Fluidized-bed Catalytic Cracker (FCC) is the third unit in this seven-step overview of Refining

Overview of Fluidized-bed Catalytic Cracker (FCC)

The primary function of the Fluid Catalytic Cracking (FCC) unit is to "crack" the gas oil fraction of the crude oil to produce more gasoline and distillate fuels. The FCC was developed as the amount of naphtha available in the crude oil is insufficient to meet the demand for gasoline per barrel of crude oil. The FCC is often the most profitable operation in the refinery.

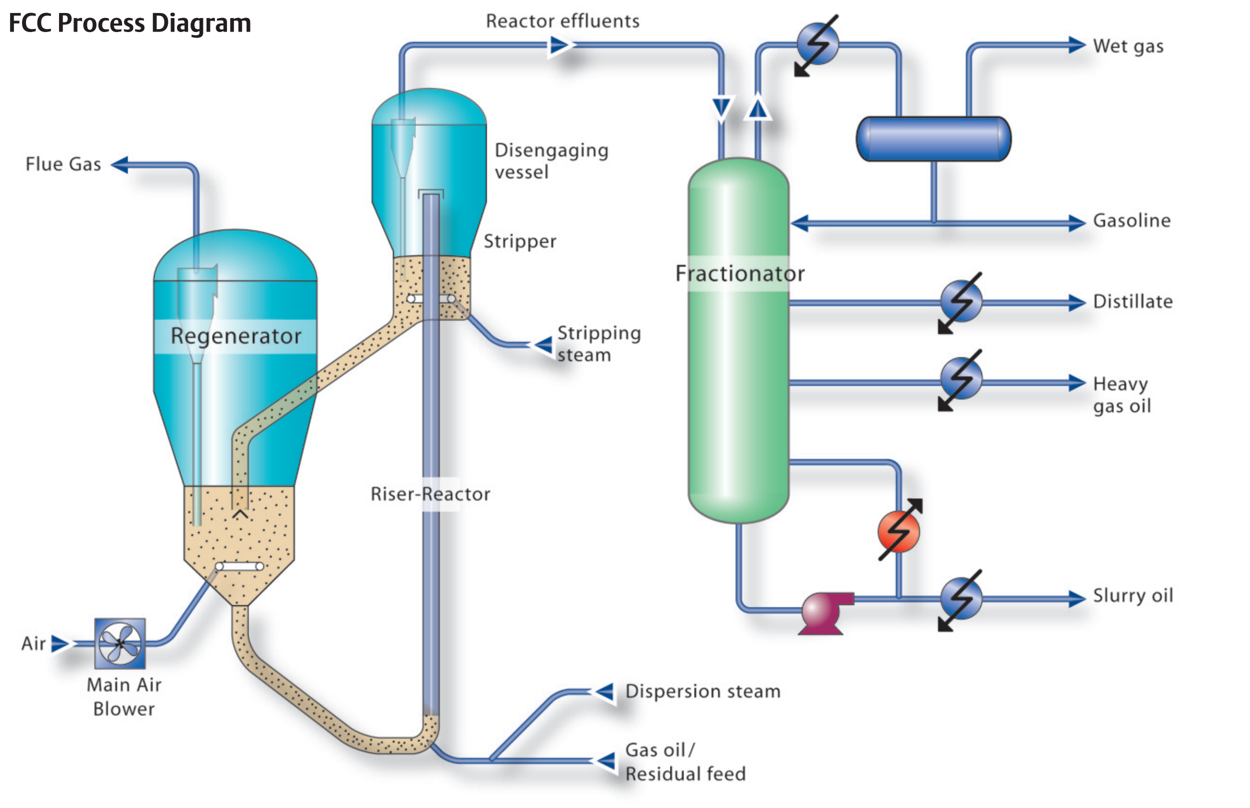
The cracking process produces carbon (coke) which remains on the catalyst particle and rapidly lowers its activity. To maintain the catalyst activity at a useful level, it is necessary to regenerate the catalyst by burning off this coke with air. As a result, the catalyst is continuously moved from reactor to regenerator and back to reactor. The cracking reaction is endothermic and regeneration reaction exothermic.

The FCC process employs a catalyst in the form of very fine particles which behave as a fluid when aerated with a vapor. The fluidized catalyst is circulated continuously between the reaction zone and the regeneration zone and acts as a vehicle to transfer heat from the regenerator to the oil feed and reactor.

The FCC unit has a lot of flexibility in the type of feedstocks it can process. Typical FCC Feedstocks include atmospheric gas oil, vacuum tower bottoms, and Coker gas oils. The hot oil feed is contacted with the catalyst in either the feed riser line or the reactor. As the cracking reaction progresses, the catalyst is progressively deactivated by the formation of coke on the surface of the catalyst. The catalyst and hydrocarbon vapors are separated mechanically and oil remaining on the catalyst is removed by steam stripping before the catalyst enters the regenerator. The oil vapors are taken overhead to a fractionation tower for separation into streams having the desired boiling ranges. The major products include alkylation unit feedstocks (Propylene, Isobutane and butylenes), gasoline, and diesel fuel or heating oil.

The spent catalyst flows into the regenerator and is reactivated by burning off the coke deposits with air. Regenerator temperatures are carefully controlled to prevent catalyst deactivation by overheating and to provide the desired amount of carbon burn-off. This is done by controlling the air flow to give a desired CO_2/CO ratio in the exit flue gases or the desired temperature in the regenerator. The flue gas and catalyst are separated by cyclone separators and electrostatic precipitators.

FCC Process Diagram



Customer Challenges

The FCC unit is often the most profitable operation in the refinery, with net profits commonly in the range of $250,000 to $500,000 a day for a unit with a capacity of 50,000 BPD. As a result, the reliability, or availability of this unit is the most important concern for the refiner. Anything that will contribute to keeping the unit up and running optimally is of interest.

The following customer challenges have been defined and Micro Motion offers integrated application solutions that provide everything needed to meet these challenges and improve quality, productivity, and profitability.

Customer Process Challenge #1 – Maximizing Feed Rate

Challenge: The feed rate to the FCC should be maximized within the existing unit constraints including air blower and gas compressor capacity, catalyst circulation, and alkylation capacity. Accurately measuring each of the feed stream flow rates is important to maximize the total feed. Also knowing the density of each of the components and the total feed is important for feed forward control.

Customer Process Challenge #2 – Unit Mass Balance

Challenge: Getting an accurate and reliable mass balance around the FCC unit is challenging because of the constant changes in the composition of feed and product streams. An accurate mass balance is critical for unit evaluation and optimization. Accurate measurement of the slurry oil is particularly difficult because of its abrasive nature. Minimizing slurry oil make is important, so measuring it accurately is important.

Improving Efficiency

Customer Challenge #1 - Maximizing Feed Rate

Control Point Challenge: Maximizing feed rate

Solution: Accurate feed rate control to the FCC is important in terms of maximizing flow to the unit, but also for production accounting purposes and following the refinery LP to maximize profitability. Measurement of feed density is also helpful to unit operations.

Several key features of the new Micro Motion meters which can benefit flow measurement in this application include:

- flow calibration verification
- no need to zero

The flow verification and zero-free features are both of interest because of the fact that this unit operates continuously for 3-5 years before shutting down for maintenance. Verifying the flow measurement during this period is very beneficial.

Competing Technology: Orifice dP

Recommended Product Solution

Micro Motion ELITE CMF400, ELITE CMF400A or D600

Application

FCC feed flows, sometimes multiple streams from different sources.

Customer Challenge #2 - Unit Mass Balance

Control Point Challenge: FCC material balance

Solution: Direct mass measurement, which is independent of composition changes leads to very accurate and reliable measurement for all fluid streams around the FCC, allowing for an accurate material balance.

Competing Technology: Orifice dP

Micro Motion ELITE CMF200, ELITE CMF300, ELITE CMF300A, ELITE CMF400, ELITE CMF400A

Application

FCC feed, fractionator products including slurry oil

EMERSON
Process Management

