

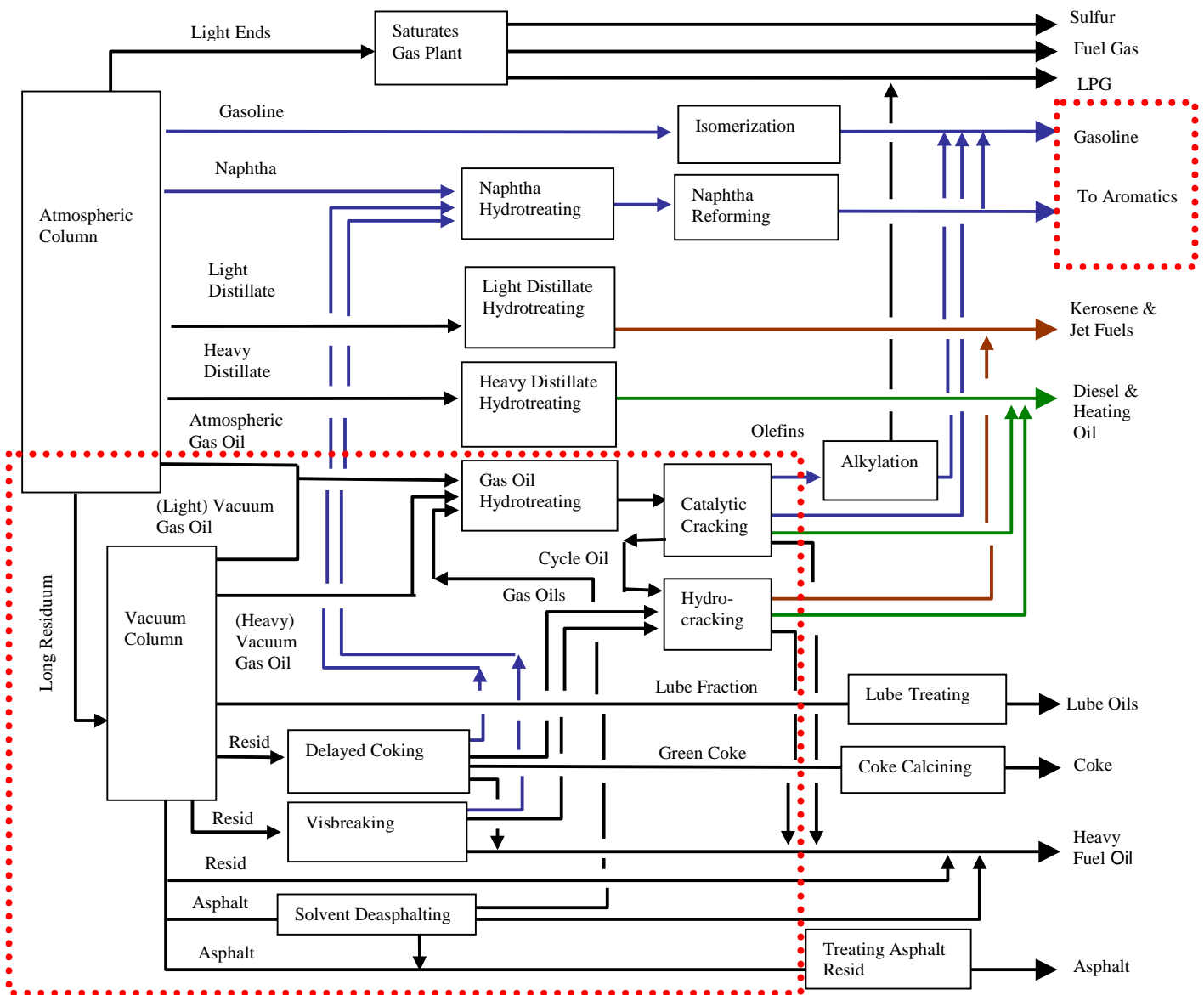
CHAPTER 9 GATEWAY TO PROCESSING TECHNOLOGY

Markets and Technology

One universal theme throughout is the concept of markets and the technology to produce products for those markets. Markets and technology have evolved to become extremely sophisticated and complex. To help understand the complicated interactions, chapters are included that provide overviews of important markets and technology.

In particular, gasoline and aromatics manufacturing and residuum processing are emphasized. The following refinery schematic highlights these areas.

Refinery Schematic



Gasoline is the Largest Market

Gasoline is the most important refinery product in terms of volume. Part 2 *The Development of the Modern Refinery* offers a chapter *The Automobile—How Petroleum Refining was Driven* relating the contribution of the automobile to the transportation fuels market.

Since gasoline is produced by many different processes, Part 3 *Processes* presents a chapter *Gasoline Manufacturing Overview* to introduce the role each process contributes to markets and technology. In particular, emphasis is placed on processes that restructure the hydrocarbon molecule such as isomerization, reforming and alkylation. Equally important are the processes that remove undesirable components such as hydrotreating. These processes provide gasoline with the proper combustion and environmental properties.

A related petrochemical market is that for aromatics produced by gasoline manufacturing. The chapter *Aromatics Complex Overview* provides a brief overview on this important market.

Processing Heavy Oils

Refinery products generally do not have the same carbon structure as most crude oils. A primary challenge of the refinery industry is processing heavy oils by breaking large molecules into smaller ones and rearranging the hydrogen/carbon ratio, as illustrated by the chart. The other part of the challenge is to remove undesirable components. The chapter *Processing Residuum Overview* presents insights on the various processing schemes. Additionally, the importance of hydrogen for hydroprocessing is detailed in the chapter *The Use of Hydrogen in Refineries*.

Finally, the impact of sophisticated processing units on a refinery's complexity is illustrated in the chapter *Simple and Complex Refineries*.

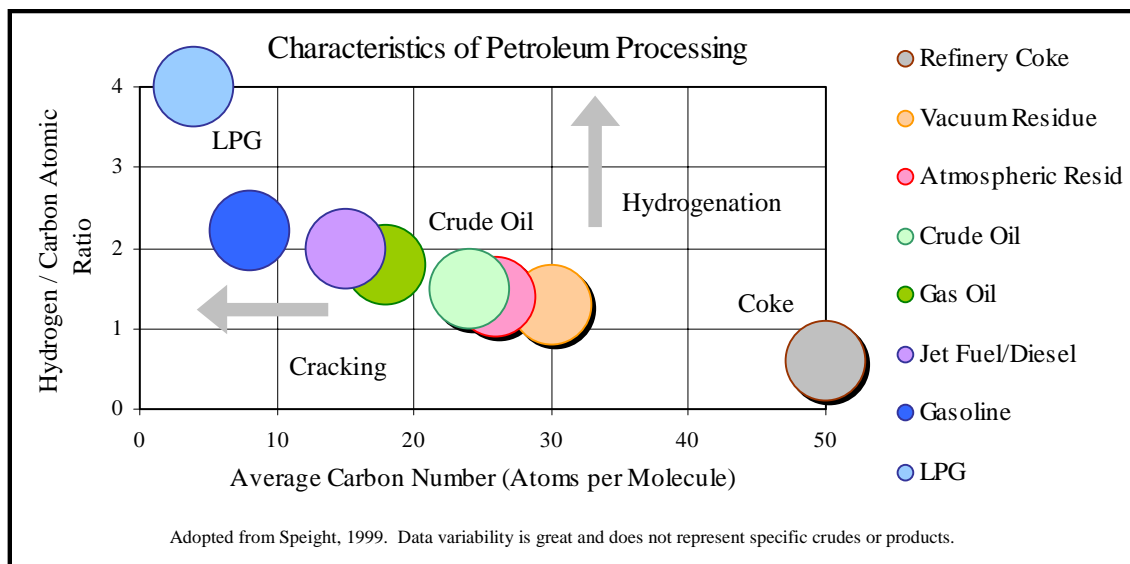


Table of Processing Units

As an aid to understanding the various refinery units with feeds and products, the following table is offered as a summary. This table is keyed to the refinery schematic.

Table of Processing Units

Feeds	Unit	Purpose Of Processing Unit	Products
Crude	Atmospheric Crude Distillation	Separate fractions for further processing	Fractions from distillation to other processing units.
Light Ends	Saturates Gas Plant	Fractionate saturates for LPGs and recovers fuel gas	LPG, fuel gas
Light Ends	Catalytic Gas Plant	<ul style="list-style-type: none"> • Recovery of light olefins and fuel gas • Remove H₂S, water 	Olefins, sulfur, fuel gas
Gasoline from Atmospheric Tower	Isomerization	Add branches to paraffins to improve octane number	Gasoline
Naphtha from <ul style="list-style-type: none"> • Atmospheric Tower • Delayed Coking • Visbreaking 	Naphtha Hydrotreater	Add hydrogen to remove sulfur as H ₂ S	Desulfurized naphtha
Naphtha from Naphtha Hydrotreater	Naphtha Reformer	<ul style="list-style-type: none"> • Remove hydrogen from naphthenes to make aromatics particularly for feed to the aromatics unit • Add branches to paraffins (isomerization) to improve octane number of gasoline 	<ul style="list-style-type: none"> • Gasoline • Feed to aromatics unit • Hydrogen for use in hydrotreating
Gasoline from Naphtha Reforming	<ul style="list-style-type: none"> • Aromatics Unit • Gasoline pool 	The aromatics unit separates benzene, toluene, xylene (B-T-X) and produces xylene isomers for sale. Removal of aromatics from gasoline is also important for environmental reasons.	<ul style="list-style-type: none"> • Benzene • Toluene • Orthoxylene • Paraxylene
Light Distillate from Atmospheric Tower	Light Distillate Hydrotreater	Add hydrogen to remove sulfur as H ₂ S	Kerosene & Jet Fuel
Heavy Distillate from Atmospheric Tower	Heavy Distillate Hydrotreater	Add hydrogen to remove sulfur as H ₂ S	Diesel & Heating oil
Gas Oil from: <ul style="list-style-type: none"> • Atmospheric Tower • Light Vacuum Gas Oil from Vacuum Tower • Heavy Vacuum Gas Oil from Vacuum Tower • Solvent Deasphalting 	Gas Oil Hydrotreater	<ul style="list-style-type: none"> • Add hydrogen to break aromatic bonds to lower average molecular weight and prevent coking on catalytic cracking catalyst. • Add hydrogen to remove sulfur as H₂S. • Remove metals to protect catalytic cracking activity. 	Feed to catalytic cracker
Gas Oil from Gas Oil Hydrotreater	Catalytic Cracking Unit	<ul style="list-style-type: none"> • Break carbon-carbon bonds to lower average molecular weight and produce higher yields of fuel products • Form olefins for alkylation to high octane gasoline 	<ul style="list-style-type: none"> • Gasoline • Light olefins to alkylation for gasoline • Diesel & Heating Oil • Cycle Oil to Hydrocracker • Heavy Fuel Oil

Table continued on next page.

Table of Processing Units (continued)

Feeds	Unit	Purpose Of Processing Unit	Products
Gas Oil from: • Catalytic Cracking (Cycle Oil) • Delayed Coking • Visbreaking	Hydrocracking Unit	• Break carbon-carbon bonds to lower average molecular weight and produce higher yields of fuel products	• Kerosene & Jet Fuel • Diesel & Heating Oil • Heavy Fuel Oil
Light olefins from Catalytic Cracking	Alkylation	Form long chain paraffins from an alkyl group and a light olefin for high-octane gasoline.	• Gasoline • LPG
Long Residuuum from Atmospheric Tower	Vacuum Crude Distillation	Separate fractions for further processing	Fractions to other processing units.
Resid from Vacuum Tower	Delayed Coking & Coke Calcining	• Produce coke that contain contaminants • Produce naphtha and gas oil with minimum contaminants for upgrading • Minimize production of Heavy Fuel Oil	• Naphtha to Hydrotreating • Gas Oil to Hydrocracking • Heavy Fuel Oil • Coke to calcining
Resid from Vacuum Tower	Visbreaking	• Lower the viscosity of Heavy Fuel Oil by thermal cracking • Produce modest amounts of naphtha and gas oil	• Naphtha to Hydrotreating • Gas Oil to Hydrocracking • Heavy Fuel Oil
Asphalt from Vacuum Tower	Solvent Deasphalting	• Precipitate asphalt for further treatment • Recover some deasphalted oil for gas oil or heavy fuel oil.	• Asphalt • Gas Oil to Hydrotreating • Heavy Fuel Oil
Asphalt from Vacuum Tower	Asphalt Treating	Treat asphalt to improve quality	Asphalt
Lube fraction from Vacuum Tower	Lube Treating	Treat lube fraction for feed to lube plant	Lube stock