FCC EXPANDER FLOW PATH EROSION - PARTICLE SEPARATOR PERFORMANCE

By David Linden

Evaluating the performance of a Third Stage Separator (TSS) can be difficult since the catalyst exiting the FCC process varies significantly over time and changes with various operating modes and parameters. In addition, the catalyst in use can be a blend of several different types of catalyst and catalyst additives that have variable physical properties and concentrations. TSS performance evaluations are generally done via simultaneous Iso-kinetic Tests of the TSS inlet, outlet and underflow lines. It should be remembered that an Iso-kinetic test is a snap shot in time of variable process conditions. Iso-kinetic test details will be elaborated on in future RMS newsletters.

Performance evaluations of Third Stage Separators (TSS) involve measuring the amount of particulate entering the TSS and comparing it to that exiting. The inlet conditions are often used to evaluate the performance of the regenerator cyclones. The outlet conditions are of high interest since this is an indication of the particulate entering the downstream gas expander. The evaluation considers either the total mass or quantity of particulate entering and exiting the TSS, as well as the particle size distribution.

Quantity

The quantity of particulate exiting the TSS is generally measured on a mass flow/hour basis. In order to normalize the data and to be able to compare different size operating units, the mass flow of catalyst is often converted to a parts per million basis (PPM). PPM equals (pounds of catalyst / pounds of flue gas per hour)*10^6. A typical 80K BPD FCC regenerator will discharge approximately 263 lb/hr of catalyst into the TSS. At a flue gas rate of 750,000 lbs/hr, the TSS inlet loading would be 350 ppm. If the regenerator has deteriorated, the catalyst losses increase and loadings in excess of 500 ppm can be experienced.

A properly operating TSS will remove a majority of the entering catalyst and the outlet is likely to be in the 100-ppm range for the above example. This would correspond to 75 lbs of catalyst per hour entering the gas expander. Catalyst loadings in excess of 120 ppm into the expander will cause flow path wear and reduce the expander operating time.

Catalyst loading data is often presented in catalyst mass per standard cubic feet (lbm/SCFM) or in metric units - milligrams per normal cubic meter (mg/Nm^3).

Distribution

The catalyst particle distribution is very important when evaluating the TSS performance. Typical catalyst distributions (both inlet and outlet) can be seen in the following Figure #1. The Figure #1 plots represent

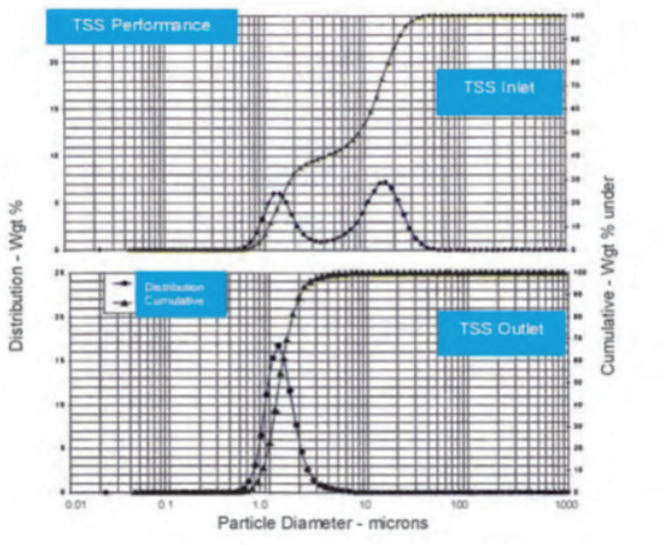

Figure 1: Typical TSS Performance (Inlet and Outlet)

both modern and properly operating FCC regenerator cyclone and TSS performance. From the plots, it can be seen that the TSS is very efficient at removing the larger catalyst particles (10 microns and larger). Conversely,

the efficiency drops off quickly for particles less than 10 microns in size.

It can also be seen that providing a single overall TSS efficiency number is of little value since it is so dependent upon particle distribution. If all of the inlet particles were large (>20 microns), the TSS overall efficiency would be close to 100%. If all of the inlet particles were small (<1.0 microns), the overall efficiency would be 25%! For reference, overall TSS efficiencies are typically in the 50 to 60% range.

By evaluating both the overall quantity and particle distribution, one can assess the TSS performance. Abnormal particle distributions can also identify deterioration or damage to either the regenerator cyclones or TSS internals. For example, an increase in the quantity and the level of fines in the TSS inlet might indicate a catalyst attrition problem in the regenerator. An increase in particle size out of the TSS might indicate wear or a mechanical issue allowing catalyst to bypass the swirl vanes or cyclones.

In order to assure long-term reliable expander operation, periodic (typically once or twice a year) testing of the TSS is recommended. The test data interpretation is best conducted by experienced personnel.

In our next newsletter, we will discuss the effects of particle loadings on the expander.

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