

PETROLEUM REFINING OPERATIONS.

INTRODUCTION. Petroleum refining begins with the distillation, or fractionation, of crude oils into separate hydrocarbon groups. The resultant products are directly related to the characteristics of the crude processed. Most distillation products are further converted into more usable products by changing the size and structure of the hydrocarbon molecules through cracking, reforming, and other conversion processes as discussed in this chapter. These converted products are then subjected to various treatment and separation processes such as extraction, hydrotreating, and sweetening to remove undesirable constituents and improve product quality. Integrated refineries incorporate fractionation, conversion, treatment, and blending operations and may also include petrochemical processing.

B. REFINING OPERATIONS. Petroleum refining processes and operations can be separated into five basic areas:

1. **Fractionation** (distillation) is the separation of crude oil in atmospheric and vacuum distillation towers into groups of hydrocarbon compounds of differing boiling-point ranges called "fractions" or "cuts."

Conversion processes change the size and/or structure of hydrocarbon molecules. These processes include:

1. Decomposition (dividing) by thermal and catalytic cracking;
2. Unification (combining) through alkylation and polymerization; and
3. Alteration (rearranging) with isomerization and catalytic reforming.

3. Treatment processes are intended to prepare hydrocarbon streams for additional processing and to prepare finished products. Treatment may include the removal or separation of aromatics and naphthenes as well as impurities and undesirable contaminants. Treatment may involve chemical or physical separation such as dissolving, absorption, or precipitation using a variety and combination of processes including desalting, drying, hydrodesulfurizing, solvent refining, sweetening, solvent extraction, and solvent dewaxing.

4. Formulating and Blending is the process of mixing and combining hydrocarbon fractions, additives, and other components to produce finished products with specific performance properties.

5. Other Refining Operations include: light-ends recovery; sour-water stripping; solid waste and wastewater treatment; process-water treatment and cooling; storage and handling; product movement; hydrogen production; acid and tail-gas treatment; and sulfur recovery. Auxiliary operations and facilities include: steam and power generation; process and fire water systems; flares and relief systems; furnaces and heaters; pumps and valves; supply of steam, air, nitrogen, and other plant gases; alarms and sensors; noise and pollution controls; sampling, testing, and inspecting; and laboratory, control room, maintenance, and administrative facilities.

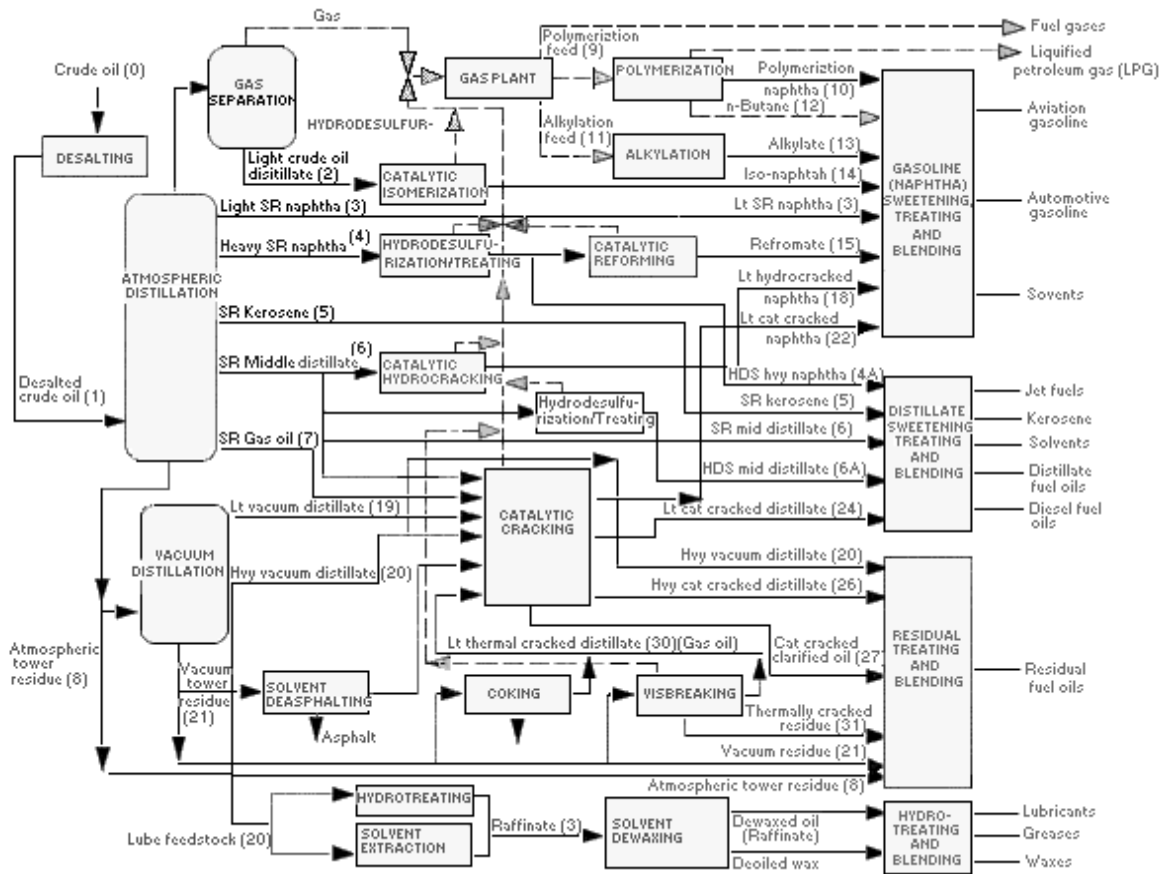


TABLE OVERVIEW OF PETROLEUM REFINING PROCESSES.

Process name	Action	Method	Purpose	Feedstock(s)	Product(s)
FRACTIONATION PROCESSES					
Atmospheric distillation	Separation	Thermal	Separate fractions	Desalted crude oil	Gas, gas oil, distillate, residual
Vacuum distillation	Separation	Thermal	Separate w/o cracking	Atmospheric tower residual	Gas oil, lube stock, residual
CONVERSION PROCESSED--DECOMPOSITION					
Catalytic cracking	Alteration	Catalytic	Upgrade gasoline	Gas oil, coke distillate	Gasoline, petrochemical feedstock
Coking	Polymerize	Thermal	Convert vacuum residuals	Gas oil, coke distillate	Gasoline, petrochemical feedstock
Hydro-cracking	Hydrogenate	Catalytic	Convert to lighter HC's	Gas oil, cracked oil, residual	Lighter, higher-quality products
*Hydrogen reforming	steam Decompose	Thermal/catalytic	Produce hydrogen	Desulfurized gas, O ₂ , steam	Hydrogen, CO, CO ₂

*Steam cracking	Decompose	Thermal	Crack large molecules	Atm tower fuel/ distillate	hvy residual	Cracked naphtha, coke, residual
Visbreaking	Decompose	Thermal	reduce viscosity	Atmospheric tower residual		Distillate, tar

CONVERSION PROCESSES--UNIFICATION

Alkylation	Combining	Catalytic	Unite olefins & isoparaffins	Tower isobutane/ cracker olefin		Iso-octane (alkylate)
Grease compounding	Combining	Thermal	Combine soaps & oils	Lube oil, fatty acid, alky metal		Lubricating grease
Polymerizing	Polymerize	Catalytic	Unite 2 or more olefins	Cracker olefins		High-octane naphtha, petrochemical stocks

CONVERSION PROCESSES--ALTERATION OR REARRANGEMENT

Catalytic reforming	Alteration/ dehydration	Catalytic	Upgrade low-octane naphtha	Coker/ hydro-cracker naphtha		High oct. aromatic	Reformate/
Isomerization	Rearrange	Catalytic	Convert straight chain to branch	Butane, pentane, hexane		Isobutane/ hexane	pentane/

TREATMENT PROCESSES

*Amine treating	Treatment	Absorption	Remove acidic contaminants	Sour gas, w/CO ₂ & H ₂ S	HCS	Acid free gases & liquid HCS
Desalting	Dehydration	Absorption	Remove contaminants	Crude oil		Desalted crude oil
Drying & sweetening	Treatment	Abspt/ therm	Remove H ₂ O & sulfur cmpds	Liq Hcs, alky feedstk	LPG, Sweet hydrocarbons	& dry
*Furfural extraction	Solvent extr.	Absorption	Upgrade mid distillate lubes	Cycle oils & feed-stocks		High quality diesel & lube oil
Hydrodesulfurization	Treatment	Catalytic	Remove sulfur, contaminants	High-sulfur residual/ gas oil		Desulfurized olefins
Hydrotreating	Hydrogenation	Catalytic	Remove impurities, saturate HC's	Residuals, cracked HC's		Cracker feed, distillate, lube
*Phenol extraction	Solvent extr.	Abspt/ therm	Improve visc. index, color	Lube oil stocks	base	High quality lube oils
Solvent deasphalting	Treatment	Absorption	Remove asphalt	Vac. tower residual, propane		Heavy lube oil, asphalt
Solvent dewaxing	Treatment	Cool/ filter	Remove wax from lube	Vac. tower lube oils		Dewaxed basestock lube

Solvent extraction	Solvent extr.	Abspt/ precip.	stocks Separate unsat. oils	Gas reformate, distillate	oil, High-octane gasoline
Sweetening	Treatment	Catalytic	Remv H ₂ S, convert mercaptan	Untreated distillate/gasoline	High-quality distillate/gasoline