Maximizing the Refinery Process

The CIRCOR Advantage

CIRCOR understands that the mission of every basic refinery process is to maximize the yield of light products from raw crude oil. We understand the unique demands and constant challenges of refining crude oil. And we respond to those demands and challenges by bringing our unique blend of experience and expertise to refineries around the world. At every step of the refinery process, we're ready with an array of pumps and pumping technologies that help maximize efficiencies and production alike.

A Step-by-Step Guide

Here's a quick look at the refinery process itself, specifically how a typical barrel of crude oil flows through the system:

- The refinery receives the crude oil from tankers, barges, trucks or pipelines. The oil is pumped into storage tanks by a variety of general transfer and forwarding pumps.
- Raw crude oil is then pumped from the tank farm into a **desalter**, which removes free gas, water, salt, some metals and other crude oil contaminants. (The product from the desalter is called desalted crude.)
- With desalted crude as charge stock, charge pumps inject atmospheric distillation into the first refining operation. In atmospheric distillation the desalted crude oil is heated at atmospheric pressure, to flash off the lighter, more volatile products. This process results in distillates (gasoline, naptha, kerosene, etc.) plus atmospheric residuum, which contains the heavy ends of the crude oil (i.e., asphalts, residual oils and base lube oil stocks).
- The atmospheric residuum is then pumped by vacuum tower charge pump into the **vacuum distiller**. In vacuum distillation, the process stream is heated and exposed to a hard vacuum. The subatmospheric pressure promotes vaporization of the heavier materials at temperatures below cracking conditions. Greater amounts of light ends are removed, including light and middle fractions of fuel oils, gas oils, and a residuum called **vacuum tower bottoms**. Vacuum tower bottoms are highly viscous and – even with positive displacement pumps – must be handled at elevated temperatures (300+ degrees Fahrenheit).
- These two distillation processes remove only the free light ends within the crude oil. In order to break down the heavier residua, and to further refine the light ends already removed during distillation, other processes are incorporated downstream of the distillers (coking, catalytic cracking, hydrocracking, etc.).

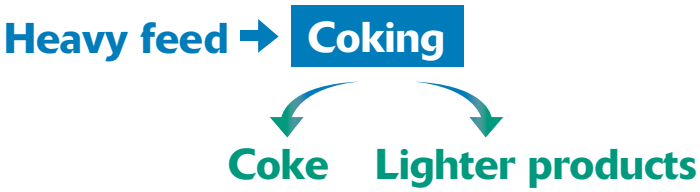
Every Refinery Is Unique

The exact downstream process is unique to each refinery. A variety of processes can be used, depending upon the nature of the crude oil, its properties and the percentages of individual petroleum fractions that it contains. For example, the amount of gasoline and naptha taken from crude oil feed stock can vary from 0 to 50 percent, depending upon the source of the crude. That's why different crude oils require different processes to maximize the production of any specific product.

Cracking Processes

Available cracking processes include:

Coking – Use of heavy residual as feed stock, yielding light products plus coke



Visbreaking – Reduction of the feed-stock viscosity, so that fewer light (expensive) stocks are needed for dilution, to meet the specifications for fuel oil viscosity

Catalytic cracking – Use of a catalyst to convert distillate feed stock, to maximize production of high-octane gasoline

Hydrocracking
Use of hydrogen as a catalyst to convert a wide range of feed stocks into fuels and gasolines

Generally catalytic cracking and hydrocracking are companion processes. Although there are many variations of each, the specific product desired and the crude oil stock determine which combination or specific process is used.

New Extraction Processes

Recent reformulated gasolines, required reduction of energy and the need for improved process yields have generated new extraction processes. The UOP-licensed Demex® and Kerr-McGee Rose® processes produce deasphalted oil to supplement catalytic-cracking and hydrocracking feed stocks.

CIRCOR pump applications can be used in processes with heavy residual oil or vacuum tower bottoms as charge stock, or those that have asphalt, residual oil or base lube oil stock as products.

Process	Charge Stock	Products
Coking Delayed coking Flex-i-coking	Vacuum tower bottoms* Residual oil* Tar, pitch* (heavy, otherwise unusable to stock)	Light ends Sulfur* Coke Gas oil
Vacuum residue cracking	Residuals from all processes Vacuum tower bottoms*	Light ends Heavy oil* Pitch
Visbreaking	Reduced crude*	Gasoline Gas oil Tar*
Heavy-oil cracking	Reduced crude*	Gasoline Gas oil Tar
Heavy-oil cracking	Residuum* Vacuum tower bottoms*	Gasoline Fuel oil Bottoms
Hydrocracking	Heavy fuel oil Fuel range distillates	Gasoline Naptha Kerosene Light gas oils Bottoms
Deasphalting	Reduced crude*	Deasphalted oil
Asphalt-blowing	Vacuum asphalt residuum*	Asphalt Gas oil Asphalt* Pitch

*CIRCOR application areas

Fluids Pumped by CIRCOR

CIRCOR pumps can be applied to all refineries, regardless of the specific crude oil or process. Although heavier crude oils generally require more positive displacement pumps, almost all refineries end up with vacuum tower bottom, asphalt or other heavy residuum that requires positive displacement pumps to effectively handle the fluid.

Fluids commonly pumped with positive displacement pumps in refinery service include:

Crude Oil	
Light	32–500 SSU
Medium	500–2,000 SSU
Heavy	2,000+ SSU

The viscosity properties and composition of crude oil vary considerably, depending on where the crude oil originates. The viscosity can range from 32 SSU Arabian crude oil to heavy tar-base Venezuelan crude oil in excess of 20,000 SSU.

Typically the products (fractions) from crude oil are identified as follows:

Crude Oil Fraction	Boiling Range (°F)
Gases	< 80
Light naptha	80–220
Heavy naptha	180–520
Light gas oil	420–650
Heavy gas oil	610–800
Residues	> 800

Viscosities	
Residuum Residual fuel oil	Viscosity 100+ SSU at 100°F – comparable to #4, #5 and #6 F.O., depending on asphaltic content
Vacuum tower bottoms Pitch Asphalt Asphalt flux	Viscosity 500–15,000 SSU at 300°F and higher, depending on specific process, crude oil and amount of light ends removed
Lube oil Heavy gas oils	Viscosity 60–3,000 SSU at 100°F – higher viscosities may be encountered, depending on process and crude feed stock
Waste oil	Viscosity 32–20,000 SSU – mixture of water, oils and other waste products from process stream spillage and overflow

About CIRCOR Corporation

CIRCOR Corporation is a global leader in critical fluid-handling solutions, including the manufacture of positive displacement industrial pumps and valves used in global oil & gas, power generation, marine, Naval and a variety of other industrial applications. Key product brands include Allweiler, Fairmount Automation, Houttuin, Imo, LSC, Portland Valve, Tushaco, Warren and Zenith.

About CIRCOR Oil & Gas Solutions

CIRCOR has served virtually every oil company throughout the world over the past 90 years, bringing particular critical expertise to crude oil transport in production facility, pipeline, tank farm and refinery applications and surrounding customers with design, engineering, manufacture, installation, testing and technical support services. The CIRCOR portfolio of pumping technologies delivers not only unsurpassed reliability, but operational and energy efficiencies, environmental responsibility and cost savings over the life cycle of the pump.

CIRCOR Corporation
8730 Stony Point Parkway
Suite 150
Richmond, VA 23235 USA
T: 804.327.5689
F: 804.560.4076

www.circorpt.com

CIRCOR Americas
1710 Airport Road
Monroe, NC 28110 USA
T: 704.289.6511
F: 704.289.9273

CIRCOR Asia Pacific
Unit 7, 31st Floor
Laws Commercial Plaza
788 Cheung Sha Wan Road
Lai Chi Kok, Kowloon
Hong Kong, China
T: +852.2136.8023
F: +852.2136.8026

CIRCOR Europe, Middle East, Africa
Allweilerstr. 1
78301 Radolfzell
Germany
T: +49 (7732) 86.0
F: +49 (7732) 86.436