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## **Question 17: What testing frequency and additional feed characterization (apart from bulk properties) should be used to accurately monitor catalyst performance on heavy feeds?**

### **FERNANDO MALDONADO (Shell Catalysts & Technologies)**

The type and frequency of tests performed are unit and refinery specific. When creating or modifying a unit's laboratory test schedule some factors to be considered include:

1. Unit objectives
2. Past and/or current operational issues
3. Refinery onsite laboratory's capability and resources
4. Catalyst vendor support

At many refineries, there is a heavy demand placed on refinery laboratory resources and a request for adding new test(s) results in the question as to which of the current test(s) will be dropped from the schedule. Additionally, for non-routine operational issues, the catalyst vendor can often provide specialized feed and product sample testing useful in troubleshooting exercises.

To monitor catalyst performance on a unit processing heavy feeds (e.g. FCC PT), Shell Catalysts & Technologies suggests the following laboratory analysis:

1. Tests to be performed daily on the feed and products:
  - a. Feed density, sulfur, nitrogen, distillation, concarbon, and metals (nickel, vanadium, iron, sodium, silicon)
  - b. VGO product density, sulfur, nitrogen, and distillation
2. The following tests should be done on at least a weekly basis:
  - a. Feed aromatics, and C7 insolubles
  - b. VGO product aromatics, concarbon, and metals (nickel, vanadium, iron, sodium, silicon)

### **JOHN PETRI (Honeywell UOP)**

ASTM D6352 is used for simulated distillations of higher boiling point feeds including DAO. Simulated distillation better captures the tail end of a feed distillation than an ASTM D1160 or D86 distillation. Some bulk analyses that refiners may not consider include silicon analysis since flow improvers are now

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more commonly used in production and transport of heavier oils. For bitumen based crude sources a particle size distribution analysis using laser refractometry will be important to size and select graded bed materials properly for pressure drop mitigation.

UOP recommends occasional HRMS and GC-GC for hydrocarbons type distribution can be used to quantify multi-ring aromatic components such as 4 and 5+ rings, which can be highly inhibiting and coke forming. In addition, for recycle operations you should analyze for PNA and HPNA using appropriate advanced analytical methods such as HPLC and UV absorbance methods. The frequency can be related to significant changes in crude selection or changes in distillation operations that increase the endpoints of feed streams.

### **SERGIO ROBLEDO (Haldor Topsoe, Inc.)**

For proper catalyst monitoring we like to see daily analyses for sulfur, nitrogen, gravity and distillation (SimDist) of the bulk feed. We also like to have feed contaminants (Ni, V, Si, etc.) measured, at minimum, on a weekly basis.

Olefin and, in particular, diolefin content of each individual stream is important to know. Lighter molecules and olefins can react with fast kinetics. To keep these reactions in a controlled range requires understanding the catalyst bed dynamics and the concentration of each. Ideally this should be done daily, but as at a minimum on a weekly basis.

Aromatic content and aromatic breakdown (mono, di, tri+) is also important to analyze to understand how much hydrogen consumption and, in turn, volume swell can be expected from each stream. We recommend this be done on a weekly basis, but at a minimum, on a monthly basis for each stream component.

C7 insolubles, or asphaltene content, should also be measured on a weekly basis.

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