UOP
A Honeywell Company

UOP Third Stage Separator

Refining

Introduction

For many years refiners have used an external, cyclonic third stage separator to remove catalyst fines from FCC regenerator flue gas. These devices have typically been used in power recovery installations to protect expander blades.

In most instances, the fines were removed from the flue gas, diverted around the power recovery expander blades, reintroduced to the flue gas, then expelled via the FCC stack. This configuration does not take advantage of the inherent flue gas upgrading possibilities associated with a TSS.

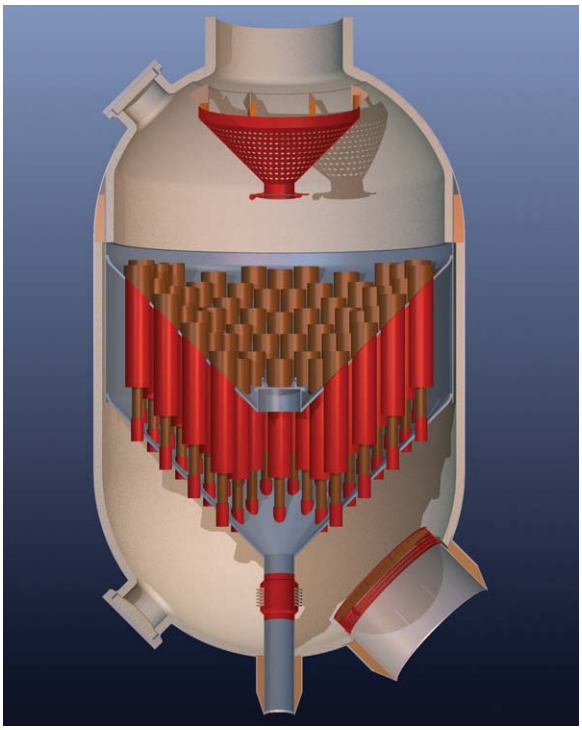
With the increasing demand on refiners around the world to decrease particulate emissions from the FCC stack, UOP recognized the need for a low cost alternative to the more expensive particulate removal technologies of wet gas scrubbing and electro-static precipitators. This need has been met with the commercialization in 2002 of the new UOP TSS.

Process Description

The UOP TSS takes FCC regenerator flue gas and passes it through a number of small diameter, high efficiency, cyclonic elements arranged in parallel and contained within the separator vessel (Figure 1). The flue gas enters the vessel through a flow distributor that uniformly distributes the gas to the individual cyclone elements. The equal distribution of catalyst laden gas ensures that each cyclone element processes an equal amount of catalyst flow. This improves the efficiency of previous TSS designs where radial gas flow from the center of the vessel could cause uneven cyclone element loading.

After the catalyst particulates are separated from the flue gas in the cyclones, the clean flue gas leaves the separator. A small stream of gas, called the underflow, exits the separator through the bottom of the separator vessel. In an environmental application the underflow is directed to an additional separation and collection stage before combining with the clean flue gas.

Figure 1 ■ **UOP Third Stage Separator**



Advantages over previous TSS designs

The new UOP TSS provides significant process, mechanical and cost advantages over previous TSS designs. The smaller vessel requirement, the possibility of shop fabrication, and the ease of system maintenance are some of those advantages.

The UOP TSS vessel is about 40% smaller in diameter for similar flue gas rates than other TSS offerings. The smaller vessel is not only less expensive to fabricate, but occupies a smaller footprint. The smaller footprint makes the UOP TSS ideal for revamps where plot space is at a premium.

In many cases, the reduced size of the UOP TSS vessel permits shop fabrication and delivery to site with internals installed. The shop fabrication not only increases the quality of the construction, but decreases the need for time-consuming field construction, which can directly impact turnaround duration.

An additional benefit of the UOP TSS is its ease of maintenance. Other TSS designs contain a “forest” of tubes that make inspection difficult and maintenance time-consuming and expensive. The UOP TSS is open, allowing access to the cyclone elements from both the top and bottom tube sheets. Although the UOP TSS has significant turn-down capacity, if there is a prolonged change in throughput, this easy access makes capacity changes as easy as dropping in or removing cyclone elements.

Commercial experience

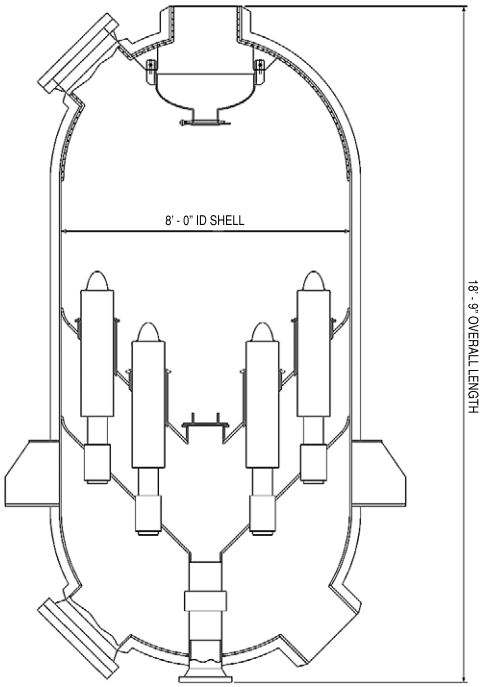
UOP has been designing and licensing third stage separators for more than 25 years. This experience has led UOP to continually improve the TSS in both mechanical and process design.

The new UOP TSS was first commercialized in 2002 downstream of an 8,000 BPD FCC unit (Figure 2). This UOP TSS was designed for environmental compliance of particulate emissions from the FCC stack, and included an underflow filter for removal of catalyst fines from the underflow stream.

Initial flue gas testing by an independent laboratory showed particulate concentrations leaving the regenerator stack between 38-50 mg/Nm3, depending on the flue gas turn-down rate. The final compliance testing of the unit resulted in particulate emissions from the regenerator stack of 0.6 lbs/1,000 lbs of coke burned in the regenerator, about 67% of that allowed by NSPS standards.

UOP is currently involved in several UOP TSS projects for both power recovery applications and particulate emissions control.

Figure 2 ■ **UOP Third Stage Separator**
8,000 BPD FCC Unit



Revamp opportunities

Significant opportunities exist in revamping older style third stage separators to increase separation performance and extend the life of power recovery expander blades. These opportunities stem from the inherent small size of the UOP TSS that permits existing vessels to operate with improved performance and higher than nameplate capacity. UOP has revamped existing third stage separators to eliminate bypassing of catalyst around swirl vanes, upgrade brittle ceramic liners and increase the effectiveness of unit underflow.

UOP technology can be used to revamp any third stage separator where high catalyst losses or short run times between expander blade replacements cause a loss in refinery profitability.

For more information

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