 2 : ZPJE solution with Multifluid stacked exchanger

With this solution, the heater mixed-feed inlet temperature was increased while the inlet temperature of the trim cooler decreased. The resulting economics are given in the following table :

	BEU type S/T	STHE
Heater Inlet Temperature	300°C	317 °C
Heat Duty	51.1 Gcal/h	56.23 Gcal/h
Heat Released Saved On Heater		72 000 Gcal/year
OPEX Saved		1 800 k$/year (*)
AIr Cooler in service	36	10
Electricity Saved		534 kWh
OPEX saved		470 k$/year (**)
Total OPEX Saved		**2.27 M$/year**

(*) Considering Fuel Price @165$/ton and CO_2 price @40$/ton.
(**) Considering energy price @0.10$/kW.

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Conclusion

ZPJE's heat exchanger technology offers innovative and smart solutions, fitted to every customer requirement. These innovative solutions propose robust and efficient equipment, leading to significant savings in both investment and operating costs.
Multiple fluid design offers tailored design adressing customers requirments for heat integration and energy savings.
Through continuous and intensive research and development, ZPJE remains a leader for tubular heat exchanger technology, delivering unique and unparalleled solutions to its clients.

ZPJE Experience

STHE as Multifluid Heat Exchanger:

>400 references

21 years in Operation

>265 MMTA total installed Capacity

>1,360,000 Days of cumulative operation

Contact Us

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