# EFFICIENCY IMPROVEMENT AND BURNER REPLACEMENT SOLUTION FOR DEPENTANIZER REBOILERS

# Introduction

**Revamping fired heaters is a practical and effective way to improve the heater performance. This strategy focuses on working with existing components, and as a result, capital investment and downtime are minimized.**

This study revolves around revamp scheme adopted for depentanizer reboiler.

Fired heaters are important part of refining and petrochemical industries. They provide thermal energy to the fluids being heated by combusting fuel. 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 East Texas to improve the capacity and efficiency of their fired heaters. The schematic representation of Split Flow Technology for reformer heater is as portrayed in Figure 1.

# Introduction

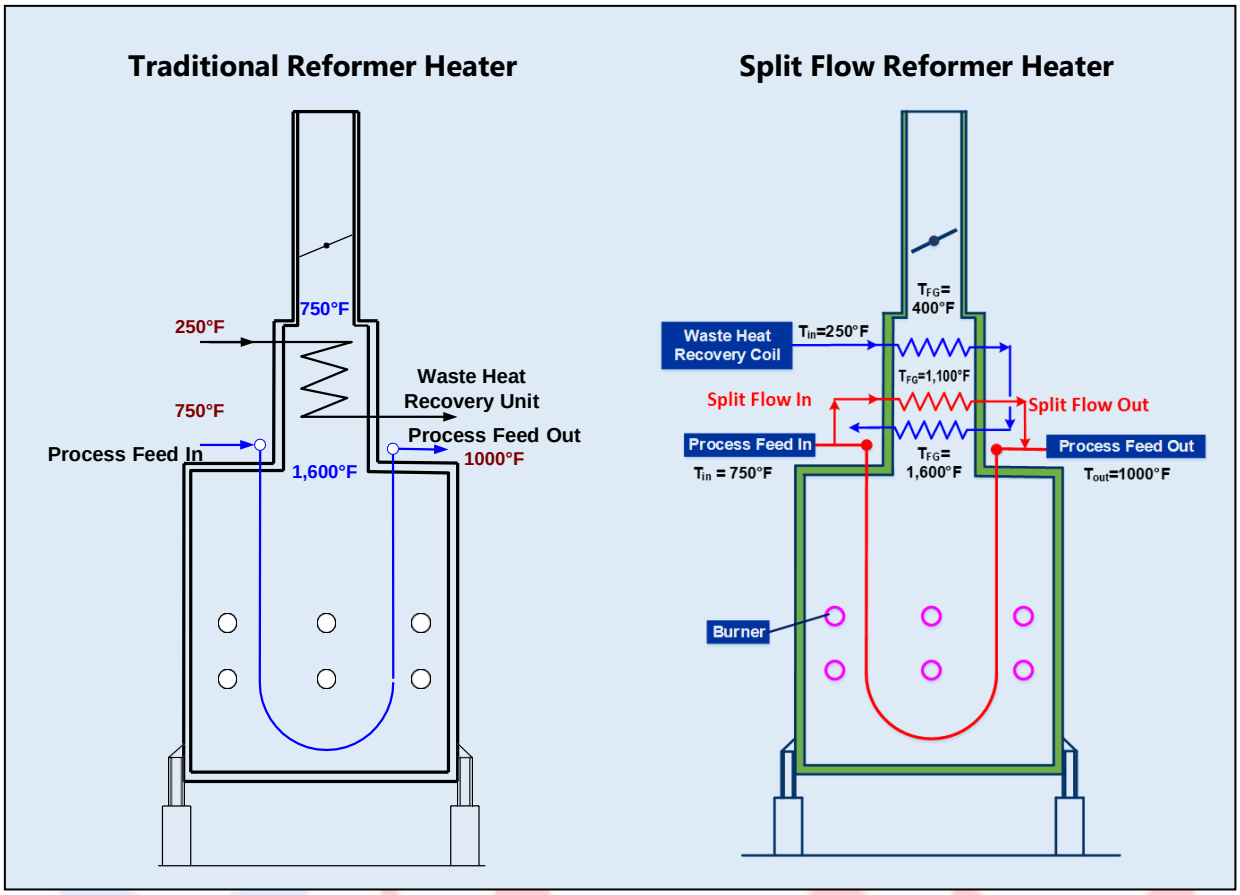


Figure 1: Reformer Heater Split Flow Technology

## INCLINED FIRING SYSTEM (IFS)

One of the most common issues faced by operators and owners is high tube metal temperatures in fired heaters. High tube metal temperatures (TMT) are often caused by the flame impingement due to long burner flames which may lead to tube failure.

In IFS arrangement, the burners are inclined to point the flames away from the tubes. FIS has done extensive CFD modeling of the inclined firing and the results have shown significant reduction in tube metal temperatures and hot spots.

FIS has developed patented **INCLINED FIRING SYSTEM** to alleviate flame impingement on heater tubes.

Salient features of Inclined Firing System are as follows:

- Improved flame pattern

# Introduction

- Lower Tube Metal Temperatures (TMTs)
- Uniform heat flux distribution
- Elimination of hot spots/ localized heating
- Longer tube life/ heater run lengths
- Lower coking rates

This technology has been very useful for installing Ultra Low NOx burners in very tight radiant chambers. Angle of inclination is determined using CFD analysis and optimum angle ensures uniform heating & no flame to flame interaction. Schematic representation of Inclined Firing System and Flue Gas Temperature Contours are portrayed in Fig. 2A and 2B respectively.

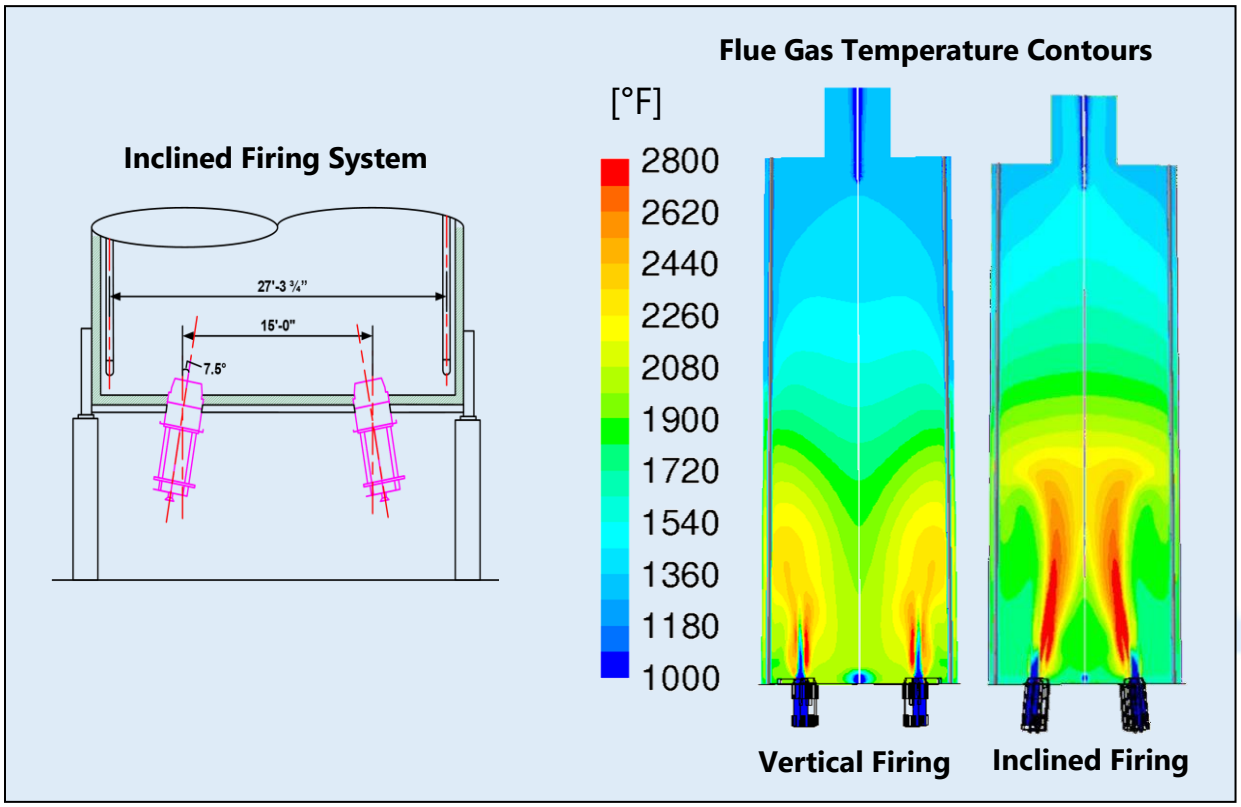


Figure 2A&B: Inclined Firing System and Flue Gas Temperature Contours

# Case Study

A refinery in East Texas has Depentanizer Reboilers (4H-102) and (5H-205), originally designed in 1972 as a vertical cylindrical type, natural draft heaters with horizontal convection section and a top mounted stack. Both the heaters were designed for an absorbed heat duty of 46.2 MMBtu/hr (4H-102) and 33.7 MMBtu/hr (5H-205) respectively.

## CAPACITY IMPROVEMENT

The refinery wanted to increase absorbed duty of their heaters by 10%. Operating data analysis of the heaters portrayed that the convection sections were fouled. FIS evaluated three options to redesign the convection section. However, based on available pressure drop and targeted efficiency improvement, FIS patented **Split Flow Technology** was selected as shown in Figure 3 & 4.

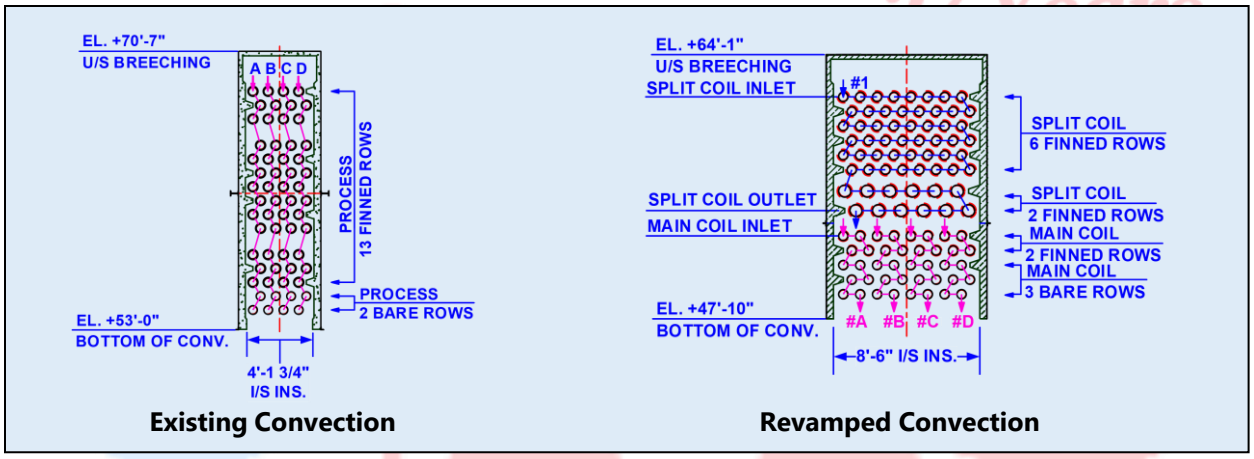


Figure 3: Depentanizer Reboiler (4H-102) convection section comparison

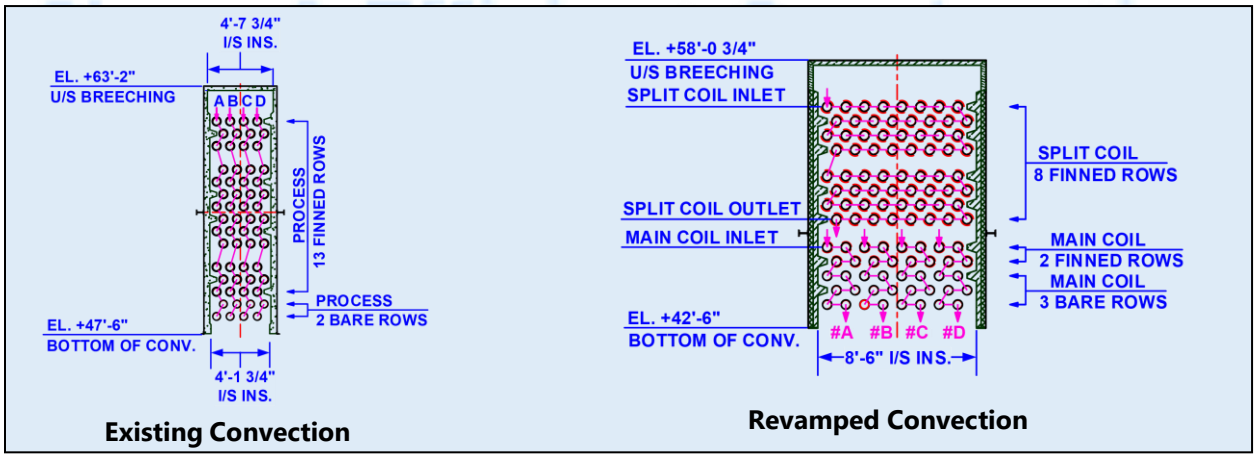


Figure 4: Depentanizer Reboiler (5H-205) convection section comparison

The revamped convection sections were wider as compared to existing convection section.

# Case Study

## BURNER REPLACEMENT

Client also wanted to improve the current heater permit level by about 15%. The conventional vertical firing would result in flame impingement. FIS installed Ultra Low NOx Burners with FIS patented **Inclined Firing Technology** to address the flame impingement issues.

| Depentanizer Reboiler Heater Data Comparison | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter** | **Units** | **4H-102** | | | **5H-205** | | |
| | | **Design** | **Operating** | **After Revamp** | **Design** | **Operating** | **After Revamp** |
| **Firing Duty (HHV)** | MMBtu/hr | 59.95 | 39.82 | 69.2 (15.4%↑) | 44.06 | 27.4 | 50.1 (13.7%↑) |
| **Firing Duty (LHV)** | MMBtu/hr | 54.5 | 36.2 | 59.52 | 40.05 | 24.9 | 43.2 |
| **Maximum Case Absorbed Duty** | MMBtu/hr | 46.2 | 30.17 | 51.15 | 33.7 | 20.1 | 37.07 |
| **Efficiency** | % | 84.8 | 83.3 | 85.9 | 84.1 | 80.7 | 85.8 |
| **Flue Gas Temp. Leaving Convection** | °F | 540 | 623 | 510 | 570 | 515 | 510 |
| **NOx Emission** | Lb/MMBtu | - | - | <0.03 | - | - | <0.03 |

Salient features of the revamped design are as follows:

- Absorbed duty of both the heaters increased by 10% as compared to original design
- Improved thermal efficiency of the heaters
- Reduction in flue gas temperature leaving convection section
- Improved efficiency led the client to save **194,265$/year** on fuel savings based on 4.8$/MMBtu fuel price

The heaters were successfully commissioned in May 2011.

# FIS Revamp Solutions

**FIS designs revamp solutions of the project based on customer specific requirements, which extend from an engineering study to a detailed engineering and execution, as portrayed in Figure 5.**

FIS revamp projects are generally focused on following areas:

- Capacity Increase
- Efficiency Improvement
- NOx Reduction

FIS scope of services includes activities exhibited in Figure 6.

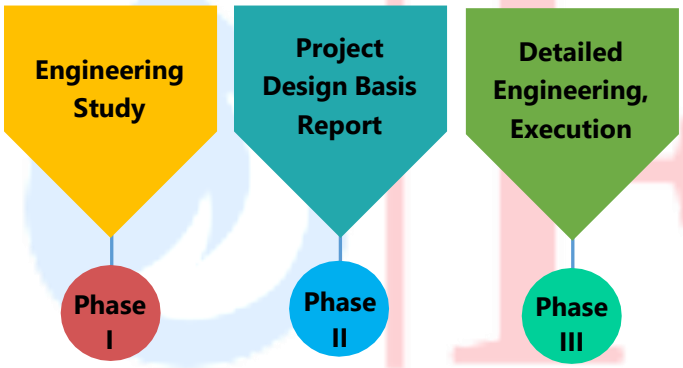


Figure 5: Typical fired heater/ boiler revamp project phases

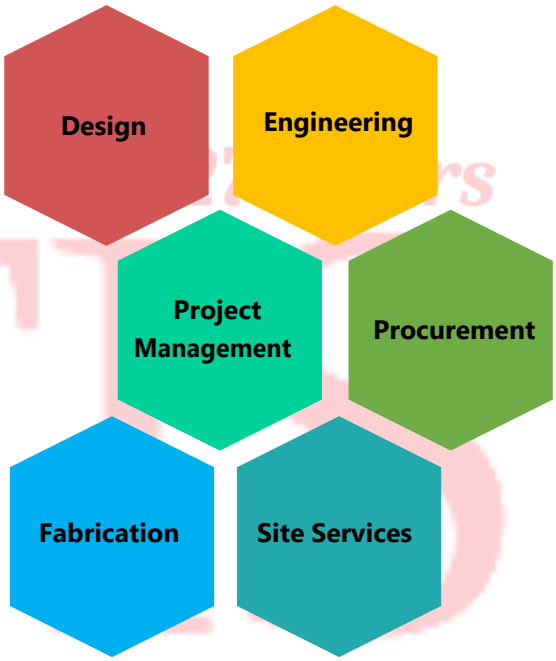


Figure 6: Furnace Improvements example of scope of services

**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.

# Furnace Improvements Services

**Uniform Heat Transfer in Fired Heaters**

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