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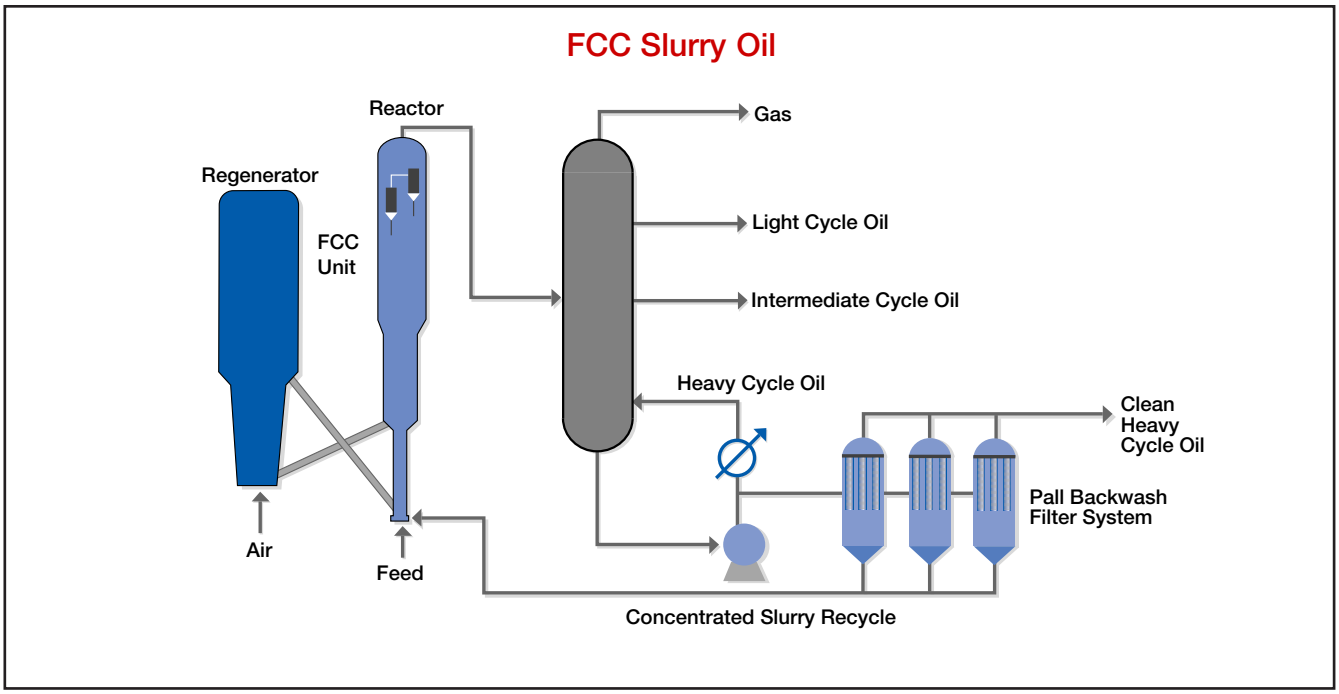
Fluid Catalytic Cracking Slurry Oil Clarification



Process Description

Fluid Catalytic Cracking (FCC) produces high octane gasoline, C_3/C_4 olefins and isobutane by the catalytic cracking of heavy gas oils in a fluid bed reactor. The primary product separation is carried out in a fractionator which produces gas as the overhead products, gasoline and heavier gas oils as side draw-off products and heavy cycle gas oil as the bottoms product. This bottoms stream contains the catalyst not collected by the cyclones in the reactor, and is sometimes referred to as slurry oil.

Need

The solids concentration of slurry oil typically exceeds 1500 ppm, which must be lowered substantially before the oil can be sold. Typically, slurry oil is disposed one of three ways:

1. It is most commonly blended into the No. 6 fuel oil pool, also known as bunker C fuel. The typical alumina concentration permitted in No. 6 fuel oil is 250 ppm, which originates solely from the catalyst in the slurry oil component. To meet this specification, refineries often add lighter, solids-free saleable products to dilute the slurry oil. This limits the total revenue capability of the refinery since No. 6 fuel oil is a relatively low price product.
2. It can be used as a feedstock to a coker unit or a hydrocracker. This converts a portion of the slurry oil to lighter, higher value products, but it does not remove the catalyst from the system.
3. It can be sold as a feedstock to carbon black manufacturers. Slurry oil with a maximum solids content of 100 ppm, can yield a selling price of $1-2/barrel higher than fuel oil.

Solution

The Pall solution is to filter the slurry oil to reduce its solids content to an acceptable level. The clarified oil can then be sold to carbon black producers at a premium, blended into the No. 6 fuel oil pool without exceeding the alumina specification, or as a boiler fuel without causing fuel nozzle erosion. The solids are discharged from the filter in a highly concentrated form to facilitate disposal, or minimize recycled volume. This approach is economically attractive since it increases the refinery's income and minimizes the waste disposal problem. When compared to conventional separators utilized by refineries, Pall filters are substantially lower in both capital and operating costs.

Pilot Testing

Pall Corporation demonstrated the technical feasibility of filtering slurry oil by side stream testing under actual operating conditions. These tests have been successfully carried out at several refineries. Rigimesh® grade K filter medium was used in a test filter unit to lower the solids

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concentration of the stream from an average of 1500 ppm to 100 ppm. This represented a 93% removal by weight of the very fine catalyst particles.

The particle size distribution of the catalyst is highly variable depending on the FCC unit and fractionator throughput and operating conditions. The following is a typical size distribution:

Diameter (µm) (actual particle count)	% by number
1-5	30
5-15	55
15-25	10
25-50	5
>50	<0.3

Flow densities of 0.3 to 1.0 gpm/ft^2 were used in the tests. The typical process conditions were:

Temperature:	400-650°F
Fluid Viscosity:	0.8-4 cp
Fluid Density:	0° - 10° API
Pressure Drop Prior to Backwash:	20 psid
Equilibrium Pressure Drop:	<4 psid
Cycle Time Between Backwashes:	2-3 hours

Using Pall's bump and settle backwash technique, the solids concentration in the discharged material (backwash waste stream) was approximately 2.5 lb/gal (about 30% by weight solids). The filter showed no tendency to blind through repeated backwash cycles.

Applications

Every refinery with an FCC unit has this need to highly concentrate solids in the slurry oil into a small volume for easy recycle, while maximizing the recovery of saleable clarified oil. The backwash waste stream contains approximately 30% by weight catalyst, allowing easy recycle to the riser of the FCC unit. The clarified oil from the backwash filter has a sufficiently low solids and alumina content to be sold at a $1-2/barrel premium as carbon black feedstock. Alternately, it can be blended into the No. 6 fuel oil pool without exceeding the alumina specification for No. 6 fuel oil. This removes the need for blending lighter, higher value products into the No. 6 fuel oil, maximizing the total revenue of the refinery. In refineries where slurry oil is used as feedstock to a coker, hydrocracker or visbreaker unit, filtration of the slurry oil prior to the unit will minimize the operating problems caused by the presence of high solids concentrations in the feeds to these units. The clarified oil can also be used as a boiler fuel without causing fuel nozzle erosion.

In each application, the appropriate filter grade will be selected for the required solids removal. The filter sizing and operation can be tailored to satisfy the specific requirements of the refinery. Automated control of multi-vessel backwash filtration units provides reliable, continuous operation.

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