UOP
A Honeywell Company

FWUSA/UOP Visbreaking Process

Refining

Visbreaking is a non-catalytic thermal process that converts atmospheric or vacuum residues via thermal cracking to gas, naphtha, distillates, and visbroken residue. Atmospheric and vacuum residues are typically charged to a visbreaker to reduce fuel oil viscosity and increase distillate yield in the refinery.

The process will typically achieve a conversion to gas, gasoline, and distillates of 10% to 50%, depending on the severity and feedstock characteristics. Visbreaking reduces the quantity of cutter stock required to meet fuel oil specifications and, depending upon sulfur specs, can decrease fuel oil production by 20%.

In 1993, UOP and Foster Wheeler USA Corporation (FWUSA) collaborated to combine their respective visbreaking technologies into a single, optimized offering supported by both companies.

Process description

The thermal conversion of the residue chargestock is accomplished by heating at high temperatures in a specially designed furnace. The residence time, temperature, and pressure of the furnace's soaking zone is controlled to optimize the thermal free radical cracking to produce the desired products. The heater effluent is quenched to stop the reaction and the quenched products flow to the fractionator for separation of the visbroken naphtha, distillate, and residue. After steam stripping, the distillate is recombined with the visbroken residue for heavy fuel oil production (Figure 1).

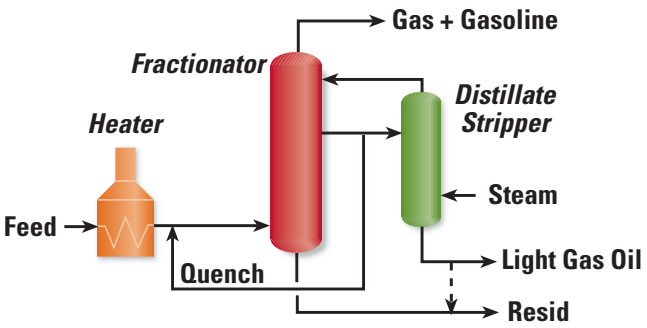
When considering a visbreaking unit for residual streams upgrading, specific objectives must be defined.

Feedstock conversion impact

Feedstocks with low *n*-pentane insolubles and softening points show good susceptibility to visbreaking, while those with high values respond poorly.

Stability of fuel oil product is a limit to the conversion attainable in the visbreaking process. The thermal mechanism will result in precipitation of unconverted materials if conversion is taken too far. The "crackable" oils dissolve the precipitates. As the "solvent" is converted away, the heavy materials fall out of the solution.

Figure 1 ■ **Typical Visbreaking Process**



Conversion is limited by asphaltene and Conradson carbon content. A feedstock with a higher asphaltene content will limit the overall conversion possible while maintaining production of a stable fuel oil product. The presence of sodium, as well as higher levels of feed Conradson carbon, can increase the rate of coking in the heater tubes. Minimizing the sodium content will result in significantly longer operating cycles.

Residues with low softening points and low *n*-pentane insolubles contain a greater portion of the heavy distillate, non-asphaltenic oil. It is this heavy oil that cracks into lower boiling and less viscous oils, and result in an overall viscosity reduction. The asphaltenes (*n*-heptane insolubles) go through the furnace relatively unaffected at moderate severities.

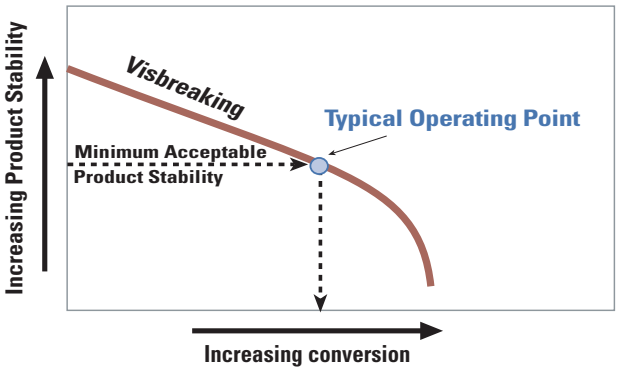
Data indicate that for a given feedstock, as the severity is increased, the viscosity of the 400 °F+ (204 °C+) visbroken tar initially decreases and then increases dramatically. This viscosity reversal indicates the point beyond which fuel oil instability may occur (Figure 2).

Types of visbreakers

The visbreaking designs are commercially available: "coil" or "soaker". Product qualities and yields from these designs are essentially the same at a given severity and are independent of visbreaker configuration. UOP and FWUSA prefer the coil design.

The "coil" or "furnace" design offers the advantage of ease of operation as conversion by high-temperature cracking occurs within a dedicated coil in the furnace, so the unit does not have to be shut down for decoking.

Figure 2 ■ **Visbreaking Operation**



The “soaker” design achieves some conversion within the heater; however, the majority occurs in a reaction vessel or “soaker” outside the furnace. The reactants are held as a two-phase effluent at an elevated temperature for a predetermined residence time on the basis of plug flow through the soaker. This lower heater outlet temperature may result in lower fuel cost, but also results in reduced steam production.

On-Stream factor

Visbreaker units are reliable. On-stream factors can be increased further by incorporating on-line decoking in the design. For small units this requires a two-cell furnace with one cell taken off-line in turn. For larger units, one heater can be taken off-line at a time.

Furnace design expertise

UOP and FWUSA have unparalleled experience in the design of black-oil heaters. These heaters are characterized by:

- High in-tube velocities to maximize inside heat transfer coefficient and limit tube wall temperature.
- Specialized design features to permit variation of cracking residence time.
- Optimum flux rate with minimum practical mal-distribution based on peripheral tube surface.
- Uniform degree of conversion to minimize localized in-tube coking.
- Symmetrical piping and coil arrangements within the furnace enclosure.
- Individual pass control with multiple steam injection points for each pass.

VGO recovery

For VGO recovery, UOP offers both a vacuum flasher and a novel technology that recovers a high percentage of the VGO in a coil visbreaker’s fractionator.

Experience

Combined, UOP and FWUSA have designed and licensed more than 50 visbreakers, over 20 of which have been designed since 1993.

For more information

UOP/FWUSA Visbreaking technological services are available on request. For more information, contact your local UOP representative or contact our Des Plaines sales office:

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