CAPACITY IMPROVEMENT AND BURNER REPLACEMENT OF NHT AND REFORMER HEATERS

Introduction

Energy conservation is the popular discussion topic among refining and petrochemical industry and fired heaters are the highest energy consumers of the industry. Revamping fired heaters is an effective way to improve their performance and hence yield fuel savings.

This study emphasizes the capacity improvement of NHT and Reformer heaters.

The naphtha cut from the crude distillation unit is sent to the Naphtha HydroTreater (NHT) to remove sulfur and nitrogen compounds which is then sent to a catalytic reforming unit. Catalytic reforming unit converts straight chain naphtha into high octane aromatic hydrocarbons called reformate. The reformate has higher energy content than the straight chain naphtha feed and is used in blending of lead-free gasoline fuel. These heaters are also susceptible to coke formation, if operated in two-phase flow. Further, fired heaters being the largest consumer of fuel, refiners tend to operate these units at their maximum capacity. Revamping of heaters is the most effective way of getting extra capacity from the existing heaters.

SPLIT FLOW TECHNOLOGY

When refiners wish to increase the capacity of their fired heaters, FIS patented **"Split Flow Technology"** aims to improve the utilization of thermal energy for process heating. This design works very well to increase the capacity of fired heaters without increasing the process side pressure drop. This is achieved by splitting the process fluid into two parallel streams as- Main Stream and Split Stream. In Main Stream the fluid is heated in the radiant or a combination of radiant and convection section. In Split Stream the fluid is heated in the convection section. The two streams are then combined at the heater outlet. The split is designed by balancing the heat transfer and pressure drop with the radiant stream. Advantages of revamped design based on Split Flow Technology are as follows:

FIS has developed patented **SPLIT FLOW TECHNOLOGY** to increase the capacity of fired heaters with limiting pressure drop.

- Increased capacity at a lower pressure drop
- Improved efficiency
- Lower radiant heat fluxes
- Lower firebox temperatures
- Lower TMTs
- Lower installation costs

This concept has proven to be very helpful to many fired heaters. This paper describes how this technology has helped a refiner in Southeast Texas to improve the capacity of their fired heater.

Introduction

The schematic representation of Split Flow Technology for Reformer heater is as portrayed in Figure 1.

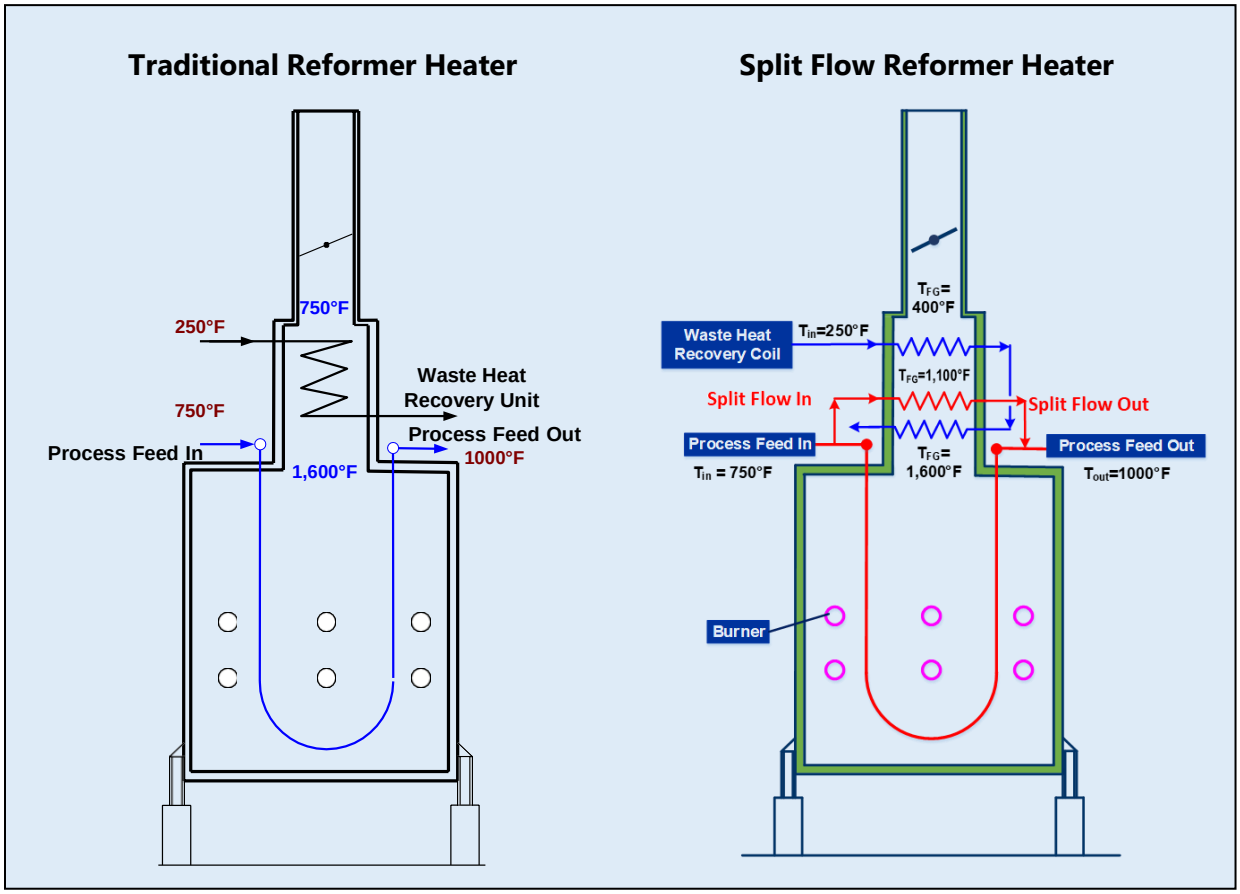

Figure 1: Reformer Heater Split Flow Technology

Case Study

CAPACITY IMPROVEMENT

In 2005, Furnace Improvements Services (FIS) was employed by a refinery in Southeast Texas to carry out a capacity improvement of the NHT and Reformer heaters.

The Reformer heater is a three-cell (H-20/21/22) hoop coil heater. There are three vertical cylindrical NHT heaters (H-18/19/23) along with the Reformer heater, which share a common convection section and a stack as portrayed in Figure 2. NHT heaters are all radiant heaters. Flue gases from these heaters flow together to a common convection section on the Reformer heater.

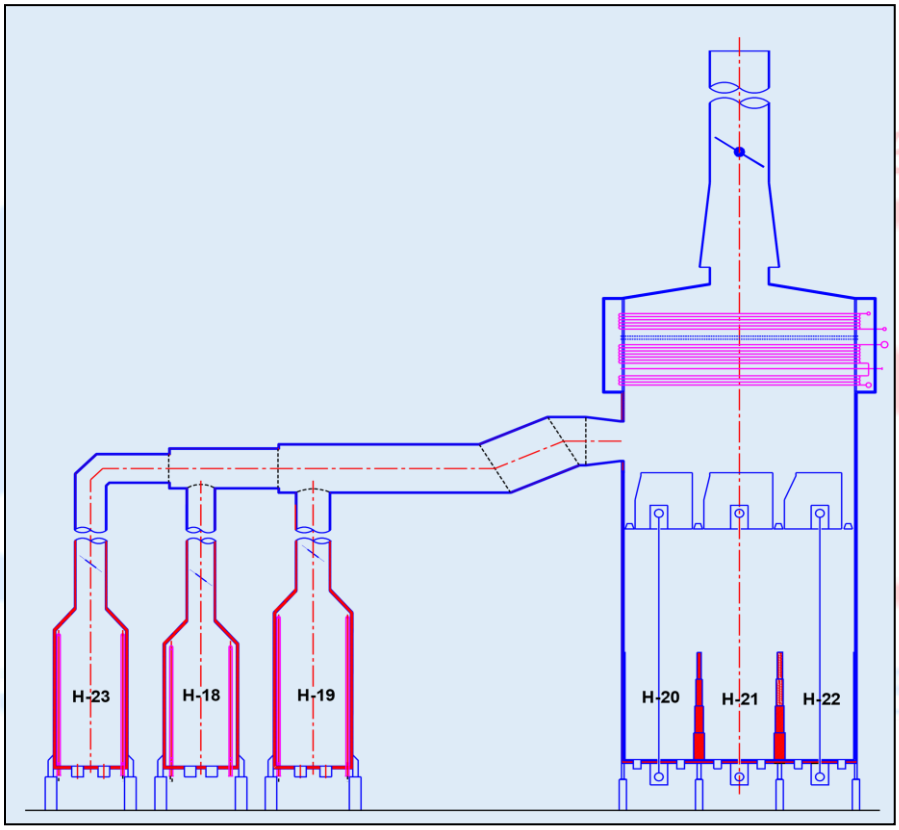

Figure 2: Schematic representation of NHT and Reformer heaters

The Reformer Heater (H-20/21/22) and Naphtha Hydrotreater Heater (H-18/19/23) were built in 1977. The Reformer heater was originally designed for 12,000 BPD operation and rated for 119.7 MMBtu/hr heat duty. The design thermal efficiency of the heater was 88% but it was operating at 13,000 to 15,000 BPD charge rate with 81%

The conventional revamp option was to extend the existing radiant cells or to install a new heater for the extra duty requirement. Both options had disadvantages i.e. 1) Space limitation 2) **Very high cost**

efficiency. Additionally, radiant tubes and convection section were in bad state, tube fins had burnt out /fouled and stack temperature was higher than the design case.

The client wanted to revamp the Reformer heater for 18,000 BPD capacity. FIS was solicited by the refinery to develop an economical scheme for increasing the capacity. FIS redesigned the heater with FIS patented **Split Flow Technology**, as exhibited in Figure 3.

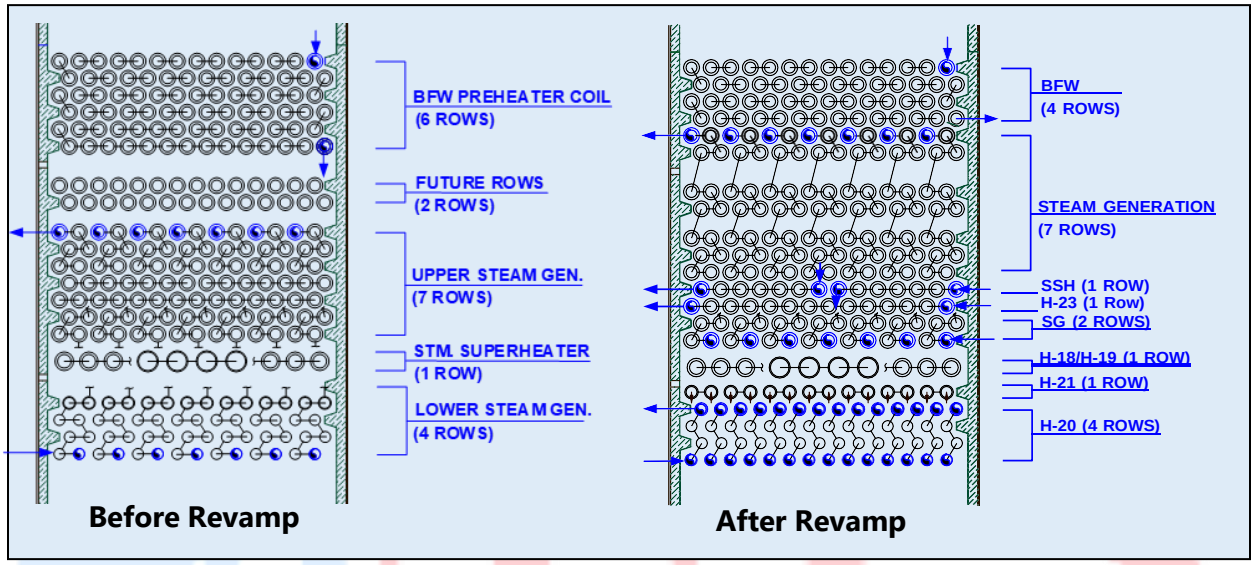

Figure 3: Capacity improvement of NHT and Reformer heaters

NHT and Reformer Heaters Data Comparison				
Heater Number	**Units**	**Existing Heat Duty**	**Revamped Duty**	**Extra Duty**
H-18	MMBtu/hr	11.97	13.80	1.83
H-19	MMBtu/hr	18.45	23.50	5.05
H-20	MMBtu/hr	27.29	41.97	14.68
H-21	MMBtu/hr	25.10	29.97	4.87
H-22	MMBtu/hr	21.70	23.30	1.60
H-23	MMBtu/hr	15.15	17.40	2.25
Total	MMBtu/hr	119.66	149.94	30.28

Case Study

Salient features of the revamped design are as follows:

- Total process duty of the heater increased by 25%
- Stack flue gas temperature is alleviated by 271°F
- The thermal efficiency of the heaters increased by 9%
- The revamp cost was **one-fourth** that of the alternate design
- The efficiency improvement led the client to save **1.46 Million U$/year** on fuel savings based on 8$/MMBtu fuel gas price

BURNER REPLACEMENT

Each cell of Reformer heater was provided with 10 number of natural draft, round flame, low NOx burners. The burners in cell H-20 and H-21 were oversized and were replaced with 10 number of ultra-low NOx flat flame burners. The estimated NOx emissions were 0.02 lb/MMBtu. The burners in cell H-22 were relocated and moved away from the tubes, closer to the wall.

The heater was revamped not only for increased capacity, but also for improved thermal efficiency and improved reliability. Additionally, lower module of stack was modified to incorporate a new pneumatically operated stack damper.

FIS carried out the entire scope of activities from conceptualization to commissioning of this heater revamp. The heater was successfully commissioned in November 2005.

FIS Revamp Solutions

FIS designs revamp solutions of the project based on customer specific requirements, which extend from an engineering study to detailed engineering and execution, as portrayed in Figure 4.

FIS revamp projects are generally focused on following areas:

- Capacity Increase
- Efficiency Improvement
- NOx Reduction

FIS scope of services includes activities exhibited in Figure 5.

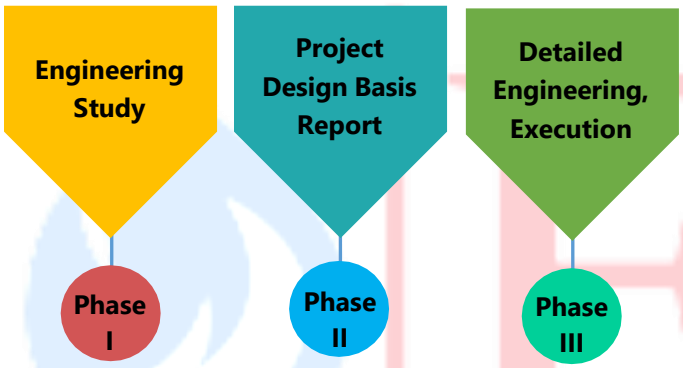

Figure 4: Typical fired heater/ boiler revamp project phases

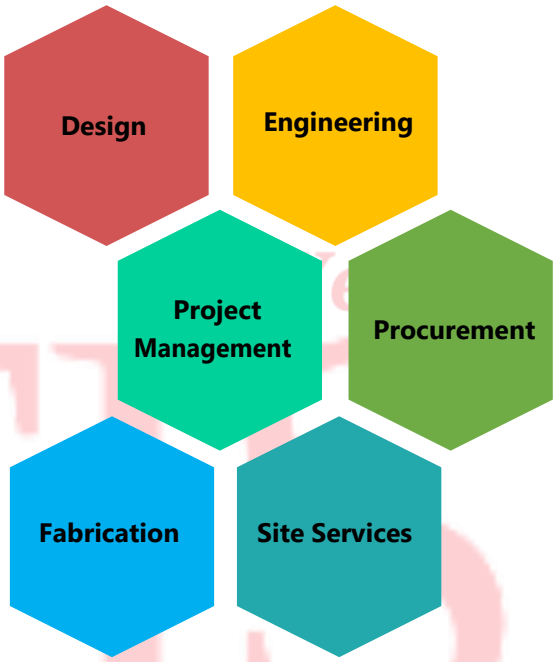

Figure 5: Furnace Improvements example of scope of services

CONCLUSION

Fired heaters being major consumers of energy in the refinery and petrochemical industries, efficiency improvements even by 1-2% can lead to huge fuel savings.

Furnace Improvements Services (FIS) is based in Sugar Land, Texas. We have been improving the efficiency and capacity of our clients' fired heaters, boilers and waste heat recovery units and reducing their NOx emissions for over 23 years. We have handled more than 400 engineering studies and projects for Valero, Phillips66, Citgo, Total, Delek, Sasol and other refineries around the world.

27 Years

FIS

Clean & Efficient Combustion

Furnace Improvements Services

Uniform Heat Transfer in Fired Heaters

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