IMO disruption impact on FCCs

Major disruption of last 20 years will impact core refinery unit as the FCC
IMO global vision
-refining perspective

IMO and FCC's impact

Summary & tangible levers
IMO regulation is expected to present ~2.5 Mbpd deficit in compliant bunker fuel
3 main sources for producing compliant bunker fuel, clearly impacting FCCs feed or products

1. Straight run low sulfur material
   - Low sulfur vacuum residue
   - Low sulfur atmospheric residue
   - Low sulfur VGO

2. Products from cracking
   - UCO from Hydrocracker
   - Heavy cracked cuts from FCC, Coker, Cracker, Visbreaker, etc.

3. Middle Distillates
   - Marine Gasoil
   - Diesel from cracking

FCC impact
There is more than enough straight run low sulfur production that could potentially meet new IMO spec

-7.2 Mbpd of compliant low sulfur material

Note: Total and low sulfur atmospheric residue has been calculated based on World crude Oil Data generated by Energy Intelligence 2018 report, crossed with crude assays, properties and yields database.
...but this LS straight run material is already used today in any of this 3 destinations

**Direct sale**

- Low sulfur material can be sold directly to end-users in the maritime, power and industrial sectors; segregated or blended with HSFO. Switching from power or industry to marine has a very low probability

**Conversion**

- Low sulfur material is converted into valuable products like gasoline, diesel and jet. By-passing conversion feed will result in lower production of valuable products

**FCC impact**

**Blending for conversion**

- Blending of low sulfur material is necessary to comply with restrictions on sulfur content in conversion units (e.g. mixed with high sulfur residue). LS straight run material produced for this blending is considered not to be available for fulfilling LSFO demand deficit
FCCs are at the core of the need for new compliant fuel

1. Crude Distillation Unit
2. Middle Distillates
3. Hydrotreatment/Mild Hydrocracker/Hydrocracker
4. Fluid Catalytic Cracker
5. Vacuum Distillation Unit

1. CDU
2. VDU
3. HDT / MHCK / HCK
4. FCC
5. VGO
6. AR
7. VR
8. UCO
9. MD
10. LSVGO (S<0.7)
11. Residue Conv
12. Residue HDT
13. Slurry
14. MD
15. RHDT
16. MD
17. LSVR (S<0.7)
18. LVAR (S<0.7)

High cost compliant material
Low cost compliant material
Over 35% of FCC's feed is impacted by IMO's pressure on low sulfur or desulfurized VGOs

-5.7 Mbpd of LS feed is processed in FCC units, representing 36% of the FCC total feed

1. 80% utilization
Straight run LS VGO to FCCs is a specially relevant lever.

SR LS feedstock destinations (Mbpd)

- **Total**: 7.2
- **Blending in HSFO**: 0.6-0.9 (13%)
- **Industry and power generation**: 0.9-1.4 (19%)
- **VGO SR to FCC**: 1.5-2.0 (24%)
- **Coker feed for anode production**: 0.7-0.9 (11%)
- **Blending for conversion (VGO+VR)**: 2.0-3.5 (34%)

- Direct sales
- LS to conversion units
- Blending
We see FCCs contributing to new bunker and diesel demand with more than 0.5 Mbpd mainly by its bypassing.

Levers to achieve valuable products demand in 2020 (Mbpd):  
1. 2020 valuable products demand  
2. FCC by-pass and operations  
3. Molecule management  
4. HSFO HDS operation mode and new capacity  
5. New HCK operation mode  
6. Anode coke operation  
7. New conversion capacity  
8. Higher Reformer and ISOM throughput/higher crude processing
~1 Mbpd of LSFO can be achieved through FCC bypassing and operation mode adjustment

A conservative 20% FCC bypass at lower FCC conversion could yield ~1 Mbpd of additional LSFO, with a net mass balance of 0.6 Mbpd
0.7-0.9 Mbpd of gasoline can be produced increasing throughput in reforming units

Current reformer and ISOM utilization is 70-80%, allowing for 2.8-4.0 Mbpd of spare capacity

There are ~6 Mbpd of naphtha production, from which 1.2 can switch to the reformer and isom pool producing 0.7-0.9 Mbpd of gasoline

1. We suppose that 30% of the naphtha production is heavy naphtha. 2. Average gasoline yield in reforming is 80%
IMO impact summary on FCCs

1. Low sulfur VGO (<0.8%S) price increase
2. HDT feed & UCO price increase as LSFO
3. Diesel and gasoline gap increase (for diesel)
4 main levers to enhance FCC profit in IMO scenario

- Move to process VGO with >0.8%S
  VGO above 0.8%S would be discounted

- Process refinery HS streams
  Streams going today to HSFO will need to be valorized, being FCC a clear candidate

- Cut deeper your VGO
  VR discount vs FCC expected to boost

- Shift to diesel
  As distillate demand will grow, the gap between gasoline vs diesel is expected to be wider
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