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

SUCCESSFUL ENERGY SAVING SOLUTION FOR PYROLYSIS GASOLINE HYDROTREATMENT UNIT

Presentation

Pyrolysis gasoline, or Py-Gas, is a by-product of high-temperature steam cracking during ethylene and propylene production. Py-Gas contains valuable components like aromatics (55% to 60%), making it a good blending material for high-octane gasoline or a valuable source for the extraction of Benzene, Toluene and Xylene (BTX). Pyrolysis gasoline contains organic impurities such as oxygen, sulfur, nitrogen, and unsaturated hydrocarbons, which requires further hydrotreating to meet the requirements of aromatic extraction.

The Project

The unit production capacity is 0.7 MMTA, and uses a two-stage process. In the first reactor, the hydrogenation of the middle distillate pyrolysis gasoline (C6~C8) is performed to mainly saturate dienes and a small quantity of styrenes. Then, in a second reactor stage, the saturation of the mono-olefins is performed together with the hydrotreatment through desulfurization, deoxidation and denitrification reactions.

Before the revamping, the second stage hydrotreatment unit was equipped with four conventional feed-effluent shell and tubes exchangers. The feed was then further heated up through a high-pressure steam exchanger before entering the reactor. This steam exchanger replaced the conventional fired heater in order to reduce the flue gas emission of the refinery as per environmental requirements. The original unit is described in **Figure 1**.

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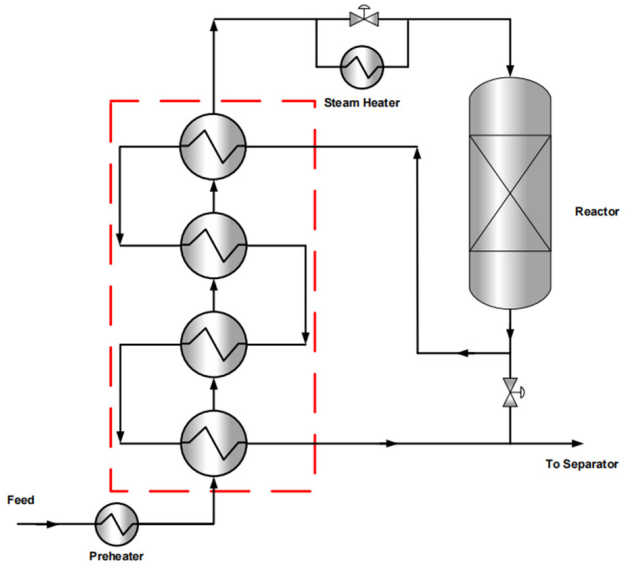

Figure 1 : Process Flowsheet before revamping

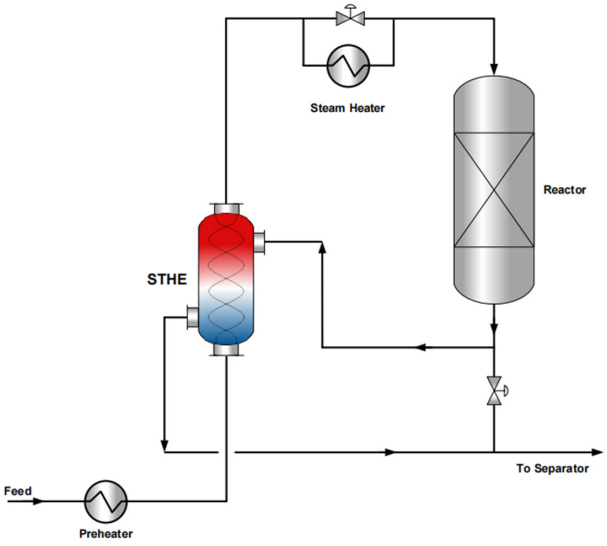

Figure 2 : Process Flowsheet after revamping

After revamping, the four exchangers were replaced by one single high efficiency Spiral Tube Heat Exchanger (STHE). The very high thermal performances offered by the STHE increased the combined feed outlet temperature from 220°C to 240°C enabling the shut down of the steam heater during normal operation. Having one single exchanger compared to 4 horizontal shell and tubes reduced the footprint of the heat exchange train from **80 m²** to only **16 m²** and reduced the number of flanges/piping connection by **75%**. The new flowsheet of the revamped unit is given in **figure 2.**

Operating Expenditure Savings

The unit was restarted in December 2019. Thanks to the high efficiency of ZPJE heat exchanger, the high pressure steam heater is only used during the startup phase. During normal operation, the steam heater is shut down and the hot side by-pass valve is open at ~50%.
This operating mode reduced the consumption of high-pressure steam by 1.8 t/h, saving over 15,000 t/y high pressure steam and reducing the unit comprehensive energy consumption by 870 kW.

	ZPJE	Shell & Tubes
Number of Exchangers	1	4
Feed to Steam heater Temperature	240°C	220°C
Steam Consumption	0	1.8 t/h
Energy Saving	870 kW	
Operation Savings (*)	$450,000 /year	

(*) Considering high pressure steam @$30/ton.

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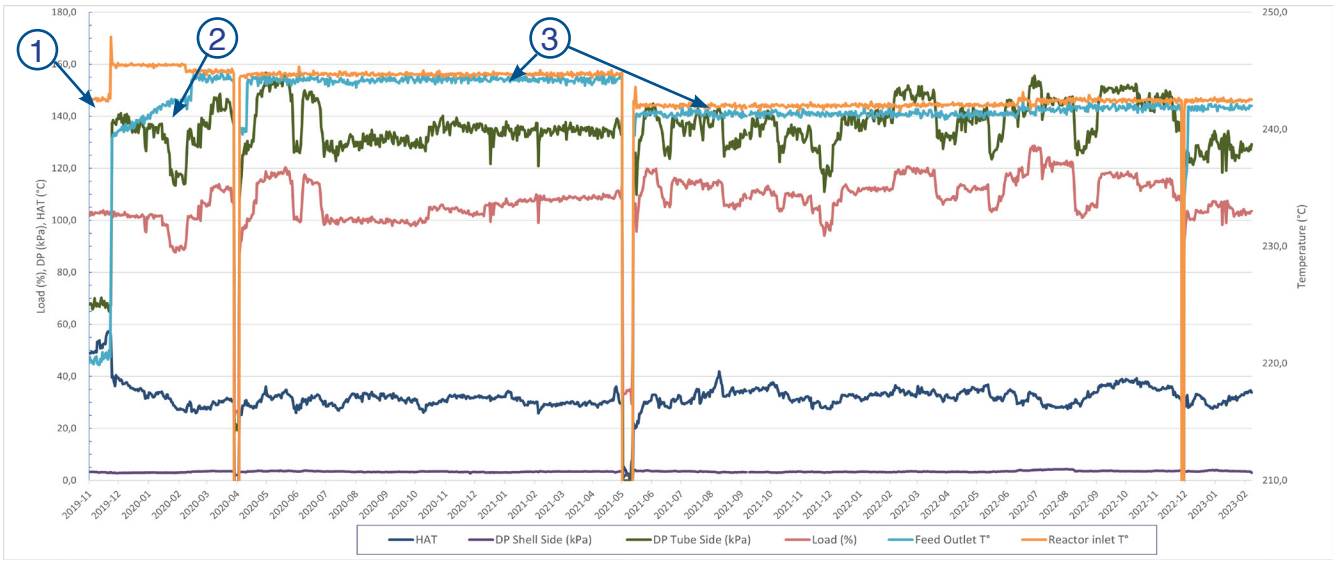
Since the start-up of the newly installed STHE, the unit is operating at design capacity within the guaranteed performances without any mechanical problem.
The following operating records shows the different phases for this project :
1 - These records show the performances with conventional shell & tubes technology. The feed outlet temperature is around 220°C, while the Reactor Inlet temperature is at 240°C, requiring high duty from the steam heater.
2- During phase 2, the bypass valve is gradually closed until complete shut down of the steam heater.
3- After March 2020, the unit is in normal mode, taking full advantage of the high efficiency of the Spiral Tube Heat Exchanger. Outlet feed Temperature and Inlet Reactor Temperature are equal, meaning that the Steam Heater is shut Down.



Operation trend of Combined Feed/Effluent Exchanger on 0.7 MMTA PyGas Unit

Customer's testimony

«On December 12, the Energy Performance Contracting (EPC) project of the Olefins Department including a spiral tube heat exchanger for our pyrolysis gasoline hydrotreatment unit was successfully completed.

The newly added heat exchanger is an important piece of equipment for the EPC project and a designated third-party energy-saving company Sinopec Energy Management Co. Ltd. (SEM). This project adopts a Share Savings Model meaning SEM carried out project investment, engineering design, project construction and equipment installation, and collects a certain proportion of energy-saving income during the contract period as a return of its investment. The energy-saving income after contract expiration belongs to our company. Preparations for the project began in January 2018, and the project was completed in September 2019. At 9:30 on December 12, it was put into operation after plan review, personnel training, and on-site process preparation. The technicians of this unit worked closely with internal and external operators. At 17:50 on the same day, the product met the company's specification, and the unit started smoothly. Currently, the process parameters such as the bed temperature of the second-stage hydrotreatment reactor are normal, and the product quality is stable.

The start-up of the new Spiral Tube Heat Exchanger has optimized the energy consumption of the pyrolysis gasoline hydrotreatment unit, replacing the original four two-stage reactor feed/effluent heat exchangers and the need of the external heat during normal operation. Through heat exchange, the high-pressure steam usage of the unit is reduced by 1.8 tons/hour, which saves more than 15,000 tons of high-pressure steam every year.»

Source : Sinopec Web Site