Chapter 8: Petroleum Refining

**Categories of Refining Operations**

- Separation processes
- Conversion processes
- Treatment processes
- Auxiliary processes
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Typical Processing Steps

Separation Processes
- Desalting
- Distillation
- Deasphalting

Distillation
- Atmospheric distillation
- Vacuum distillation
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Atmospheric Distillation Unit

Vacuum Distillation

Deasphalting

Separates asphaltic compounds using liquid-liquid extraction with liquid propane
Conversion Processes

- Coking
- Visbreaking
- Catalytic cracking
- Polymerization
- Alkylation
- Isomerization
- Reforming

Delayed Coking Unit

Visbreaking

- Milder form of cracking than coking
- Residues from atmospheric and vacuum distillation fed to process heater
- Thermal cracking produces residual tars, gas oils, gasoline and light gases
- Used to reduce viscosity of residual fractions for blending into fuel oils
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Catalytic Cracking Unit

Polymerization

- Catalytic conversion of olefin gases to liquid condensation products
- Provided a gasoline blending stock when octane level were low
- Rarely used today
- Polymers are valuable as additives for motor oil

Alkylation

- Branched hydrocarbons are synthesized by the catalytic addition of a paraffinic or aromatic hydrocarbon to an olefin
- The product, alkylate, is used as an antiknock additive
### Isomerization

- Rearranges feedstock molecular structure to produce branched-chain compounds from straight-chain compounds
- Process is usually applied to butane or mixtures of pentane and hexane

### Reforming

- Converts straight-chain naphtha compounds to ring or branched structures
- Predominate use is the dehydrogenation of naphthenes to form aromatics

### Treatment Processes

- Hydrotreating
- Amine treating
- Chemical sweetening
- Asphalt blowing
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Hydrotreating

- Removes sulfur, nitrogen and metal compounds from intermediate fractions
- In hydrodesulfurization, the petroleum stream is mixed with hydrogen and passed over a fixed-bed catalyst
- Reactor effluent is separated to recover the hydrogen and the hydrogen sulfide and ammonia

Amine Treating

- Removes acid impurities, mainly hydrogen sulfide and carbon dioxide, from intermediate fractions
- Petroleum stream is contacted with an aqueous amine solution in a tray or packed tower
- Spent amine solution is processed to regenerate the scrubbing solution and producing a concentrated acid-gas stream

Chemical Sweetening

- Sweetens distillates by extraction or conversion of mercaptans
- In conversion process, sour feed is sparged with air and passed over a fixed-bed catalyst wetted by caustic solution
- In extraction process, sour feed is contacted with caustic solution in a packed tower. Spent caustic is regenerated and mercaptans recovered as alkyl disulfides
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Asphalt Blowing

Auxiliary Processes

- Sulfur recovery
- Wastewater treatment
- Fuel gas recovery
- Blowdown systems

Sulfur Recovery

- Sulfur compounds in petroleum fractions are converted into hydrogen sulfide by treatment processes
- Hydrogen sulfide is collected and converted to elemental sulfur, usually with a Claus process
Wastewater Treatment

- Specific design of system varies
- Systems generally include:
  - Drain systems
  - Oil-water separators
  - Air flotation units
- Additional treatment may involve secondary and tertiary processes

Fuel Gas Recovery

- Recovers hydrocarbon vapors from various refinery processes
- Collected gases are compressed, condensed and separated into constant vapor pressure mixtures
- Recovered mixtures used as refinery fuel or feedstock or sold

Blowdown Systems

- Provides for safe disposal of liquid and gaseous hydrocarbons from pressure-relief devices
- Blowdown is separated into liquid and vapor fractions and recycled or flared
Emission Control Techniques

- Flares
- Incinerators
- Process heaters
- Covers
- Fugitive emission control

Emission Regulation

Process Inspection