Course 288
Petroleum Refining
*2017*

# PROCESSES
## CONVERSION AND BLENDING

The National Air Compliance Training Program

# Petroleum Refining Process

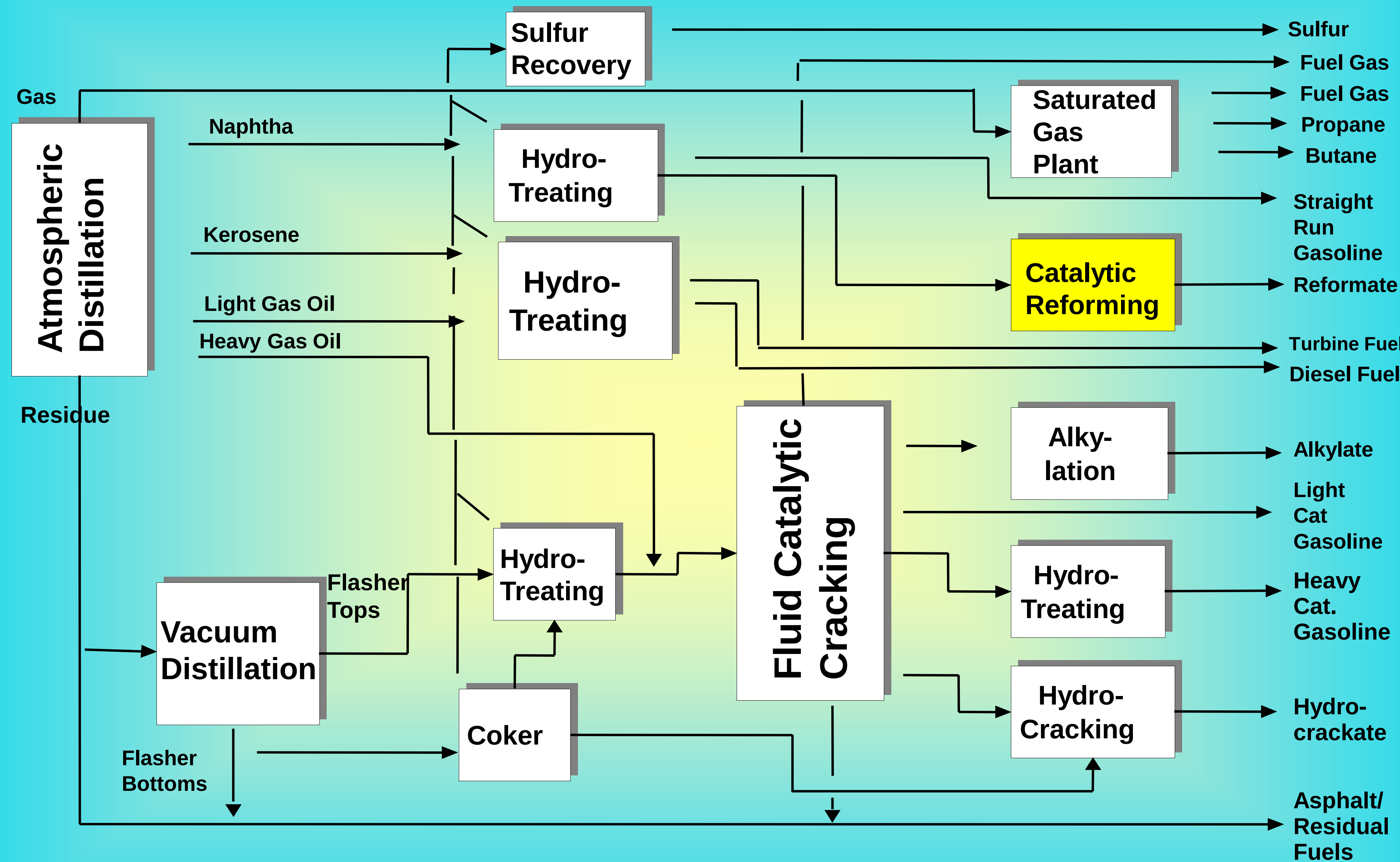
- Separation
- Treatment
- <u>Conversion</u>
- Blending

# Types of Conversion Processes

- Property Change
  - Catalytic Reforming
  - Isomerization
- Build-Up
  - Alkylation
- Break-Up
  - Fluid Catalytic Cracking
  - Hydrocracking
  - Coking
  - Visbreaking

# Catalytic Reforming

- PURPOSE:  Increase octane level of C3-C12 molecules by reshaping through use of a catalyst.


Sulfur Recovery
Sulfur
Fuel Gas
Gas
Saturated Gas Plant
Fuel Gas
Propane
Butane
Atmospheric Distillation
Naphtha
Hydro-Treating
Straight Run Gasoline
Kerosene
Hydro-Treating
Catalytic Reforming
Reformate
Light Gas Oil
Heavy Gas Oil
Turbine Fuel
Diesel Fuel
Residue
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Alky-lation
Alkylate
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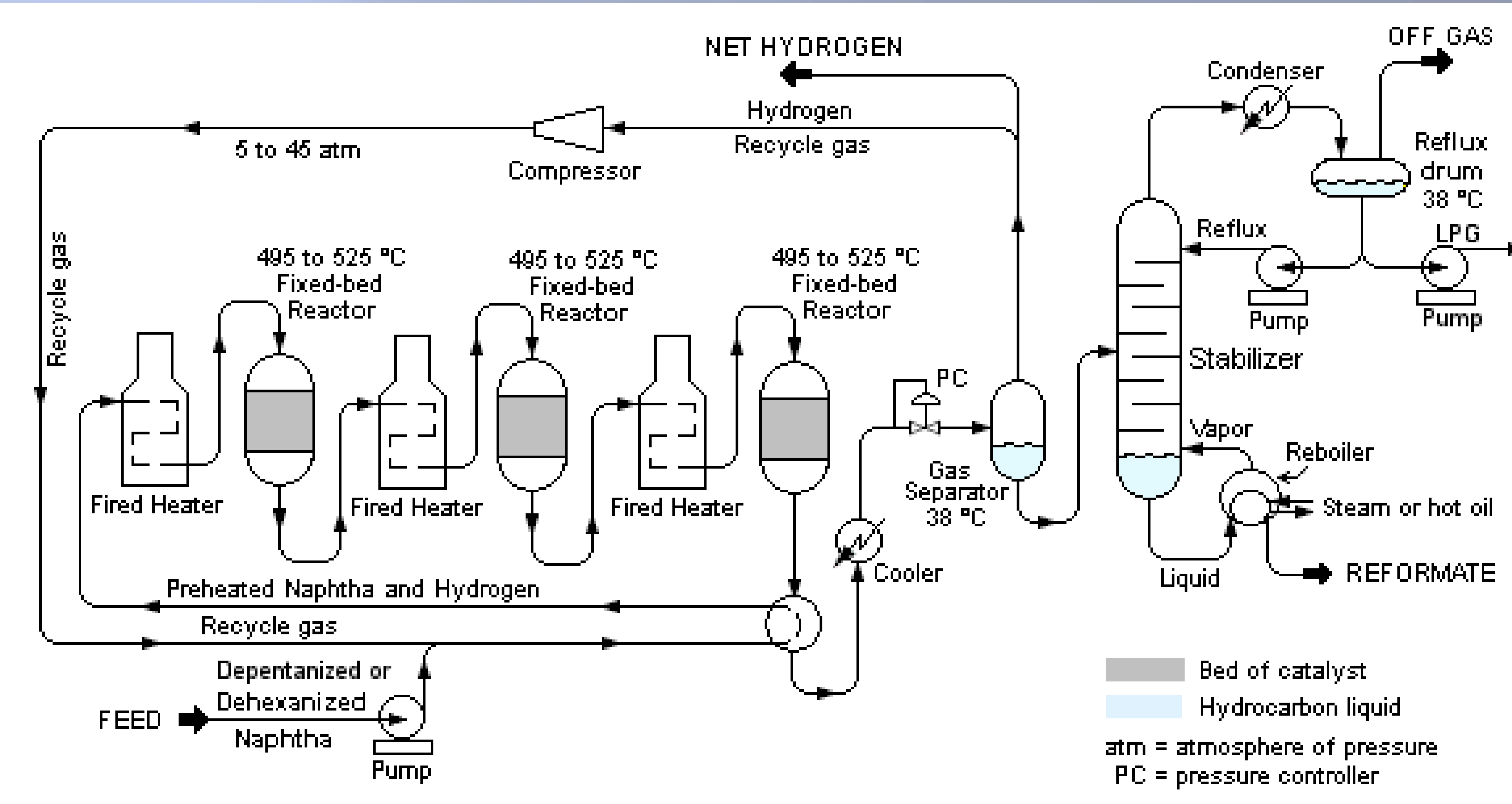
Hydro-Treating
Flasher Tops
Vacuum Distillation
Hydro-Treating
Heavy Cat. Gasoline
Coker
Hydro-Cracking
Hydro-crackate
Flasher Bottoms
Asphalt/ Residual Fuels

# Catalytic Reforming

- REACTION:  An endothermic process used to convert straight chained molecules to branched or cyclic/ring structures in a series of reactions.  Takes place on a fixed bed of catalyst.  Usually preceded by hydrotreating to protect the catalyst.
- PRODUCT:  Reformate and $H_2$

Page 51 of the Student  Handbook

# Catalytic Reforming



# Catalytic Reformer

# Catalytic Reformer - Reactor Pre-Heat Furnaces

# Catalytic Reforming

- REGULATIONS:
- INSPECTION POINTS:
  - Heaters
  - Fugitive VOC’s
  - Cooling Towers
  - Hazardous Waste

# Isomerization

- PURPOSE:  To increase the octane of a light hydrocarbon (sweet pen/hex) by rearranging molecules.  Can also be used to provide feedstock to other processes such as conversion of n-butane to i-butane.
- REACTION:  Molecular structures are changed over a solid or fixed bed of catalyst in the presence of hydrogen.

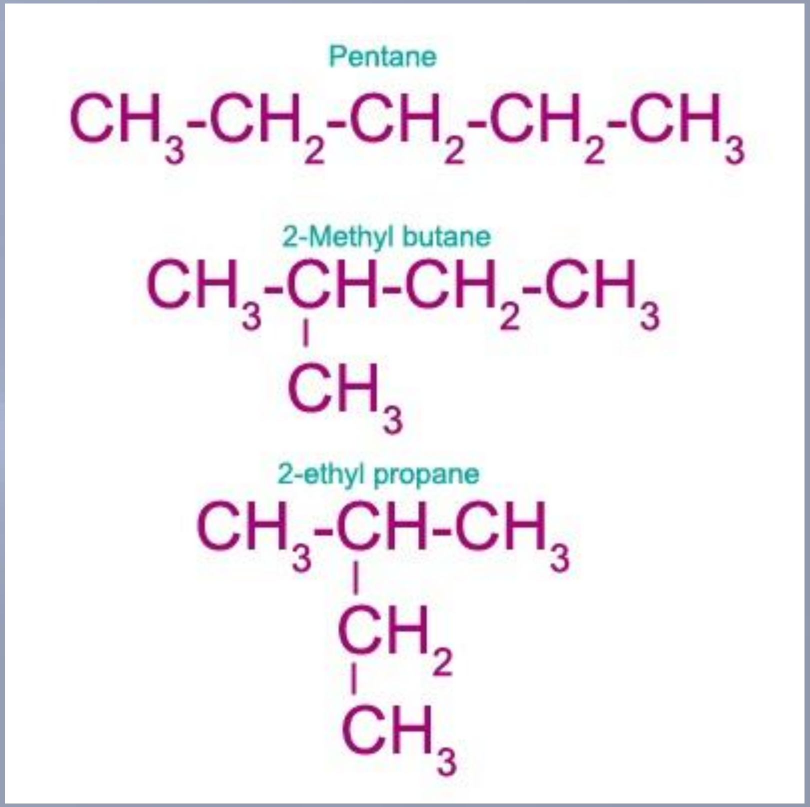
# Isomerization

## Butane Isomerization Plant

# Property Change

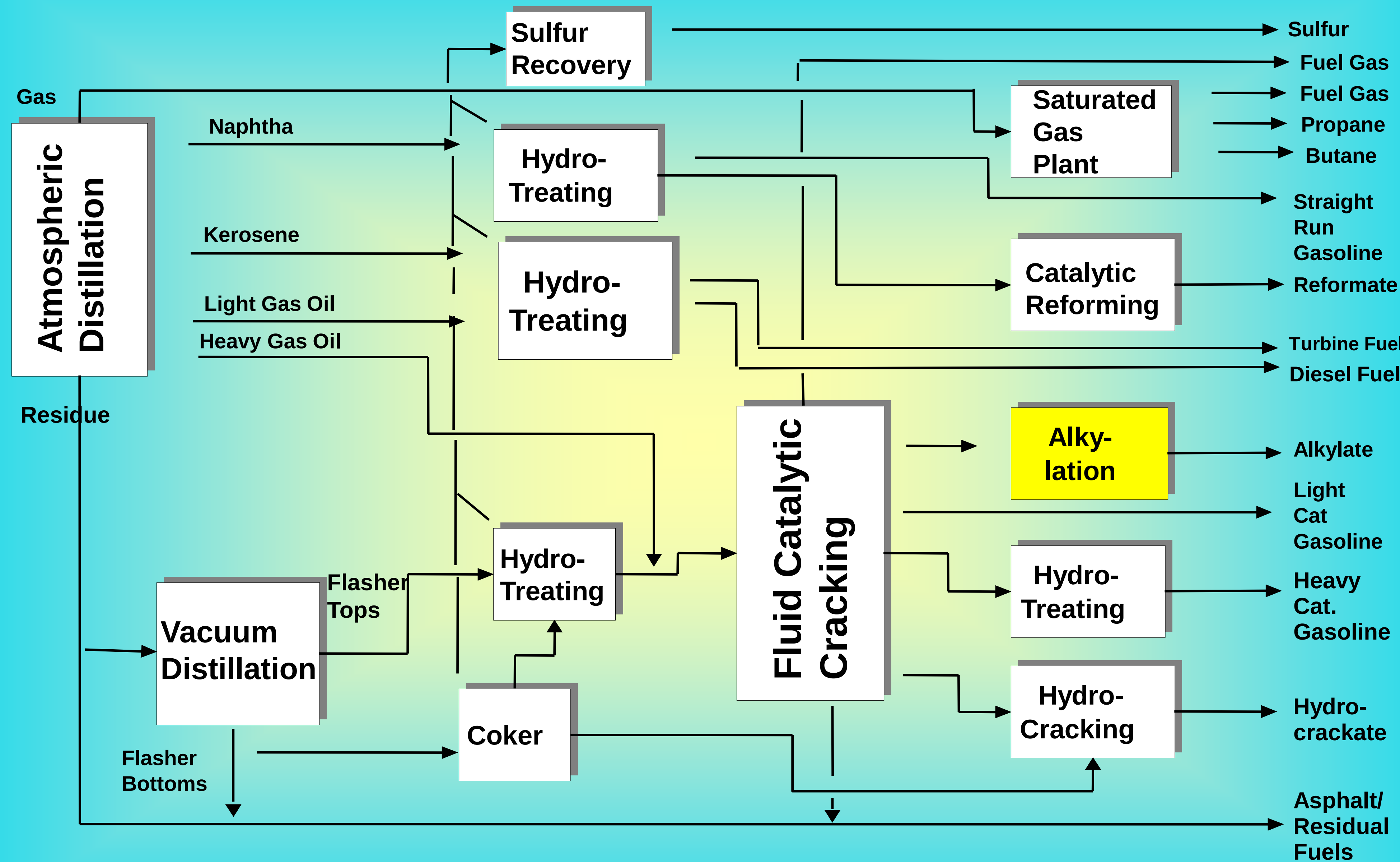
## Isomerization

- Rearrange atoms in low-octane normal parafins (30-35 octane) into higher octane isoparafins (65 octane) in the presence of hydrogen (H2) and hydrochloric acid (HCL).



# Alkylation

- PURPOSE:  Smaller molecules have higher vapor pressure therefore can not be blended into gasoline. This process combines two small molecules into a larger high octane molecule.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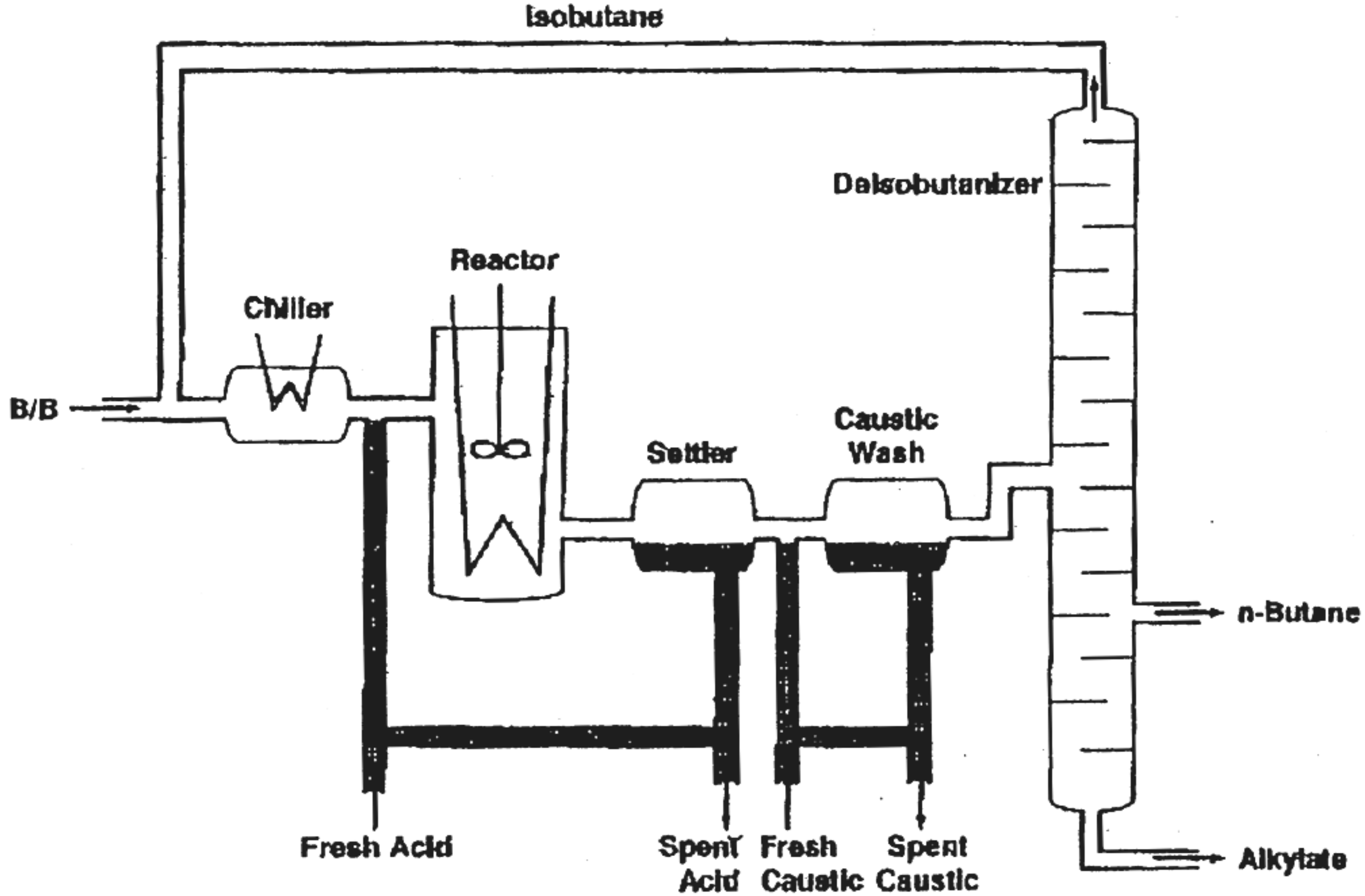
# Alkylation

- REACTION:  Isobutane (iso-C4) and isobutylene (unsaturated C4) are reacted to form iso-octane in the presence of a acid catalyst.  The catalyst can be either hydroflouric acid or sulfuric acid.

# Alkylation

- What does that mean?
- Shorter chain gasses: butene or *propene and isobutane (predominately  produced in the FCC)* to make high octane gasoline

# Sulfuric Acid Alkylation



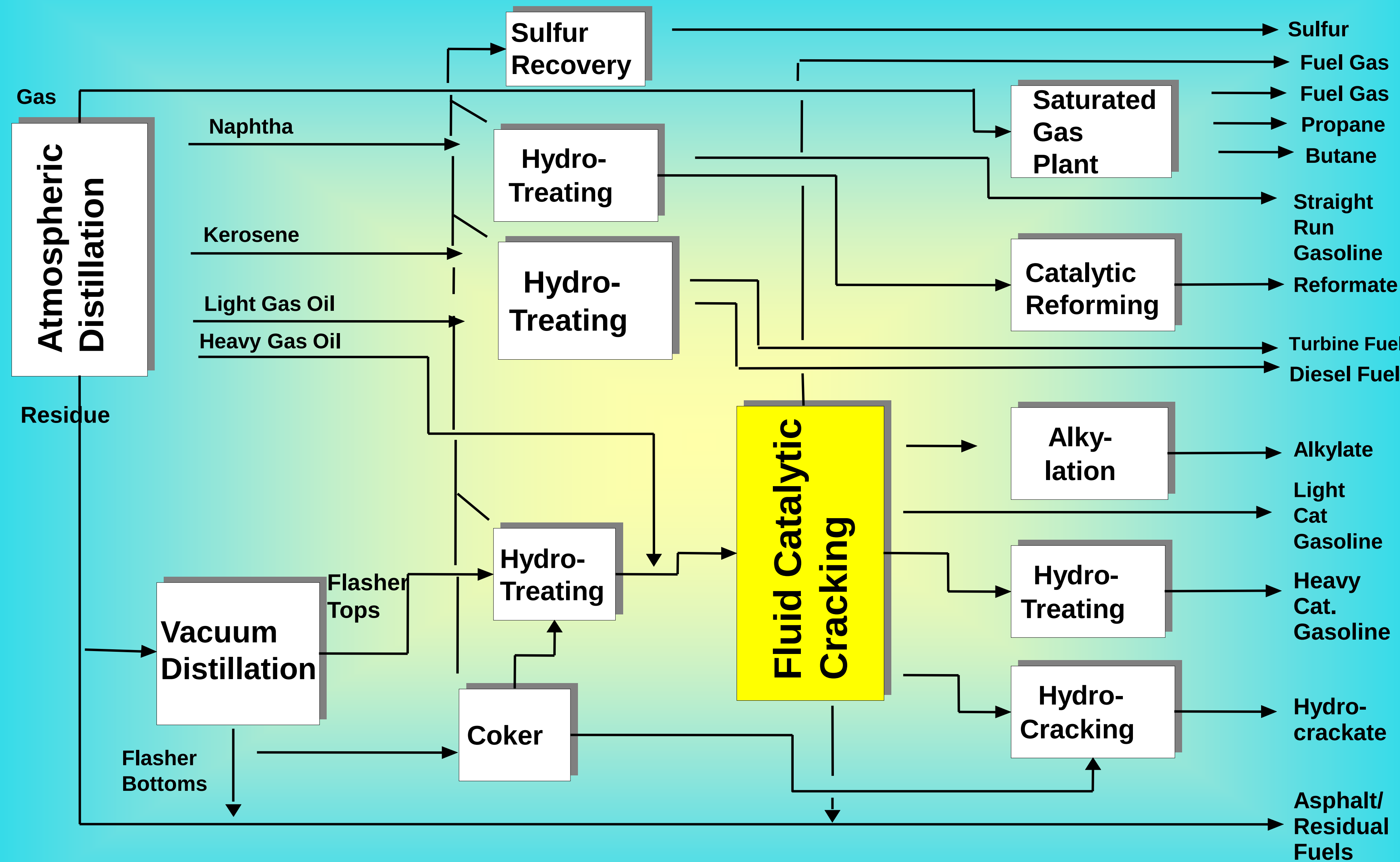
# Sulfuric Acid Alkylation Unit

# Catalytic Polymerization

- Also combines smaller HCs to create a more valuable HC
- I.e., Combine three C3s to form one C9

# Fluid Catalytic Cracking

- PURPOSE:  To convert the heavier crude fractions to usable fractions that can be blended into gasoline, jet fuel or diesel.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# Fluid Catalytic Cracking

- REACTION:  Heavy crude fractions (gas-oils) are cracked to form lighter molecules and carbon in the presence of a catalyst.  The carbon is burned off the catalyst which is then recycled back into the process.  The cracked products are condensed and distilled into blending fractions.

# Fluid Catalytic Cracking

- CATALYST: The catalyst used is a zeolite material (fine powder). This material is used through the process in a fluidized form. Once the carbon is burned off the catalyst then any particulate matter needs to be removed from the flue gas stream.

# Gas-oil Feeds

- Atmospheric gas-oil from atmospheric crude tower
- Vacuum gas-oil
- Coker gas-oil
- Unconverted oil (cycle oil) from FCC
- Light gas-oil
- Heavy gas-oil
- Hydrotreated gas-oil

# Cracking Products

- Ethane
- Propane, Proplyene
- Butane, Butene
- Gasoline
- Light Gas Oil

# Fluid Catalytic Cracker

# Primary FCC Emissions

- Particulates (Cat. Fines)
- CO
- SOx
- NOx

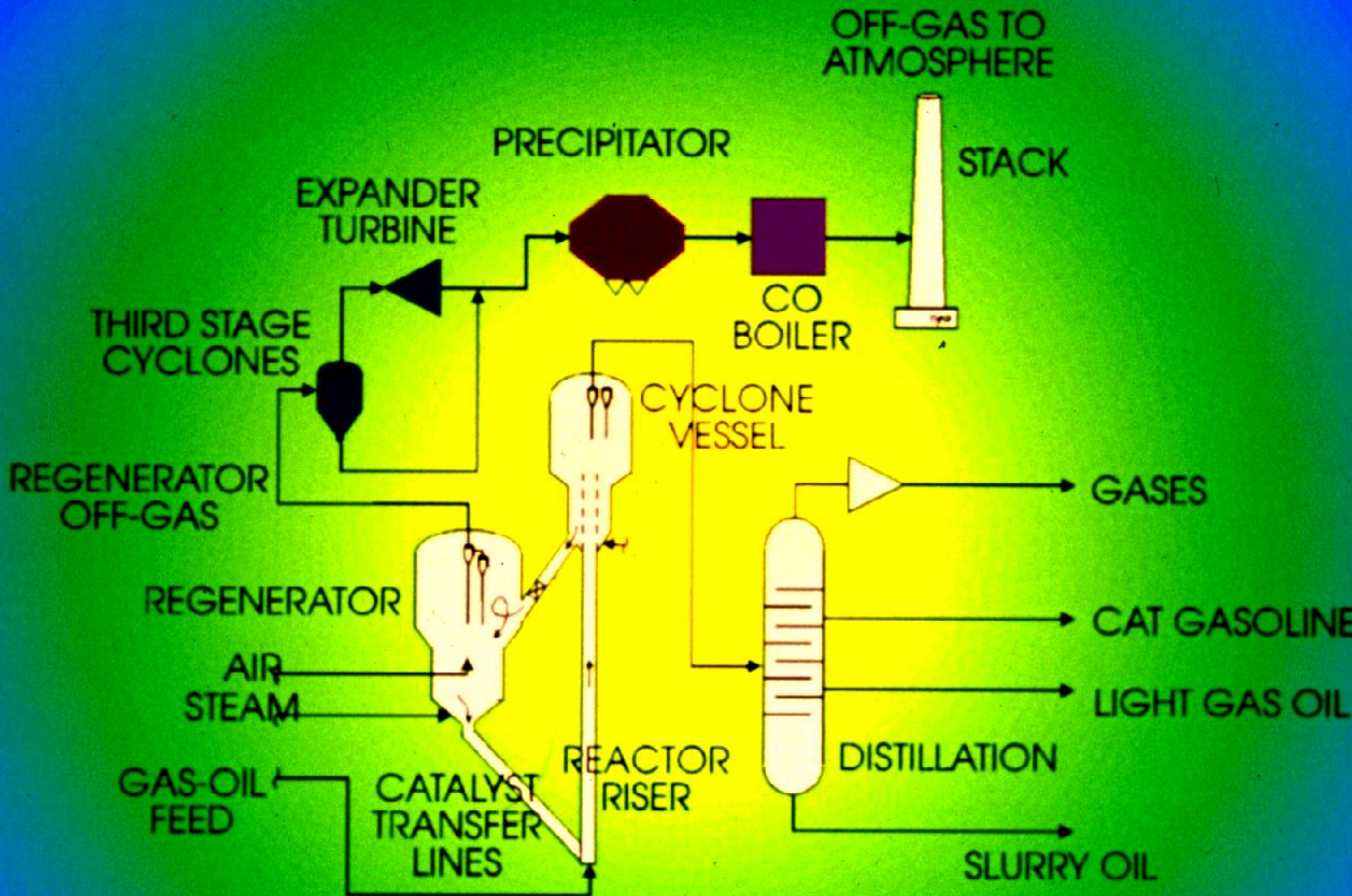



Figure 203.1
Fluidized Catalytic Cracking Unit

# Fluid Catalytic Cracking

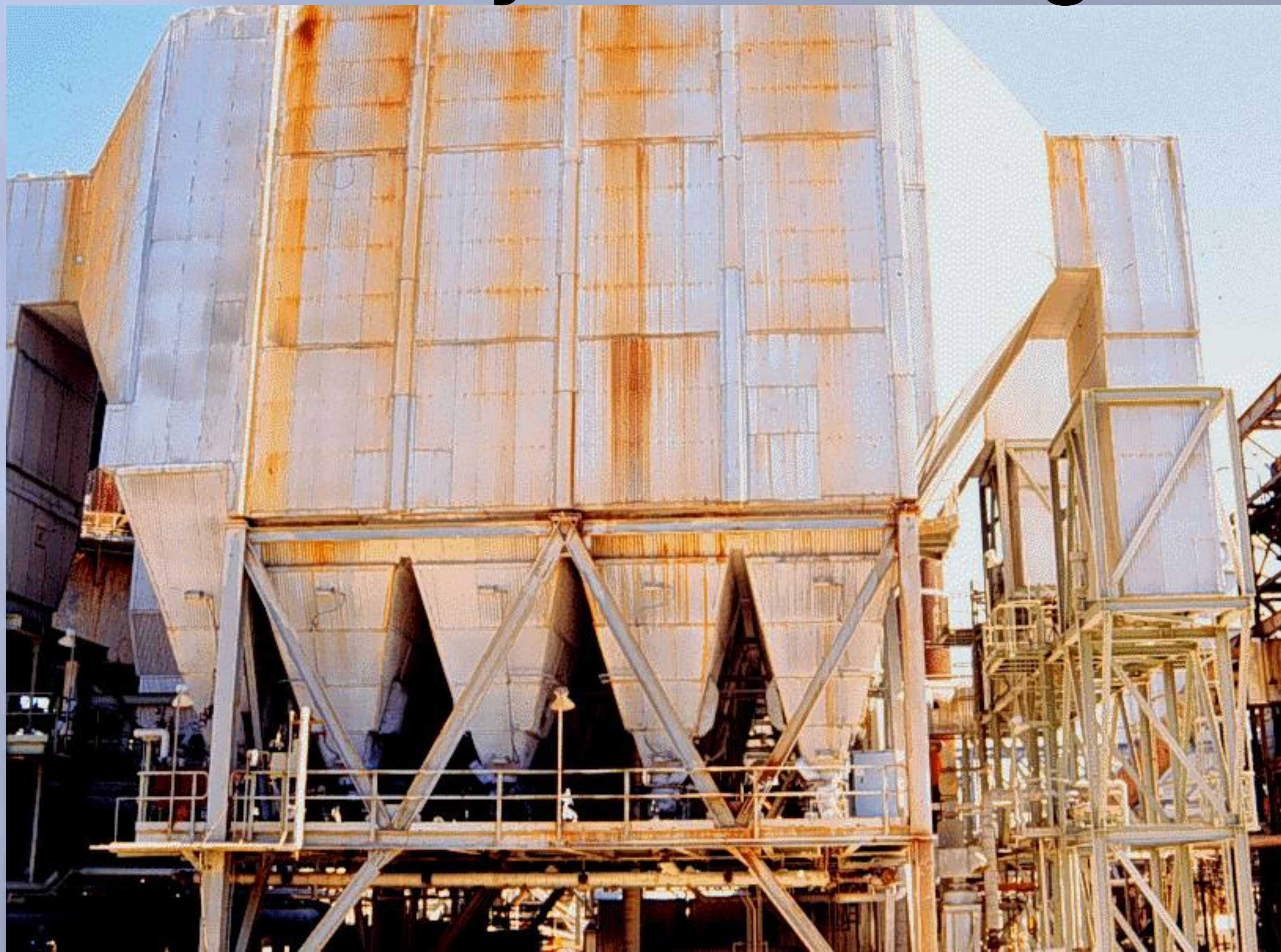
- PARTICULATE CONTROL TECHNOLOGY:  A cyclones with electrostatic precipitator or bag house are generally used to control the particulate matter. Wet scrubbers (also good for SOx) may also be used.

# Fluid Catalytic Cracking

- NOx control technology: SCR
- SOx control technology: Feed desulfurization
- CO control technology: High temperature regeneration, or CO Boilers

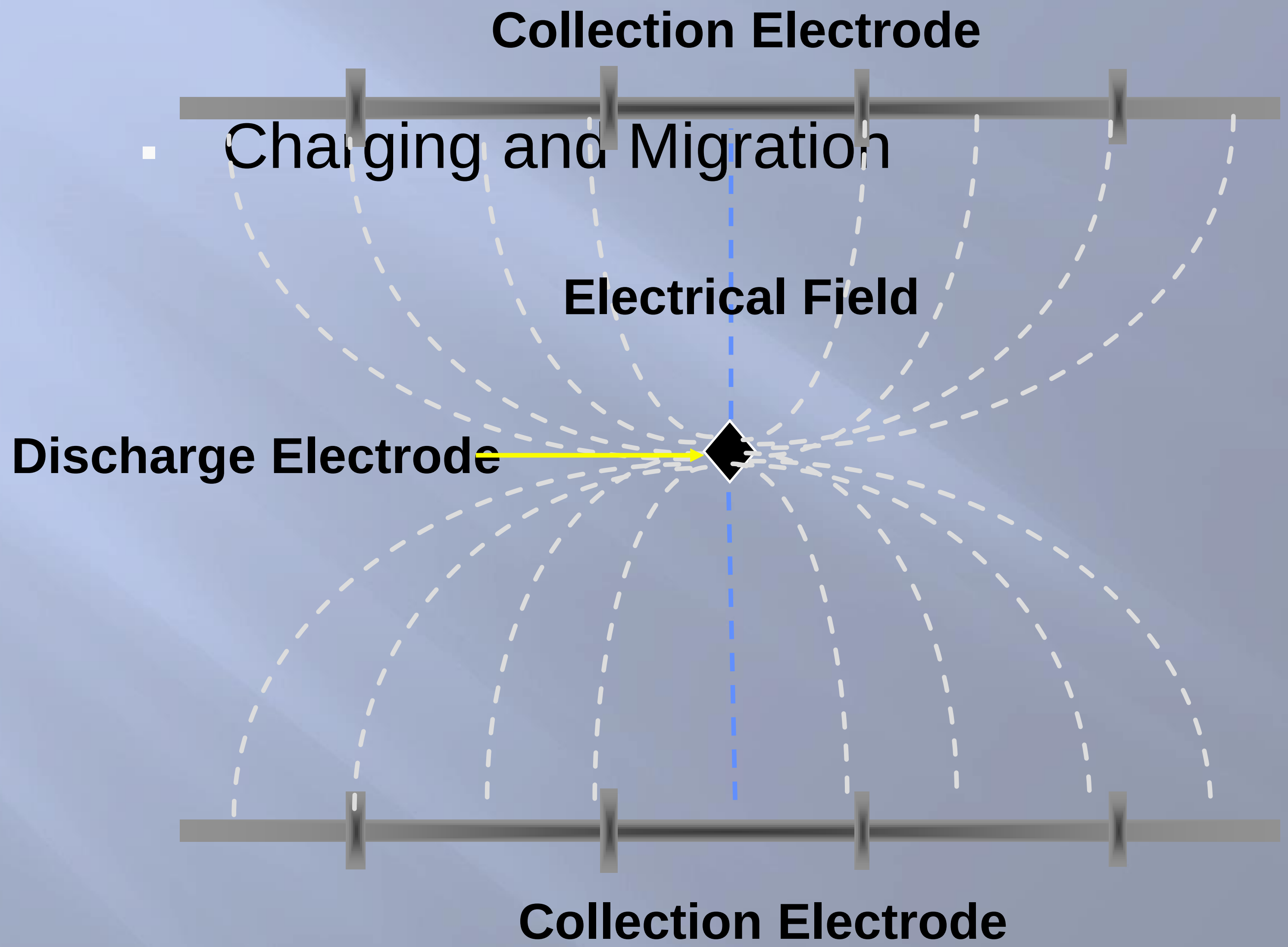
# Catalytic Cracker With Scrubber

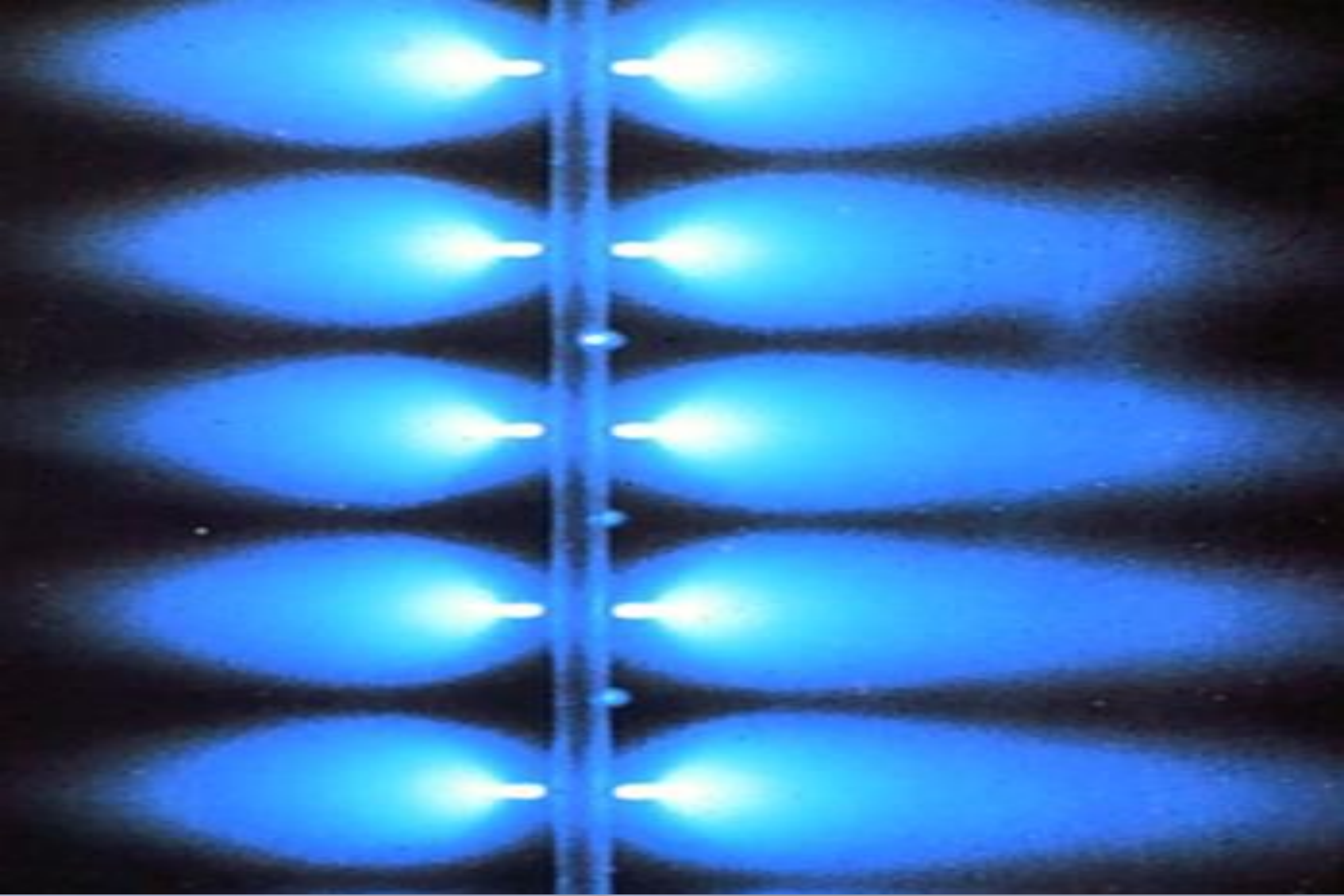
# Electrostatic Precipitator on Fluid Catalytic Cracking Unit



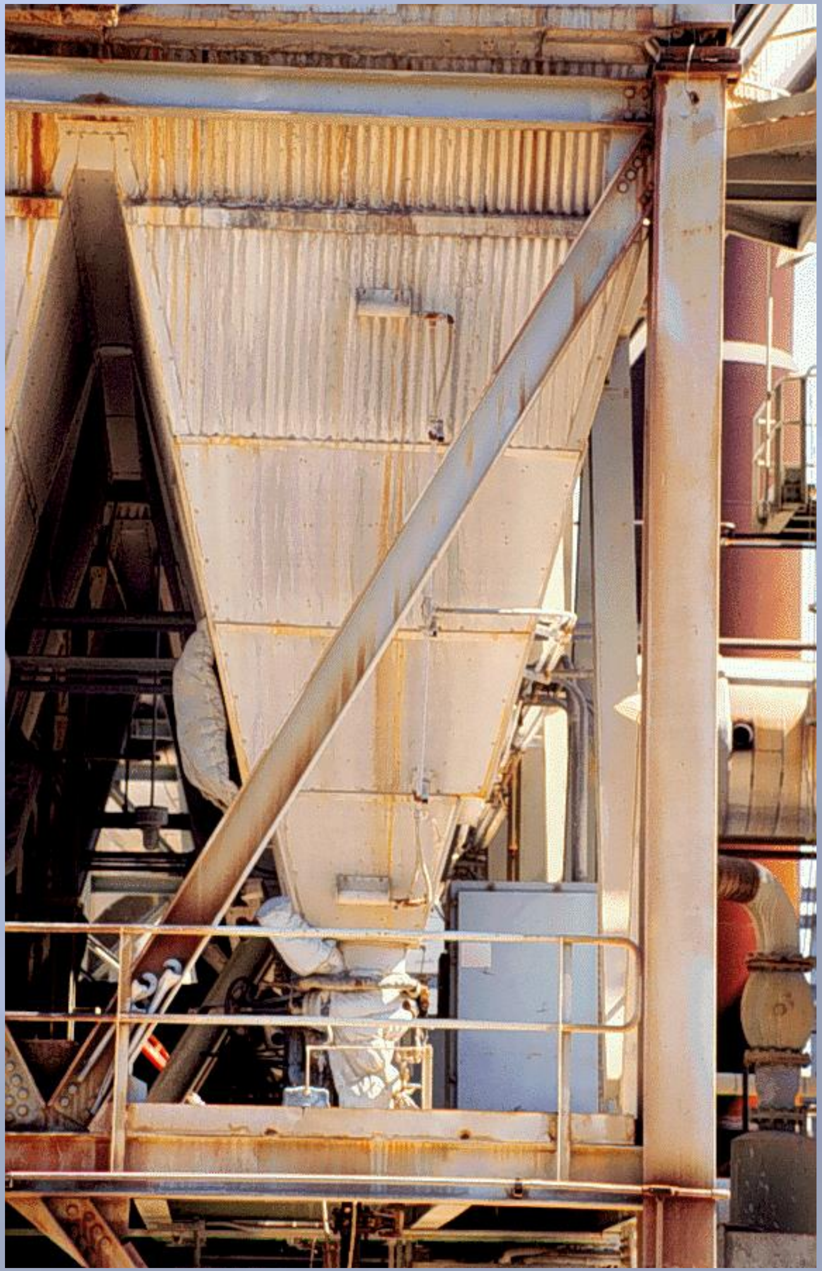
# *Electrical Field Generation*

- Charging and Migration





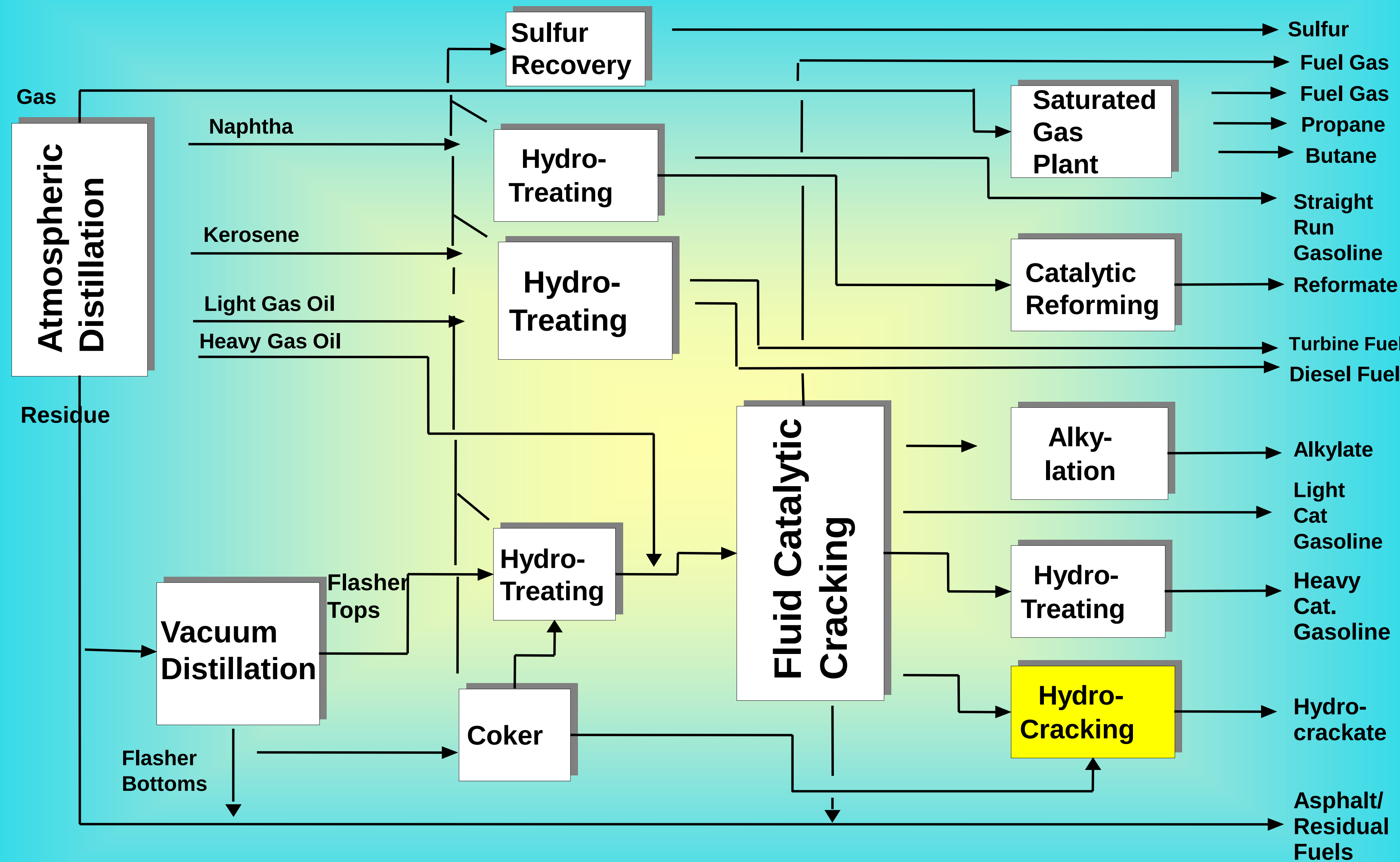
# Electrostatic Precipitators



# Catalyst Fines Hopper

# Hydrocracking

- PURPOSE:  To convert heavier crude fractions into components that can be blended into gasoline and jet fuel.
- REACTION:  Larger molecules are cracked into lighter components in the presence of a fixed bed catalyst, hydrogen, and high temperature and pressure.
- Useful for sour feedstocks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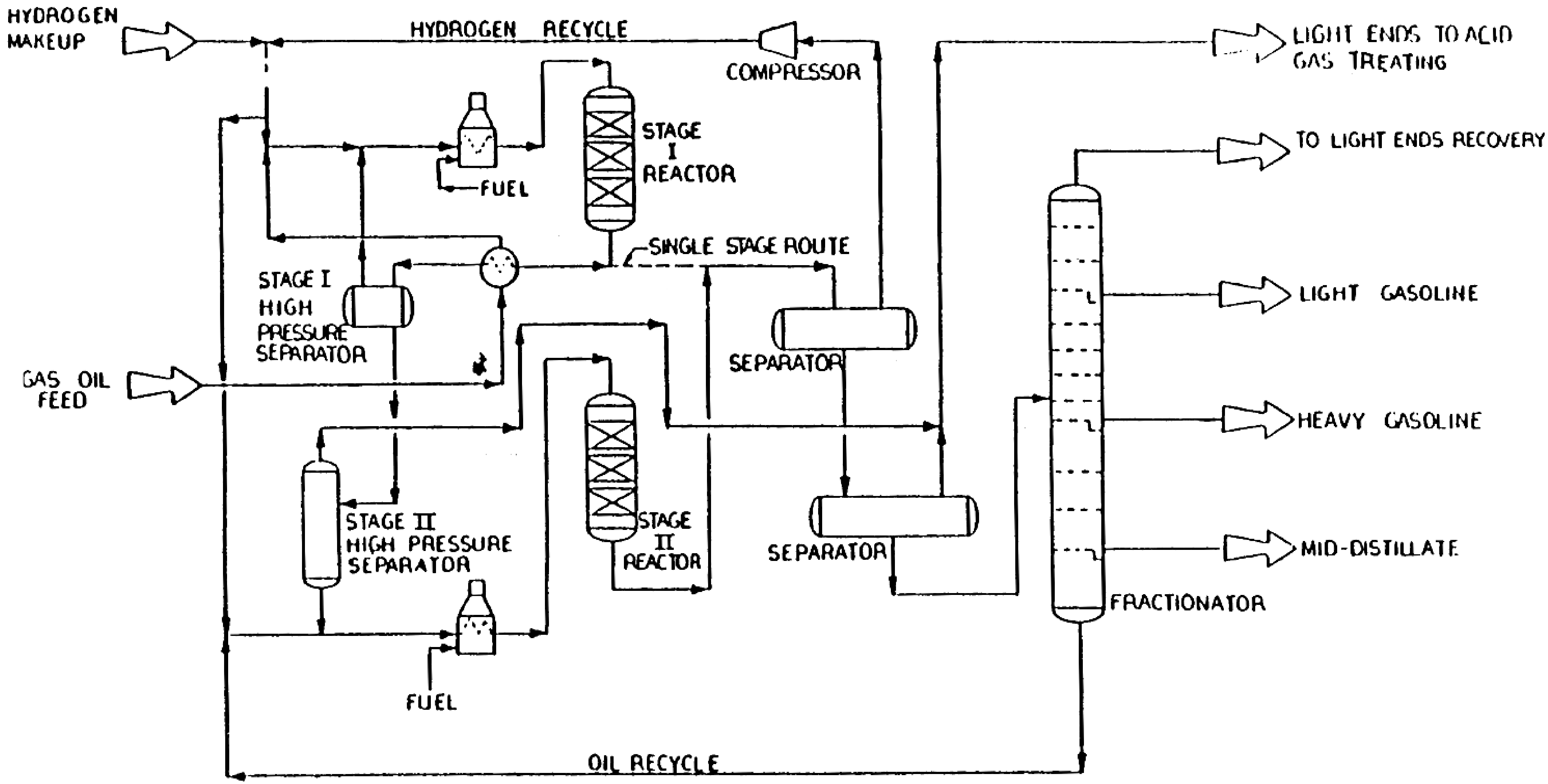
Flasher Bottoms
Asphalt/ Residual Fuels

# Hydrocracking

- Go to page SHB-55 of the Student Handbook

## HYDROCRACKING UNIT



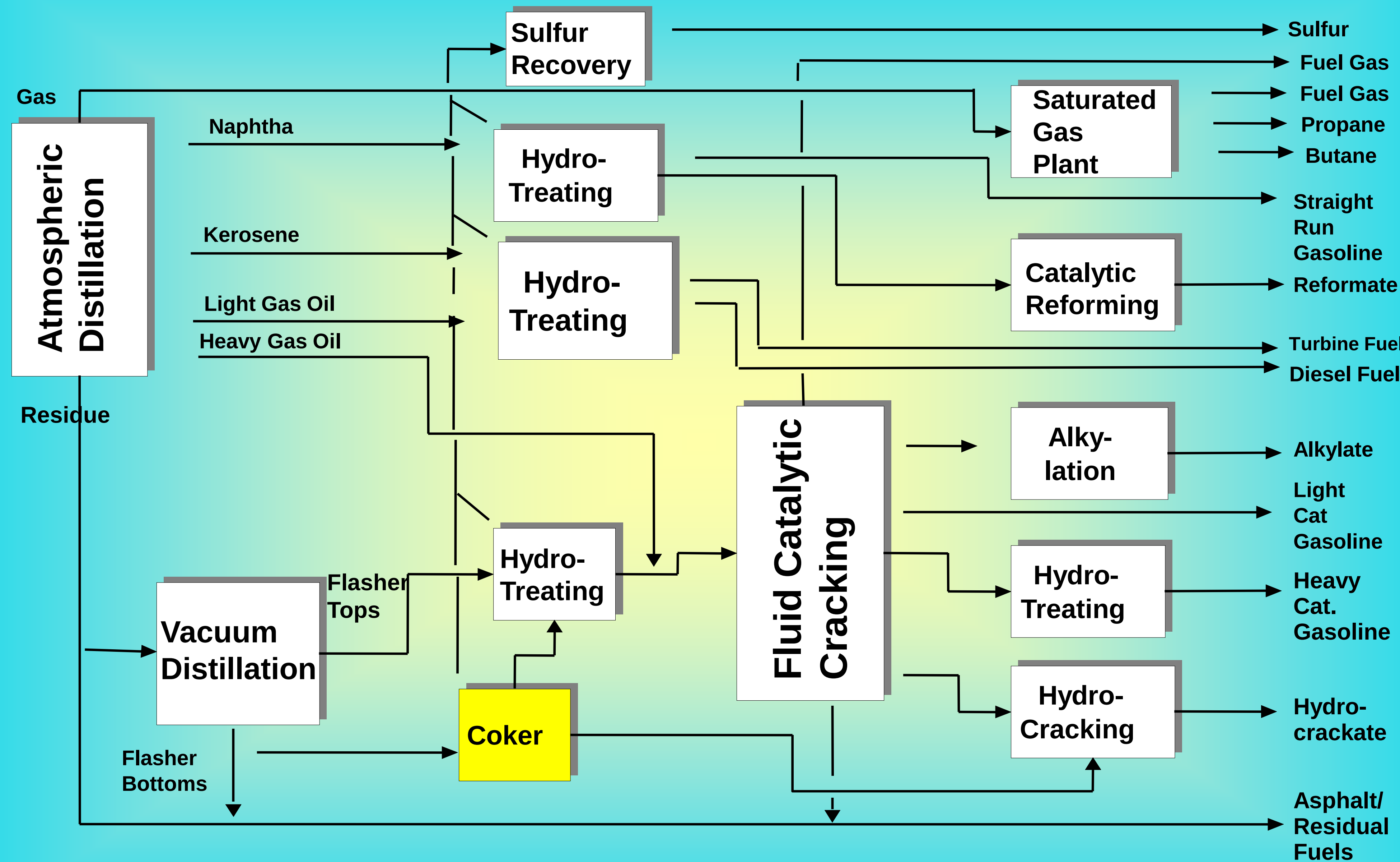
# Hydrocracker

# Hydrocracker Reactors

# Coker

- PURPOSE:  To convert the heaviest crude fractions into lighter components for blending.

- By products are coke or low BTU gas



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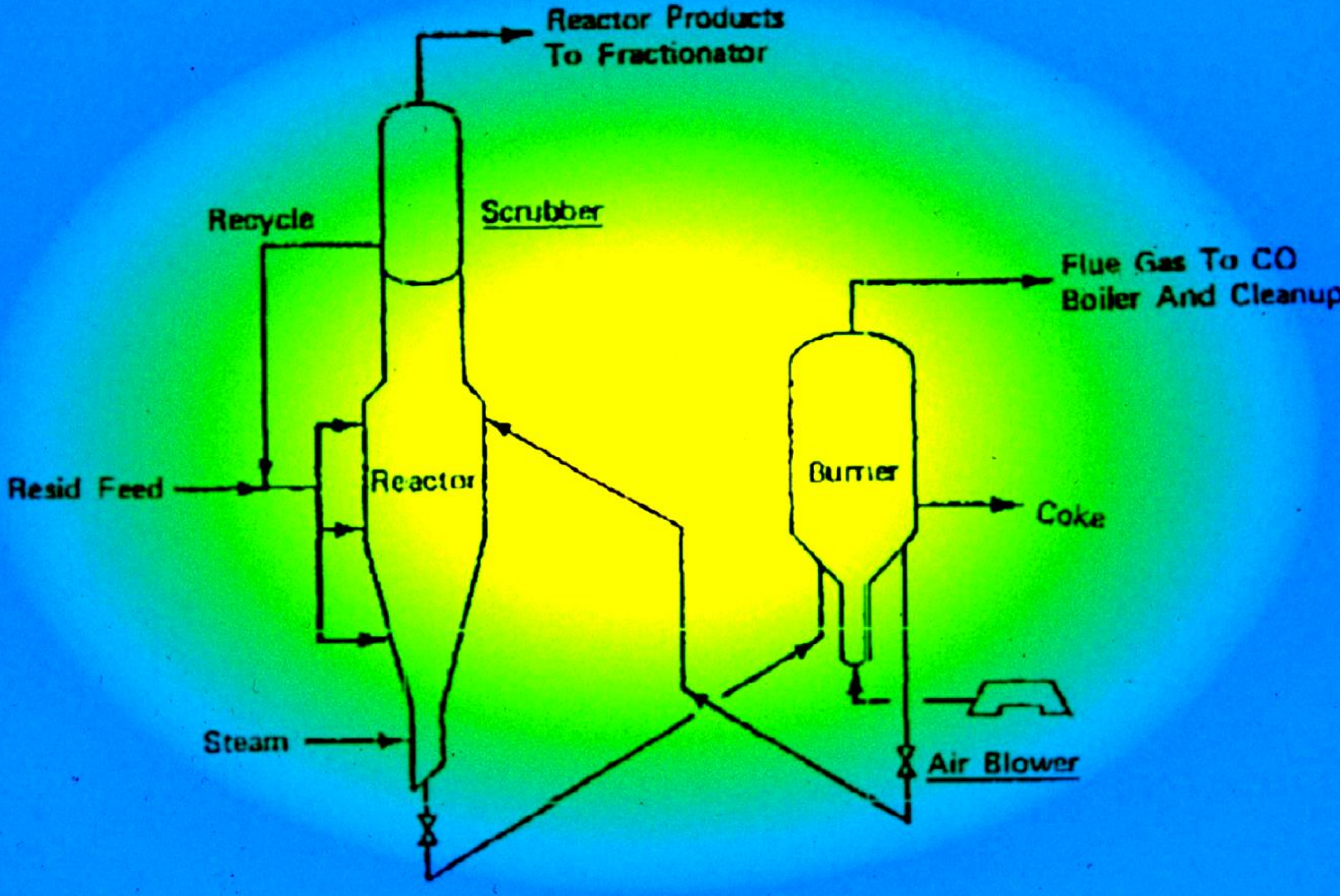
# Coker

- REACTION: There are 3 types of coking processes utilized. Each process uses high temperature to crack the large molecules and form by-product coke.
  - Flexi-Coking
  - Fluidized Coking
  - Delayed Coking

# Coking Process Comparison

| TYPE | FEED | PRODUCTS | USES FOR COKE |
|---|---|---|---|
| ***Flexi Coker*** | | Low BTU Gas | No coke |
| ***Fluidized Coker*** | | High quality coke | Welding anodes |
| ***Delayed Coker*** | | Low quality coke | Steel |

# Fluidized Coking

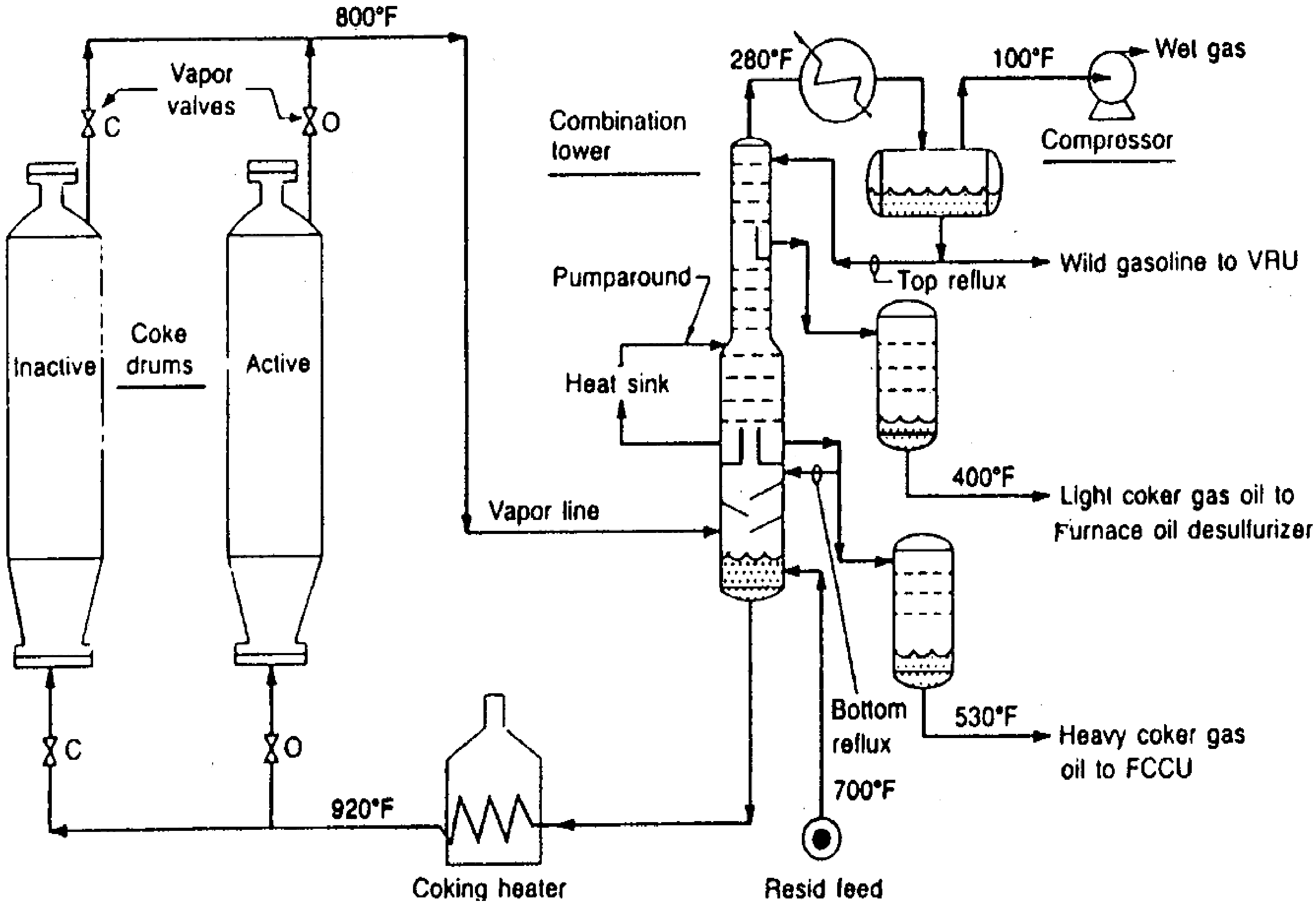


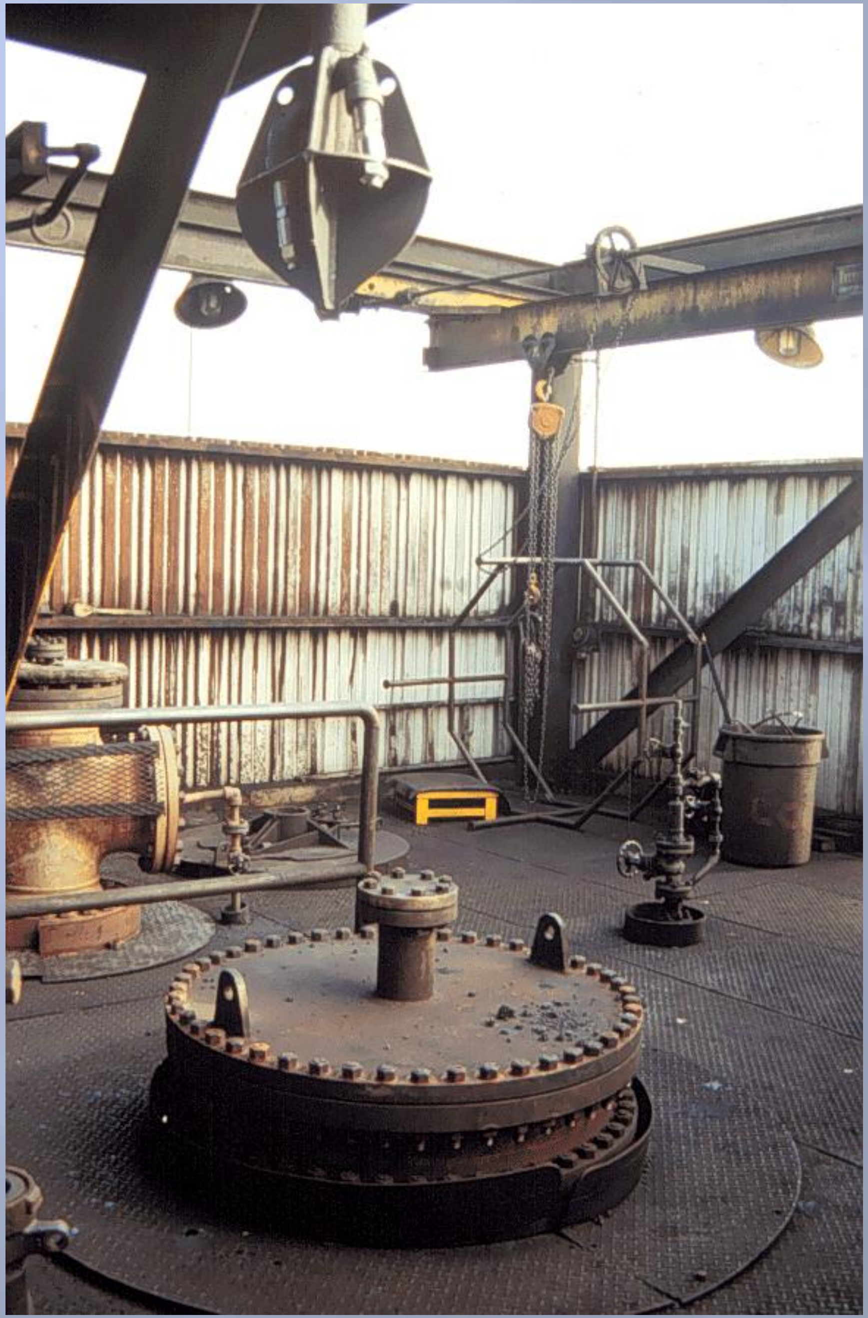
Reactor Products
To Fractionator
Scrubber
Recycle
Flue Gas To CO
Boiler And Cleanup
Burner
Resid Feed
Reactor
Coke
Steam
Air Blower

# Fluid Coker

# Delayed Coker

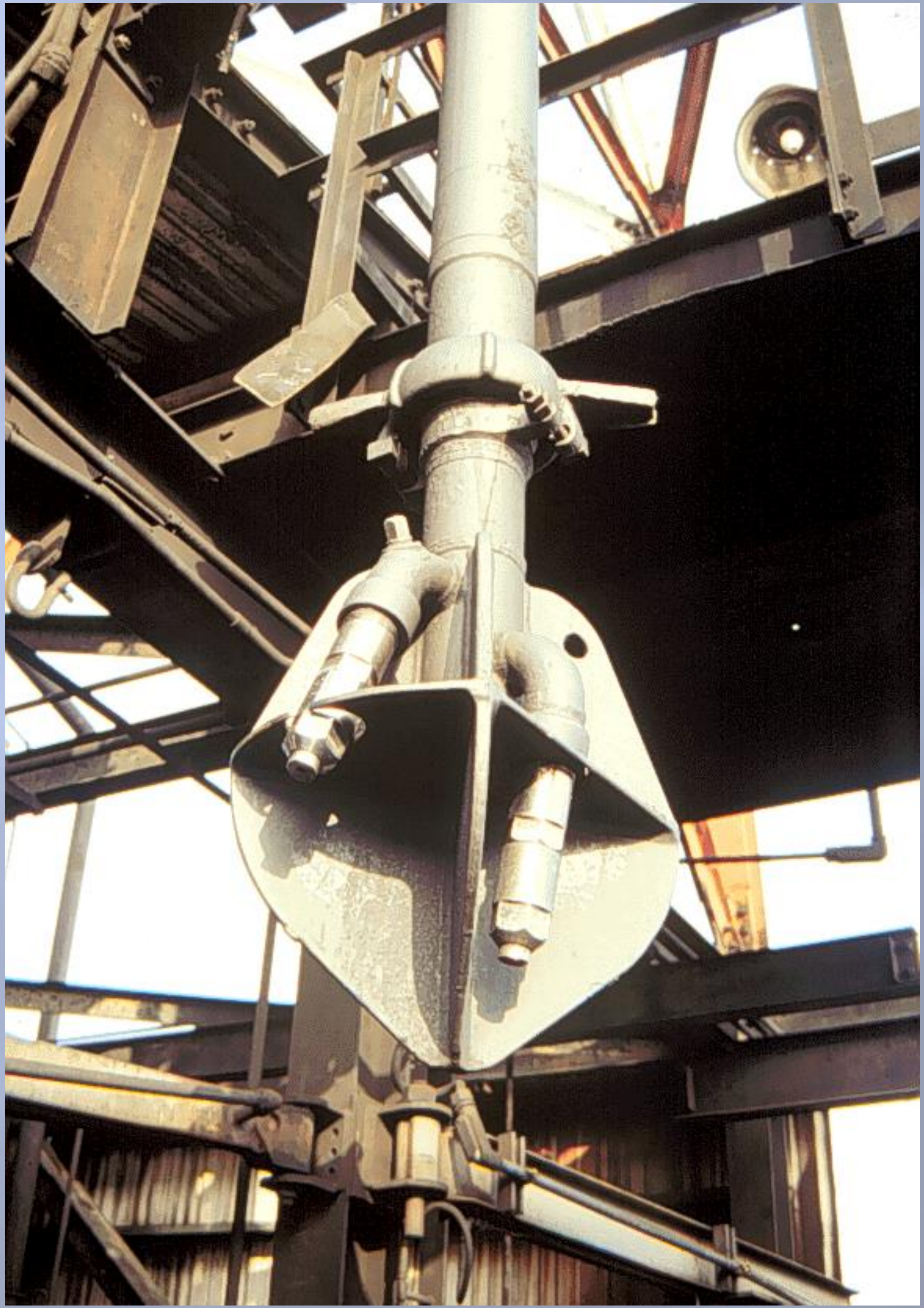
# Delayed Coker


800°F
Vapor valves
C
O
Coke drums
Inactive
Active
Combination tower
280°F
100°F
Wet gas
Compressor
Pumparound
Heat sink
Top reflux
Wild gasoline to VRU
Vapor line
400°F
Light coker gas oil to Furnace oil desulfurizer
Bottom reflux
530°F
Heavy coker gas oil to FCCU
700°F
920°F
Coking heater
Resid feed

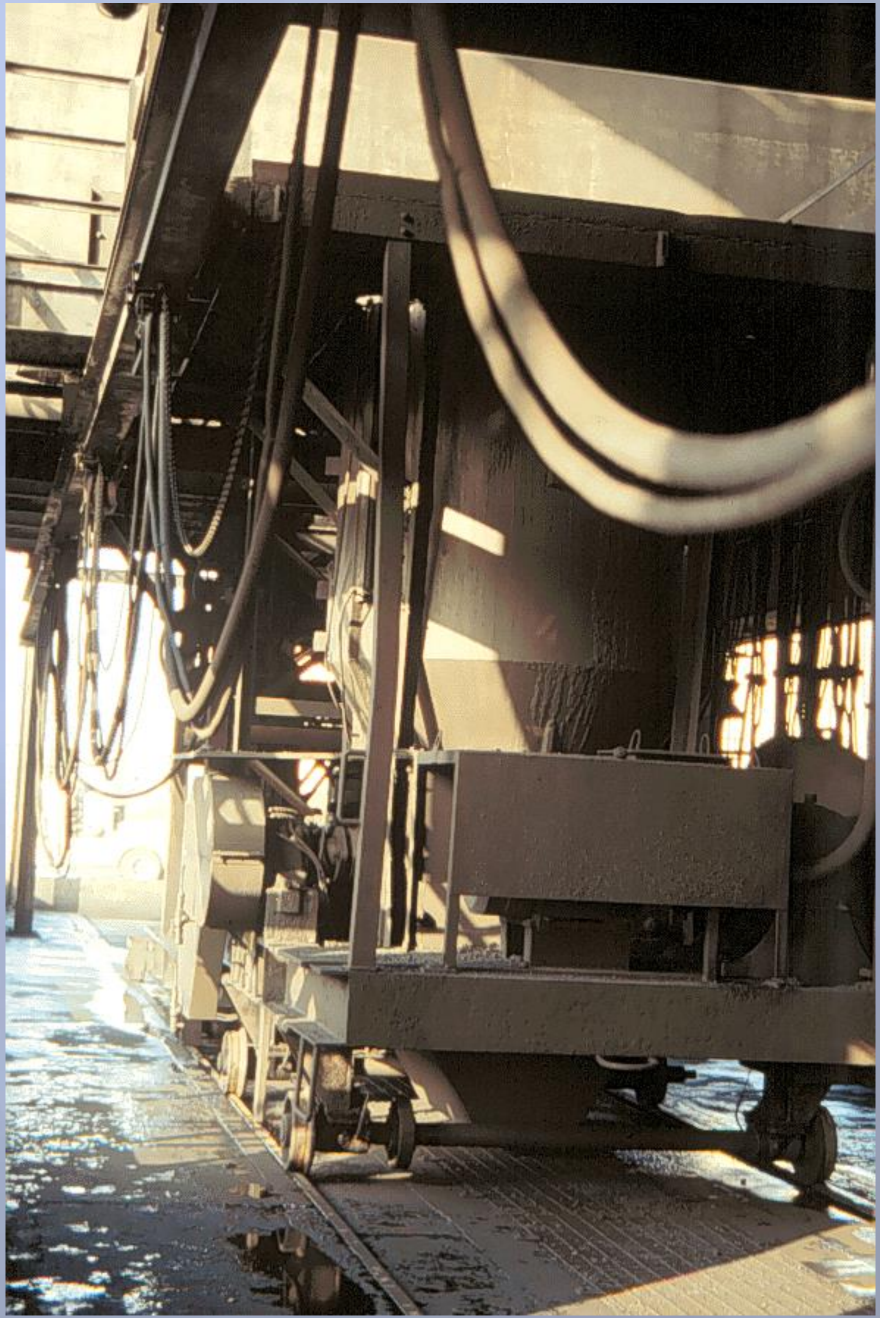


# Top of Coke Drum -Hot

# Bottom of Coke Drum

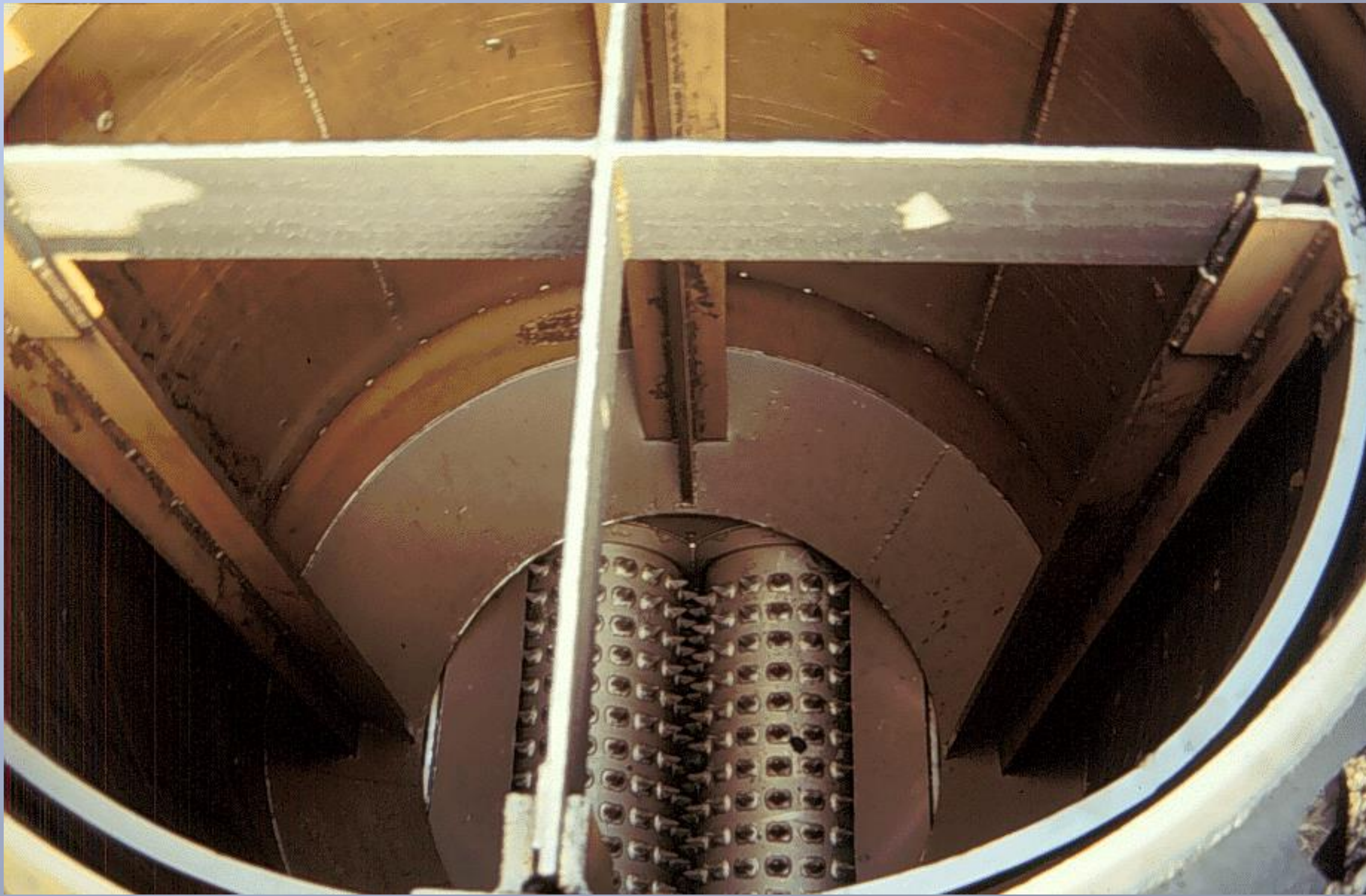


# Hydro-Drill Assembly for Coke Removal



# Coke Treatment Facility

# Coke Grinder



# Coker Wastewater Treatment

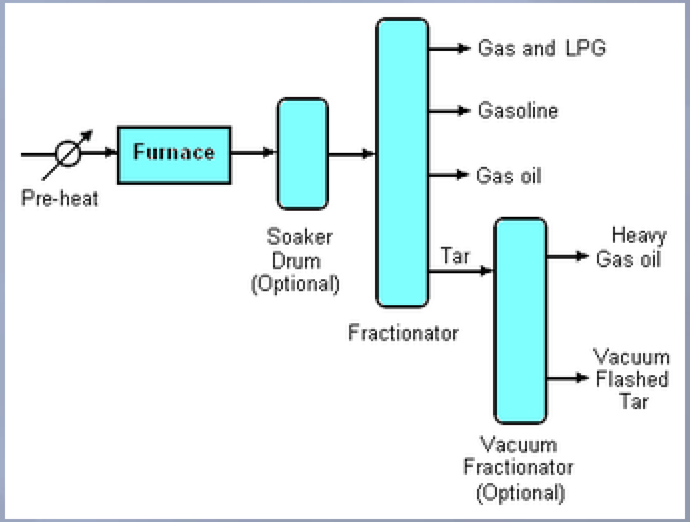
# Coke Loading

# Visbreaking

- PURPOSE:  Heavier crude fractions are thermally treated to improve the viscosity and pour point of products.
- mild cracking/reforming of residium resulting in unsaturated products without coke laydown

# Visbreaking

- REACTION: Through mild thermal cracking larger molecules are cracked to somewhat smaller molecules. Cracking takes place in a furnace at between 850 and 900 F.

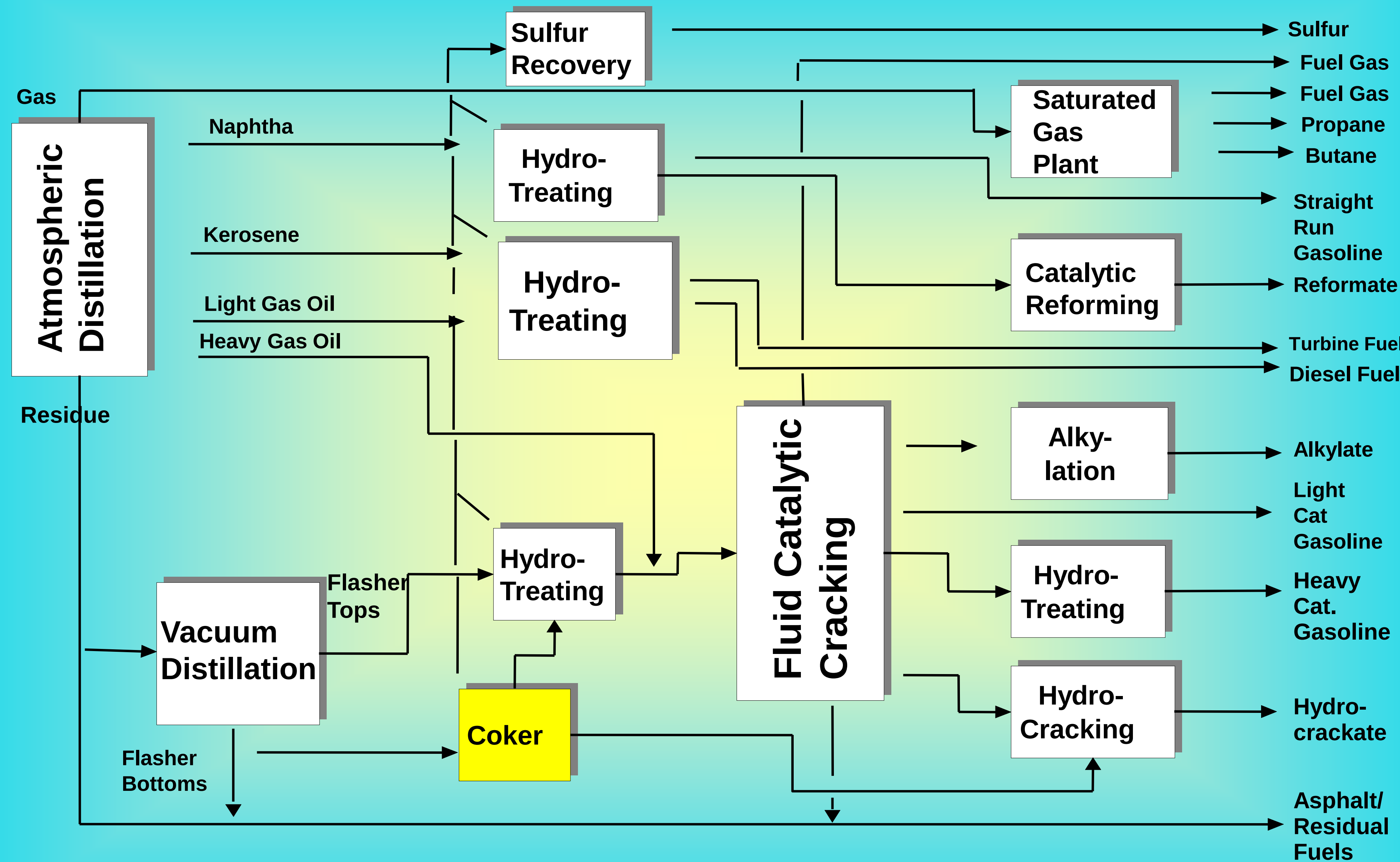


# Quick Review 5

- Conversion
  - Property change
    - Catalytic reforming
    - Isomerization
  - Build up
    - Alkylation
    - Polymerization
  - Break up
    - Fluid Catalytic Cracking
    - Hydrocracking
    - Coking
    - Visbreaking

# Petroleum Refining Process

- Separation
- Treatment
- Conversion
- <u>Blending</u>



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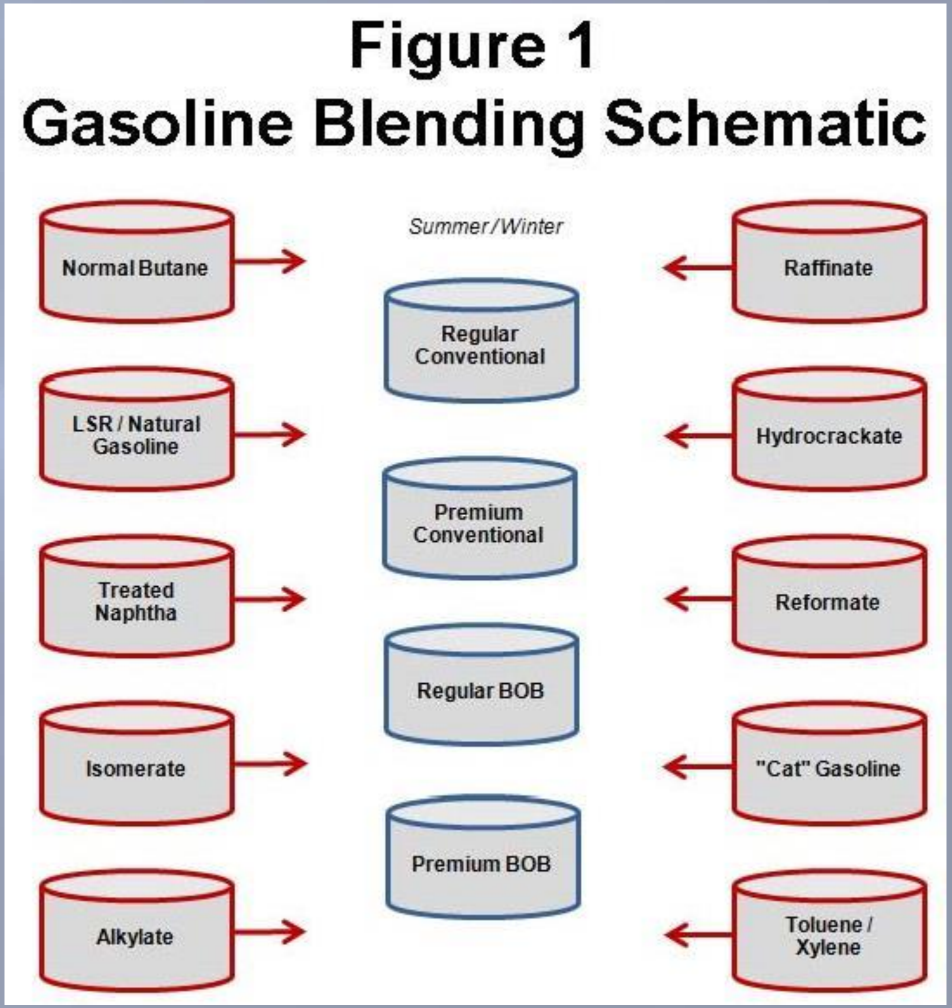
# Blending

- PURPOSE:  Refinery products such as gasoline, jet fuel, diesel, and lubricating oils have specifications that must be met.  The blending process utilizes all of the available components into end products which meet these specifications.

# Blending

- PROCESS:  Blending components are drawn from storage tanks into a blend manifold where they are metered into a final blend tank.  The blend is mixed and sampled to determine if it meets the specifications prior to sale.



# Gasoline Specifications

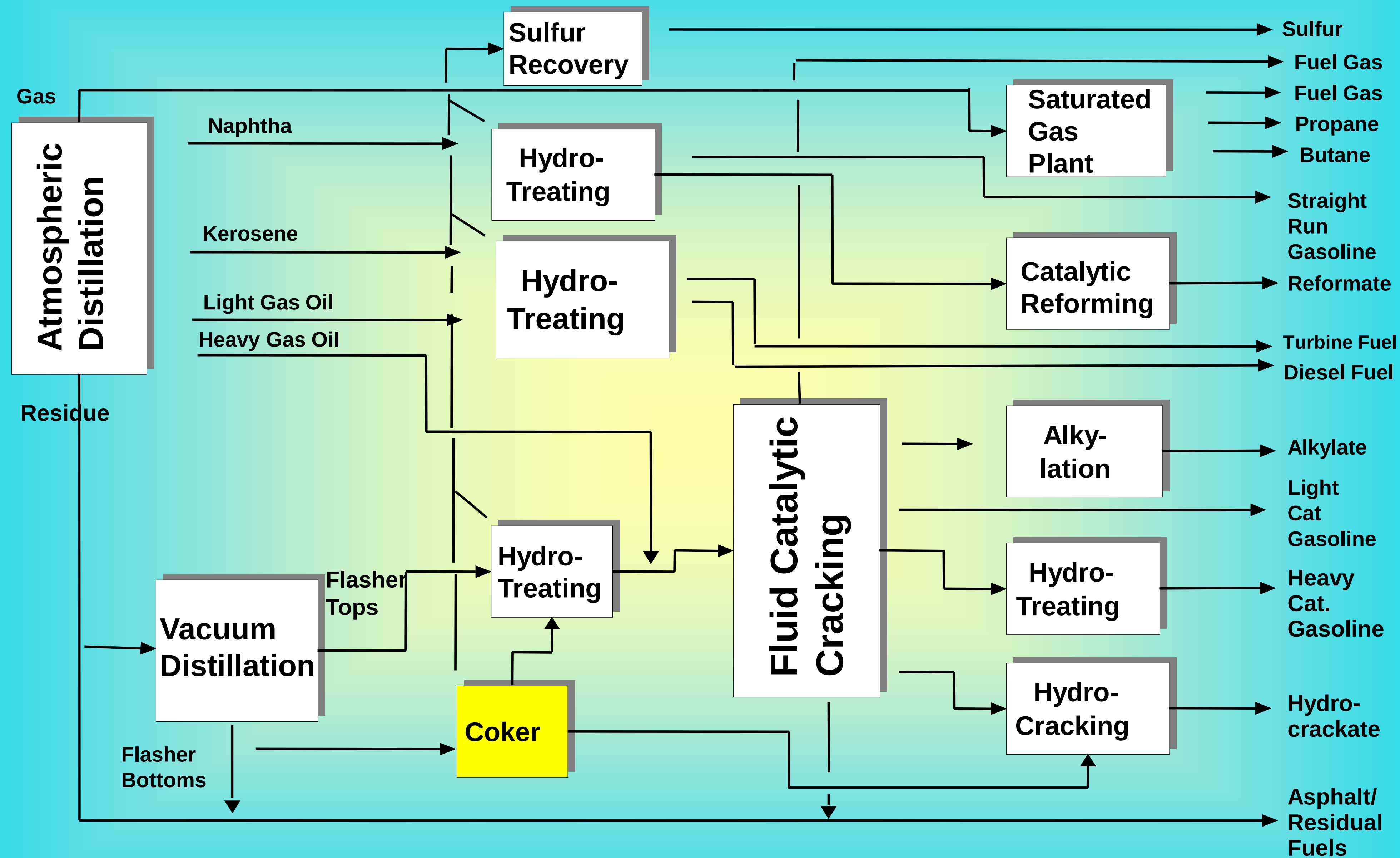
- Octane
- Reid Vapor Pressure
- Sulfur Content
- Benzene Content
- Olefin Content
- Oxygen Content
- Distillation
- Aromatic Content
- Lead Content
- Phosphorus
- Manganese Content
- Deposit Control Additive

# Diesel Specifications

- Cetane Number
- Sulfur Content
- Aromatic Hydrocarbon Content
- Polynuclear Aromatic HC Content
- Nitrogen Content

# Quick Review 6

- Separation
  - No molecular manipulation
- Treatment
  - Removes impurities
- Conversion
  - Molecular manipulation
    - Desired size
    - Desired properties
- Blending



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*2017*

# PROCESSES

## THE REST OF THE PROCESS

The National Air
Compliance Training
Program

# Wastewater Treatment

- PURPOSE: To remove any traces of hydrocarbons from water used in the processes throughout the refinery prior to discharge.

# Wastewater Treatment

- PROCESS:  A series of gravity separation and skimming steps followed by biological treatment to remove traces of hydrocarbons.  Some refineries may use filtration or carbon adsorption depending on the permit requirements.

# Wastewater Sources

- Crude Desalting Operations
- Process Water
- Steam Stripping Operations
- Equipment/Tank Washouts
- Storage Tank Roof Drains
- Unit Washdowns and Spills

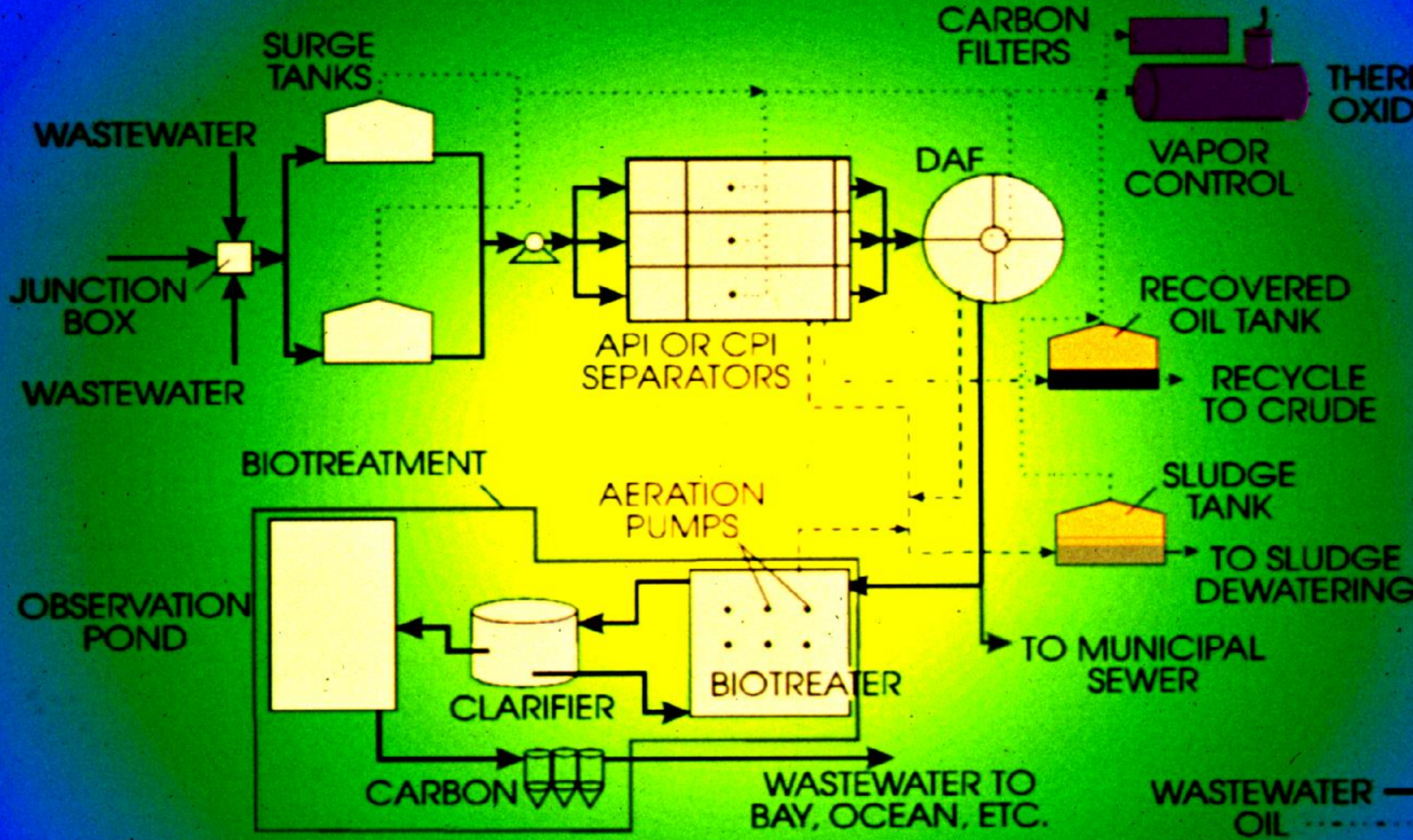



Figure 303.2
Main Wastewater Treatment Flows

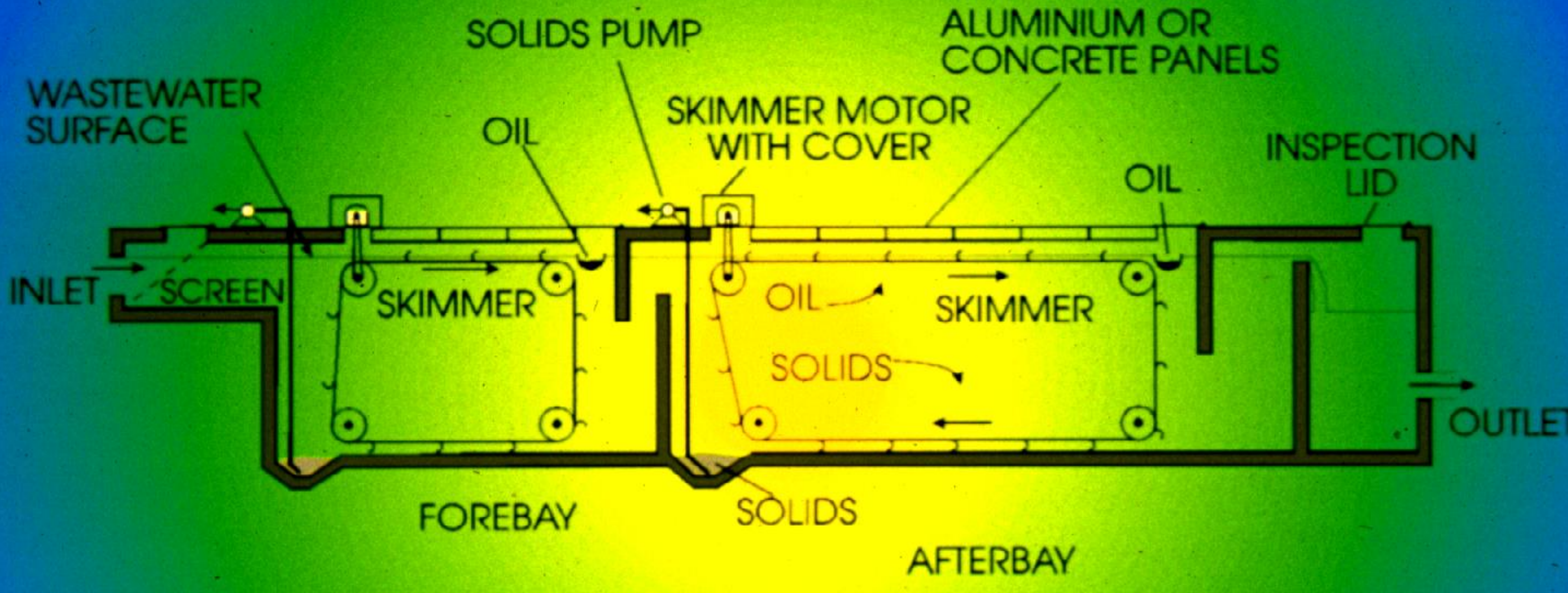



Figure 303.3
API Separator

# API Separator Forebay

# API Separator

# API Separator

# API Separator with Open Cover

# Oil Skimmer Inside API


# Corrugated Plate Interceptor (CPI) Wastewater Separator

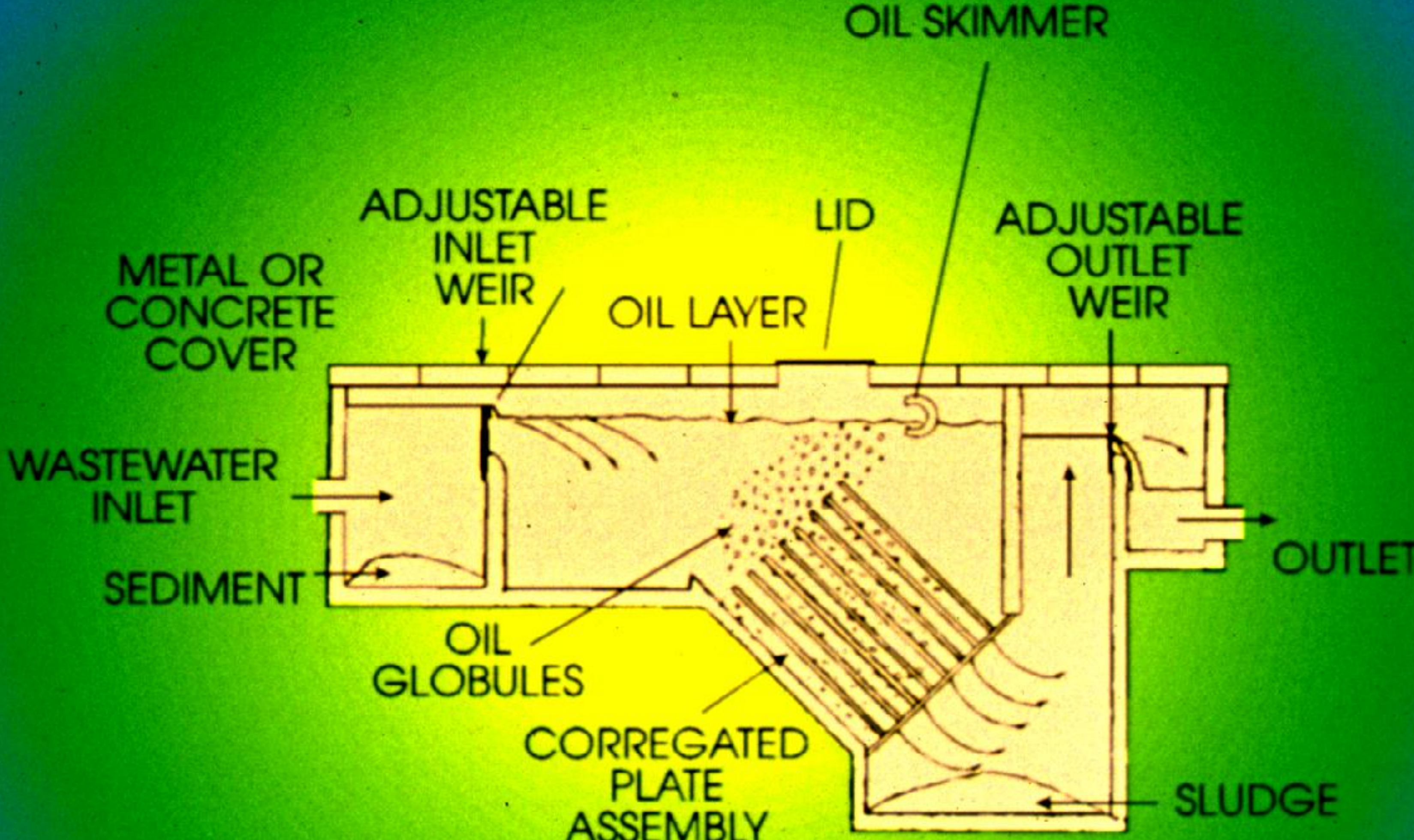



Figure 303.4 CPI Separator


# Induced Air Floatation (IAF)

# Inside of a IAF

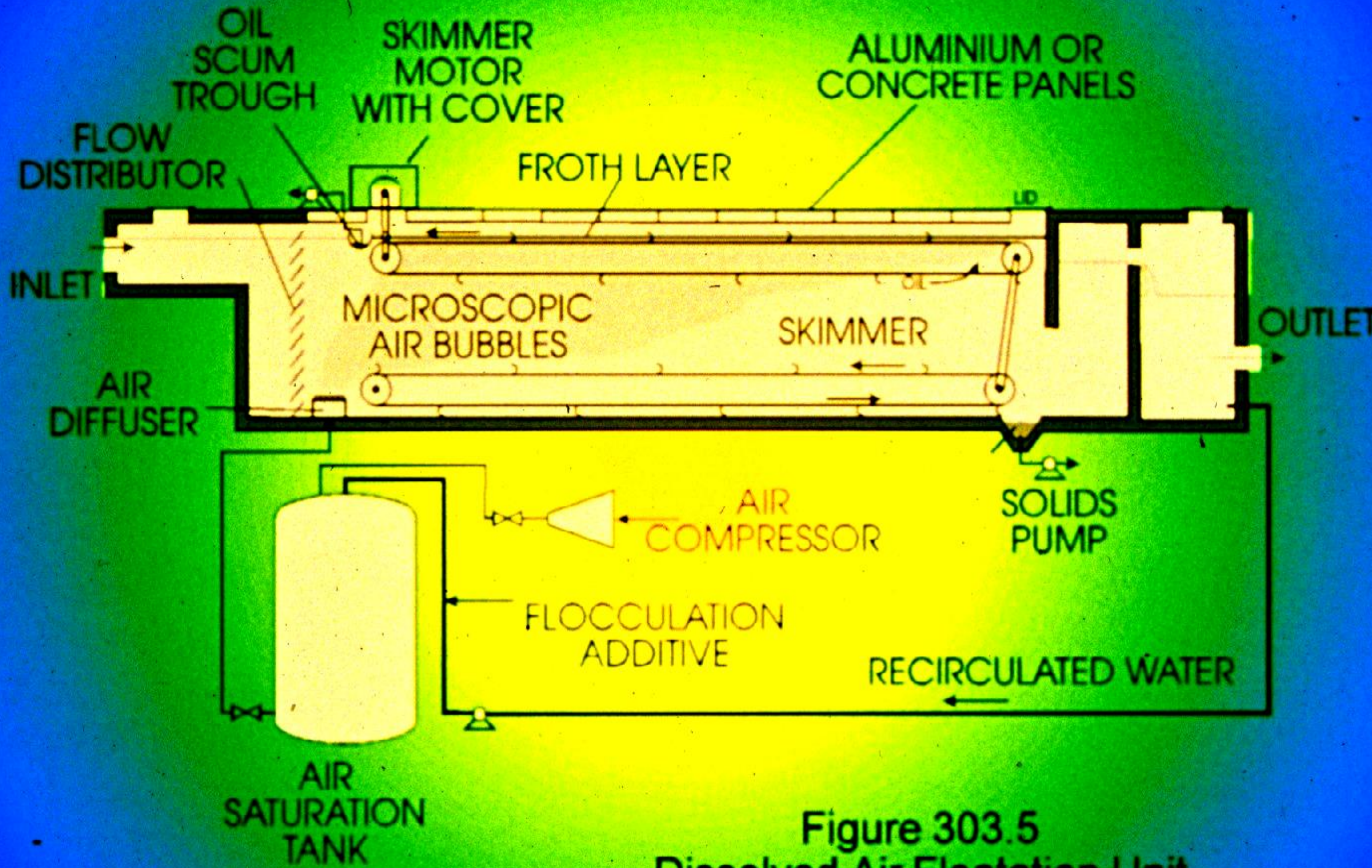



**Figure 303.5**
**Dissolved Air Floatation Unit**

# Clarifier

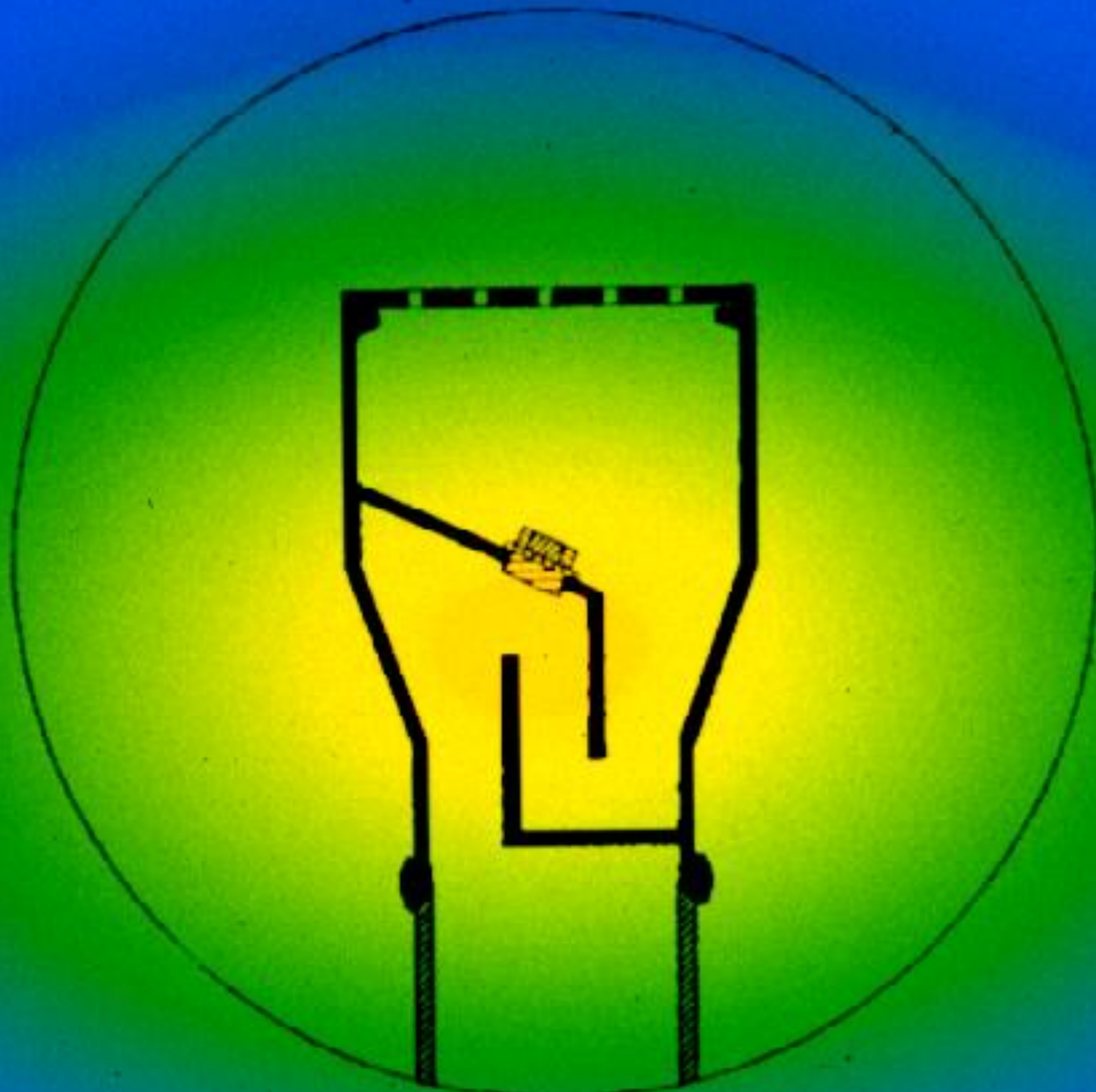
# Biological Wastewater Treatment (Biotreaters)

# Aerators on Treatment Ponds

# Bioreactor (Pond)

# Granular Activated Carbon (GAC) Treaters

# Process Sewer



# P-trap

# Process Drain with a P-Trap

# Junction Box for Wastewater

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Petroleum Refining
*2017*

# REGULATIONS


The National Air Compliance Training Program

# REFINERY REGULATIONS

| Refinery NSPS/NESHAP/MACT Standards (Also General SIP Requirements and NSR Consent Decree) | | | |
|---|---|---|---|
| **NSPS - 40 CFR Part 60** | | | |
| **Subpart** | **Date** | **Affected Facility** | **Pollutant** |
| 60.18(b) | Depends | Flares | |
| Cd (EG) | Pre 8/17/71 | Sulfuric Acid Production Unit | $H_2SO_4$ mist |
| D | 8/17/71 | Fossil Fueled Fired steam gen >250 mmbtu | PM, $SO_2$, NOx |
| Da | 9/18/78 | Elec Utility steam gen >250 mmbtu (may include certain combined cycle turbines) | PM, $SO_2$, NOx, Hg |
| Db | 6/19/84 | ICI steam gen >100 mmbtu | PM, $SO_2$, NOx |
| Dc | 6/9/89 | ICI steam gen 10 – 100 mmbtu | PM, $SO_2$, |
| H | 8/17/71 | Sulfuric Acid Production Unit | $H_2SO_4$ mist |
| J | '76 or '84 | FCCU cat regen/fuel gas combustion devices/Claus Plant > 20 LTD | *PM, CO (FCCU)* $SO_2$ |
| Ja | 5/14/07 | FCCU, Fluid Coking Unit, delayed coking units, fuel gas combustion devices (inc. flares and process heaters) and sulfur recovery plants | *PM, NOx, $SO_2$, CO (FCCU or FCU);* $SO_2$ (SRU); $SO_2$, $H_2S$, NOx (fuel gas comb. dev.) |
| K | 6/73 - 5/78 | Storage Vessel for Pet. Liq. > 40K gal | VOC |
| Ka | 5/78 – 7/84 | Storage Vessel for Pet. Liq. > 40K gal | VOC |
| Kb | 7/23/84 | Organic Liquid Storage Vessel >= 75 $m^3$ | VOC |
| GG | 10/3/77 | Stationary Gas Turbines | $SO_2$, NOx |
| UU | '80 or '81 | Asphalt Processing and Asphalt Roof Mfg | PM |
| VV | 1/5/81 | SOCMI Equipment Leaks | VOC |
| XX | 12/17/80 | Bulk Gasoline Terminals | VOC |
| GGGa | 11/7/06 | Equip Leaks of VOC in Petrol Refineries | VOC |
| III | 10/21/83 | VOC Emissions from SOCMI Air Oxidation Unit Processes | TOC |
| NNN | 12/30/83 | VOC Emissions from SOCMI Distillation Operations | TOC |
| QQQ | 5/4/87 | VOC Emissions from Petrol Refinery Wastewater Systems | VOC |
| RRR | 6/29/90 | VOC Emissions from SOCMI Reactor Processes | TOC |
| CCCC | 11/30/99 m/r 6/1/01 | Commercial and Industrial Solid Waste Incinerators | Dioxin/furans; 3 metals; PM; opacity; 3 acid gases; CO; ash |
| DDDD (EG) | Pre 11/30/99 | Commercial and Industrial Solid Waste Incinerators | Dioxin/furans; 3 metals; PM; opacity; 3 acid gases; CO; ash |

| **Subpart** | **Date** | **Affected Facility** | **Pollutant** |
|---|---|---|---|
| IIII | Varies | Stationary Compression Ignition IC Engines | HC, NOx, CO, PM |
| JJJJ | Varies | Stationary Spark Ignition IC Engines | NOx, CO, VOC |
| KKKK | 2/18/05 | Stationary Combustion Turbines | SOx, NOx |
| **NESHAPS – 40 CFR Part 61** | | | |
| **Subpart** | **Date** | **Affected Facility** | **Pollutant** |
| J | <> '84 | Equipment Leaks of Benzene | Benzene |
| M | <> '84 | Asbestos | Asbestos |
| V | <> '84 | Equipment Leaks | Benzene, Vinyl Chloride |
| Y | <> '89 | Benzene Storage Vessels | Benzene |
| BB | <> '90 | Benzene Transfer Operations | Benzene |
| FF | <> '90 | Benzene Waste Operations | Benzene |
| **MACT – 40 CFR Part 63** | | | |
| Subpart | Date | Affected Facility | Pollutant |
| F | '94 | SOCMI (HON) | HAPs |
| G | '94 | SOCMI Process Vents, Storage Vessels, Transfer Operations, Wastewater | HAPs |
| H | '94 | Equipment Leaks | HAPs |
| I | '94 | Equipment Leaks (certain processes) | HAPs |
| Q | '94 | Industrial Cooling Towers | Chromium |
| R | '94 | Gasoline Distribution Faciities | HAPs |
| T | '94 | Halogenated Solvent Cleaning | Halogenated Solvents |
| CC | '95 | Petroleum Refineries (MACT I) | HAPs |
| EEE | '99 | Hazardous Waste Combustors | HAPs |
| UUU | '02 | Petroleum Refineries (MACT II – cat cracking, cat reforming, sulfur plant units) | HAPs |
| EEEE | '04 | Organic Liquids Distribution (non-gasoline) | HAPs |
| FFFF | '03 | Misc. Organic Chemical Mfg | HAPs |
| YYYY | '04 | Stationary Combustion Turbines | Formaldehyde |
| ZZZZ | '04 | Reciprocating Internal Combust. Engines | Formaldehyde |
| DDDDD | '04 | ICI Boilers and Process Heaters | HAPs |
| GGGGG | '03 | Site Remediation | HAPs |
| LLLLL | '03 | Asphalt Processing and Asphalt Roof Mfg | HAPs |
| **General SIP Rules** | | | |
| **NSR Consent Decree** | | | |
| **Construction and Operating Permit Requirements** | | | |

Thanks to the MWRPO for allowing reliance on a document developed for them by MACTEC.

# REGULATIONS

- Federal regulations are NSPS, NESHAPS (MACT)
- State and local agencies may have additional regulations
- This course will touch on a few of the applicable NSPS and NESHAPS applicable to refineries

# CONTINUOUS EMISSION MONITORING

CEM Requirements

40 CFR 60, Subpart J

FCC

Tailgas Units

# CEM Requirements

- 40 CFR 60, Appendix B - Performance Specifications
- 40 CFR 60, Appendix F - Quality Assurance Programs

# Purpose of CEMs -Regulators View

- Determine emission compliance
- Identify periods of excess emissions
- Assess control equipment efficiency
- Monitor operating parameters
- Validate emission credits
- Public perception reports

# Purpose of CEMs - Industry View

- Comply with regulations
- Demonstrate compliance
- Monitor control equipment
- Monitor process parameters
- Validate emission credits
- Complaint protection
- Plant safety

# MACT 1 AND MACT 2

- 40 CFR 63 NESHAP, Subpart CC [MACT 1]
- 40 CFR 63 NESHAP, Subpart UUU [MACT 2]

Revised or brand-new standards for various refinery equipment (including storage tanks, flares, catalytic cracking units, & coking units), as well as the introduction of mandatory continuous fenceline monitoring for benzene.

# MACT 1 AND MACT 2

**The EPA performed this rule revision in accordance with the mandatory technology and residual risk reviews that are required every 8 years by the Clean Air Act.**

- **Signed September 29, 2015.**
- **Compliance Dates**
    - All new sources installed after February 1, 2016 - Upon start-up
    - All existing sources - it depends, February 1, 2016 – February 1, 2019
- **Specific Information Be Found**

  EPA Website:
  http://www3.epa.gov/airtoxics/petref.html

# WORK PRACTICE STANDARDS

- **Maintenance Vents**
  - *Maximum hydrocarbon limits prior to opening*
- **Pressure Relief Devices**
  - *Continuous monitoring & release reporting requirements*
- **Delayed Coking Units**
  - *Maximum pressure limits prior to opening*
- **Flares**
  - *Continuous monitoring & maximum flare tip velocity limits*
- **Fluid Catalytic Cracking Units (FCCU)**
  - *Minimum $O_2$ and cyclone face velocity operating limits during start-up, shut-down, & hot standby*
- **Sulfur Recovery Unit (SRU)**
  - *Minimum temperature and $O_2$ operating limits during start-up & shut-down.*

# PRESSURE RELIEF DEVICES (§63.648)

**Compliance Date: February 1, 2016**

**Operating requirements:** *Except during a pressure release, operate each pressure relief device in organic HAP gas or vapor service with an instrument reading of less than 500 ppm above background*

**Returning to normal operation after a release episode:**

The owner or operator must conduct instrument monitoring, no later than 5 calendar days after the pressure relief device returns to organic HAP gas or vapor service following a pressure release to verify that the pressure relief device is operating with an instrument reading of less than 500 ppm.

In addition to the above, if the pressure relief device consists only of a rupture disk, a replacement disk must be installed no later than 5 calendar days after the pressure release. The owner or operator may not initiate start-up of the equipment served by the rupture disk until the rupture disc is replaced.

# DELAYED COKING UNITS (§63.657)

**Compliance Date: February 1, 2016**

Each owner or operator of a delayed coking unit shall depressurize each coke drum to a closed blowdown system until the following conditions are met:

For delayed coking units at an existing affected source, meet either:
(A) An average vessel pressure of 2 psig determined on a rolling 60-event average;
(B) An average vessel temperature of 220 degrees Fahrenheit determined on a rolling 60-event average.
For delayed coking units at a new affected source, meet either:
(A) A vessel pressure of 2.0 psig* for each decoking event; or
(B) A vessel temperature of 218 degrees Fahrenheit for each decoking event.

***Notice the additional significant digit for a new affected source, not trivial**

Each operator of a delayed coking unit complying with these pressure limits must install, operate, calibrate, and maintain a pressure monitoring system to determine the coke drum vessel pressure.

# FLARES (§63.670)

**Compliance Date: January 30, 2019**

**Pilot flame presence:** The owner or operator shall operate each flare with a pilot flame present at all times when regulated material is routed to the flare.

**Pilot flame monitoring:** The owner or operator shall continuously monitor the presence of the pilot flame using a device (e.g. thermocouple, ultraviolet beam sensor, or infrared sensor) capable of detecting that the pilot flame is present.

**Flare tip velocity:** Actual flare tip velocity (Vtip) must be less than 60 feet per second OR less than 400 feet per second AND also less than the maximum allowed flare tip velocity (Vmax).

**Combustion zone operating limits:** For each flare, the owner or operator shall operate the flare to maintain the net heating value of flare combustion zone gas ($NHV_{cz}$) at or above 270 Btu/scf.

**Flare vent gas, steam assist and air assist flow rate monitoring:** The owner or operator shall install, operate, calibrate, and maintain a monitoring system capable of continuously measuring, calculating, and recording the volumetric flow rate in the flare header or headers that feed the flare, as well as any supplemental natural gas used.

# FLARES (§63.670)

**Compliance Date: January 30, 2019**

**Visible emissions monitoring*:*** The owner or operator shall monitor visible emissions while regulated materials are vented to the flare. An initial visible emissions demonstration must be conducted using an observation period of 2 hours using EPA Method 22. The owner or operator must record and report any instances where visible emissions are observed for more than 5 minutes during any 2 consecutive hours. Subsequent visible emissions monitoring must be performed either by daily visible emissions monitoring or continuous video surveillance.

**Flare vent gas composition monitoring***:* The owner or operator shall determine the concentration of individual components in the flare vent gas using a continuous monitoring or grab sampling system.

# FLARES (§63.670)

**Compliance Date: January 30, 2019**

If either criteria (i) or (ii) occurs, the refinery is now required to complete a root cause analysis and implement corrective action within 45 days of event.

**Violation Criteria:**

(i) The vent gas flow rate exceeds the smokeless capacity of the flare and visible emissions are present from the flare for more than 5 minutes during any 2 consecutive hours during the release event.

(ii) The vent gas flow rate exceeds the smokeless capacity of the flare and the 15-minute block average flare tip velocity exceeds the maximum flare tip velocity.

The following are a **violation** of the emergency flaring work practice standards:

(A) Any flow event for which a root cause analysis was required and the root cause was determined to be operator error or poor maintenance.

(B) Two visible emissions exceedance events meeting the criteria in (i) that were not caused by a force majeure event from a single flare in a 3 calendar year period for the same root cause for the same equipment.

(C) Two flare tip velocity exceedance events meeting the criteria in (ii) that were not caused by a force majeure event from a single flare in a 3 calendar year period for the same root cause for the same equipment.

# FLUID CATALYTIC CRACKING UNITS (§63.1564 & §63.1565)

**Compliance Date: February 1, 2016 → August 1, 2017?**

**New Standards for start-up, shut-down, and hot standby operation:**

**PM Standard**

- Maintain the inlet velocity to the primary internal cyclones of the catalytic cracking unit catalyst regenerator at or above 20 feet per second *as an alternative to the normally permitted PM limit.*

**HAPS Standard**

- Maintain the oxygen ($O_2$) concentration in the exhaust gas from your catalyst regenerator at or above 1 volume percent (dry basis) *as an alternative to the normally permitted CO limit.*

# FLUID CATALYTIC CRACKING UNITS (§63.1571)

**Compliance Date: August 1, 2017**

**PM Performance Test Standard**

- Conduct a periodic performance test for PM or Ni for each catalytic cracking unit at least once every 5 years*. You must conduct the first periodic performance test no later than August 1, 2017.

**Exempt from this requirement if monitoring with a PM CEMS*

**HAPS Performance Test Standard**

- Conduct a one-time performance test for HCN* for each catalytic cracking unit no later than August 1, 2017

**If you conducted a performance test for HCN for a specific catalytic cracking unit between March 31, 2011 and February 1, 2016, you may submit a request to the Administrator to use the previously conducted performance test results.* **Request must be submitted by March 30, 2016.**

# SULFUR RECOVERY UNITS (§63.1568)

**Compliance Date: February 1, 2016 → August 1, 2017?**

**New Standards for start-up & shut-down:**

**<u>HAPS Standard</u>**

- Send any <u>start-up or shut-down purge gases to a flare</u> *as an alternative to the normally permitted SOx limit.*

**OR**

- Send any <u>start-up or shut-down purge gases to a thermal oxidizer or incinerator</u> operated at a minimum hourly average temperature of 1,200 ˚F in the firebox and a minimum hourly average outlet $O_2$ concentration of 2 volume percent (dry basis) *as an alternative to the normally permitted SOx limit.*

# MISCELLANEOUS CHANGES

**MARINE VESSEL LOADING (Compliance Date: February 1, 2016)**

- EPA has deleted the exclusion for marine vessel loading operations at petroleum refineries in 40 CFR 63 NESHAP, Subpart Y. Removing this exclusion will require small marine vessel loading operations (i.e., operations with HAP emissions less than major source thresholds) and offshore marine vessel loading operations to use submerged filling based on the cargo filling line requirements in 46 CFR §153.282.

**GROUP 1 STORAGE VESSELS (Compliance Date: May 1, 2016)**

- Group 1 storage vessels now include smaller tanks with lower vapor pressures. An existing tank is now classified as Group 1 if:

| Capacity (gallons) | Maximum True Vapor Pressure (psia) | Annual Average Weight HAP Content |
|---|---|---|
| 20,000 ≤ X < 40,000 | 1.9 | 4% |
| 40,000 ≤ X | 0.75 | 4% |

*If any existing tanks are now redefined as a Group 1 storage vessel, new control requirements specified in 40 CFR §63.646 will need to implemented.*

# FENCELINE MONITORING

Fenceline Monitoring Requirements are now required as part of 40 CFR 63, NESHAPS CC.  The requirements are part of the package the refinery MACT 1 and MACT 2 updates signed September 29, 2015. Refineries have three years to deploy monitoring.  Significant emission reductions are expected to result from action plans in response to fenceline monitoring.

**https://www.epa.gov/stationary-sources-air-pollution/petroleum-refinery-sector-risk-and-technology-review-and-new-source**

# FENCELINE MONITORING

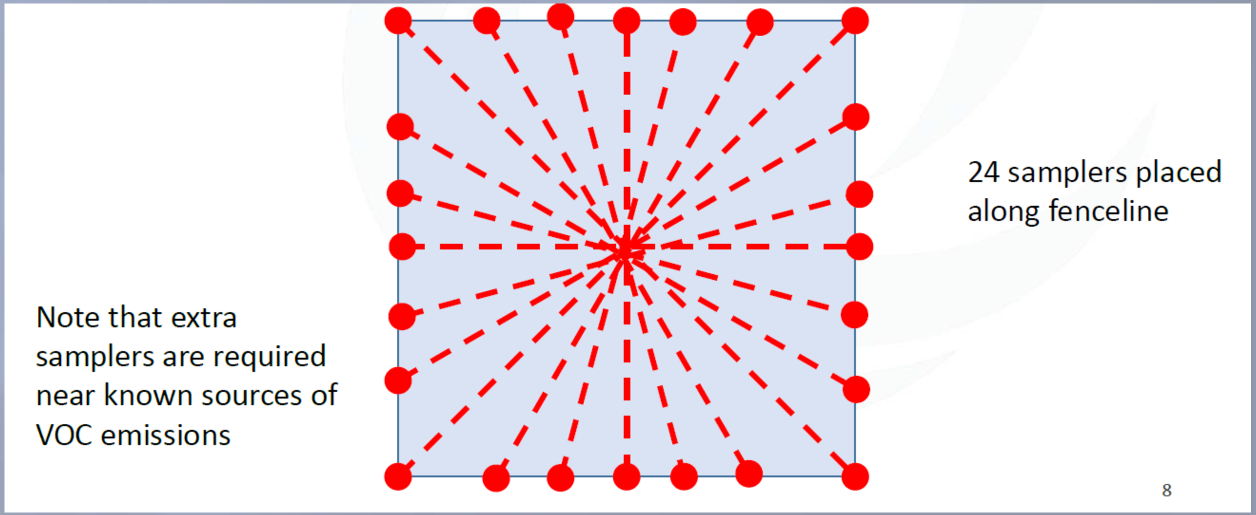
- The Benzene Fenceline Monitoring Rule was added as part of 40 CFR 63 NESHAP, Subpart CC [Refinery MACT 1] as a completely new subsection (§63.658) along with 2 new EPA Test Methods 325 A/B.
- This rule is being implemented to account for and monitor fugitive emissions from sources such as leaking equipment and wastewater treatment**. The air concentration limit set forth by this continuous monitoring is 9 µg/m$^3$.**
- Any exceedance of this limit will trigger corrective action to be completed by the facility.

# FENCELINE MONITORING

- **Program Requirements:**
  - 12 month's worth of data must be obtained by **February 1, 2019** (i.e. must start sampling by February 1, 2018)
  - EPA 325A and 325B – sorbent tube sampling (passive sampler (PS)), 14-day sampling period (next sampling event starts immediately after the end of previous event)
    - <750 acres – 30 degrees (12 samplers)
    - >750, < 1500 acres – 20 degrees (18 samplers)
    - >1500 – 15 degrees (24 samplers)
    - *Additional samplers may be required if there is an emission source that is close to the fence
  - Siting of monitors determined by proscribed methods, based on facility layout, at a minimum of 2,000 feet apart

# FENCELINE MONITORING

- Refineries required to deploy passive time-integrated benzene samplers – 14 day sample period
- Up to 24 monitoring locations distributed around the perimeter (fenceline) of the refinery
- Action level of 9 micrograms per cubit meter (μg/m3)



# FENCELINE MONITORING

- Refineries required to deploy passive time-integrated benzene samplers – 14 day sample period
- Up to 24 monitoring locations distributed around the perimeter (fenceline) of the refinery
- Reduction in frequency allowed if 2 years of samples are below 0.9 µg/m3

Photo courtesy of Enthalpy Analytical, Inc.

# FENCELINE MONITORING

- Corrective actions may include
  - Leak inspection using Method 21 and repair
  - Leak inspection using optical gas imaging and repair
  - Visual inspection to determine the cause of the high benzene emissions and repair
  - More frequent Methods 325A and 325B sampling or active sampling
  - Other measures

Photo courtesy of Camsco, Inc.

# Fugitive Leak Regulations Wastewater Systems

- Federal NSPS
  - 40 CFR 60 Subpart QQQ

https://www.epa.gov/stationary-sources-air-pollution/volatile-organic-compounds-voc-emissions-petroleum-refinery

# Fugitive Leaks

- NSPS – Leak Detection and Repair (LDAR)
- 40 CFR Part 60, Subpart GGGa
  - Equipment Leaks of VOC in Petroleum Refineries
- PURPOSE:  To ensure that the numerous pump seals, compressor seals, valves, flanges and other components are not leaking beyond a threshold value.

https://www.epa.gov/stationary-sources-air-pollution/equipment-leaks-volatile-organic-compounds-voc-petroleum-refineries

# Requirements

- Leakage Limits
- Self Inspection
- Leak Repair
- Component Identification
- Recordkeeping and Reporting

Handbook Pages 301-19 thru 301-33

# LDAR Equipment/Methods

- Organic Vapor Analyzer (OVA)
- Threshold Limit Value Meter (TLV)
- Flame Ionization Detector (FID)
- Photoionization Detector (PID)
- Infrared Detector (FLIR)
- Look and Listen
  - Soap Solution
  - Visual Distortion
  - Odor

# Inspection Points

- Screen as many components as possible
- Review records
- Verify repair tag dates

Handbook Page 301-39

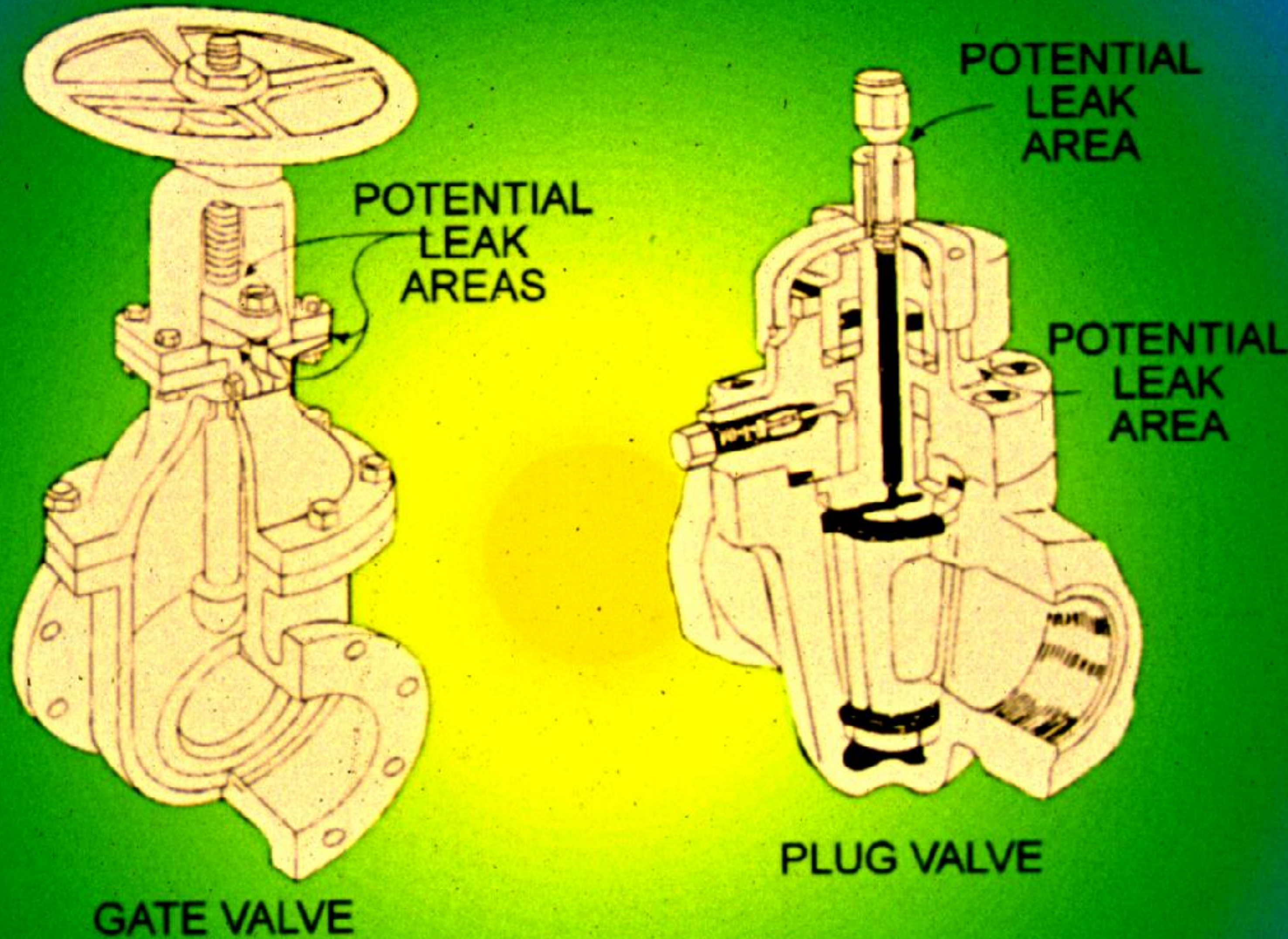



Figure 301.4
Potential Leak Areas for Gate Valves and Plug Valves

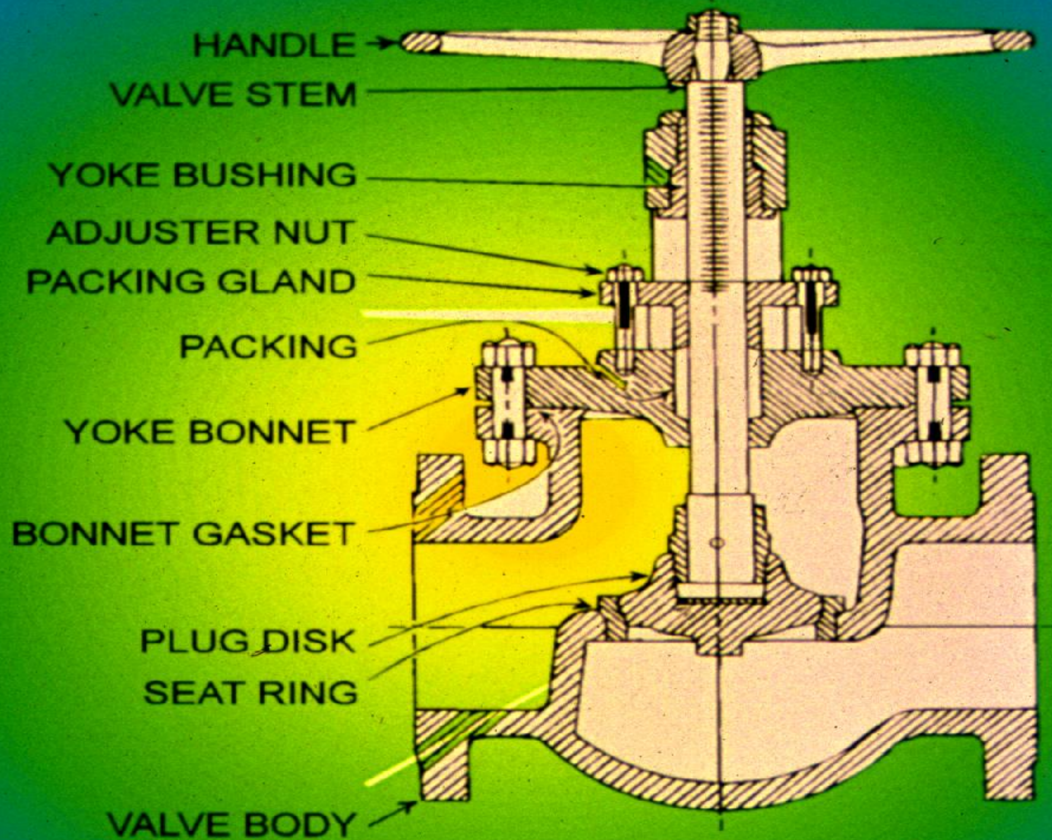



Figure 301.2
Parts of a Globe Valve

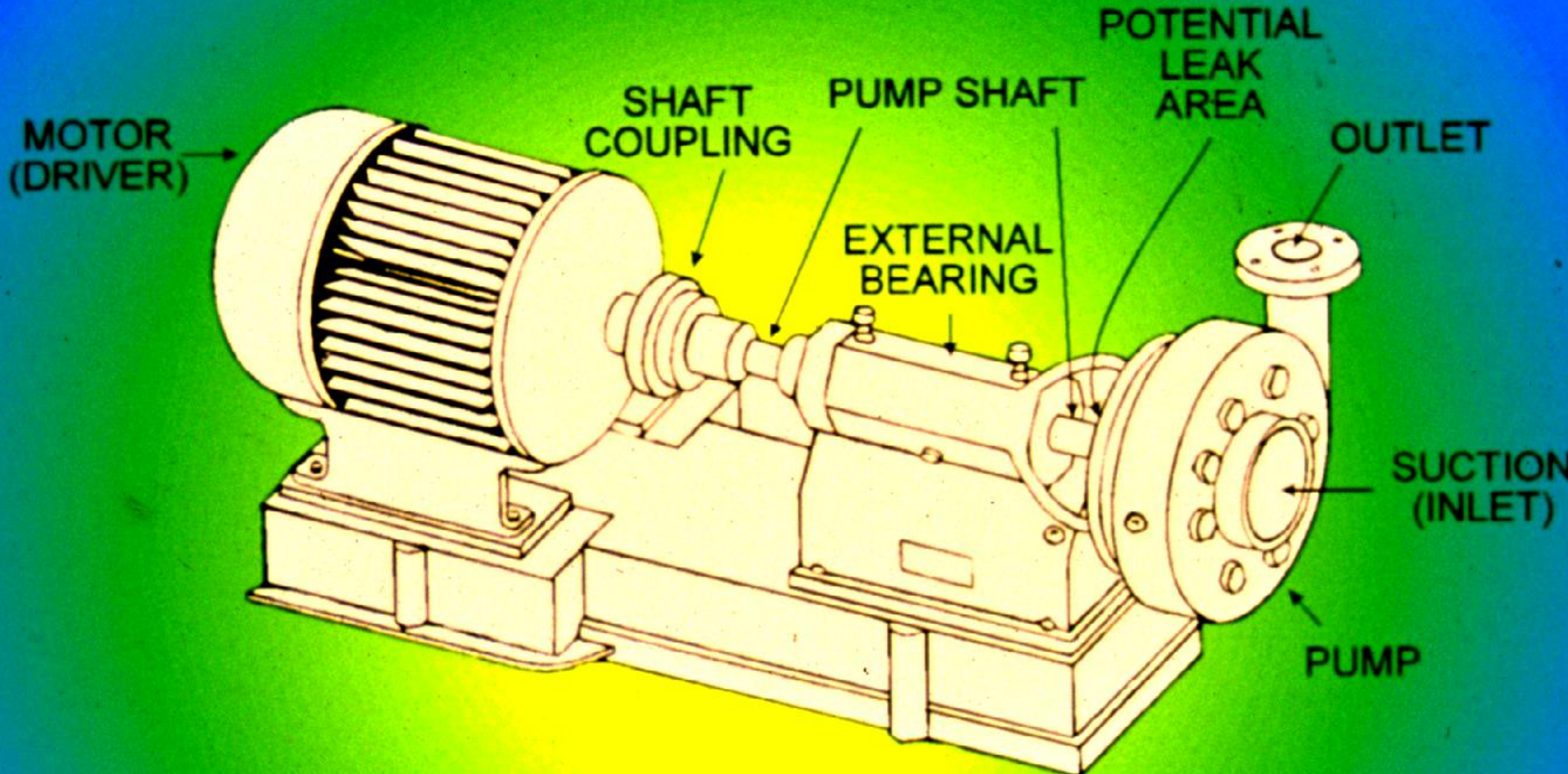
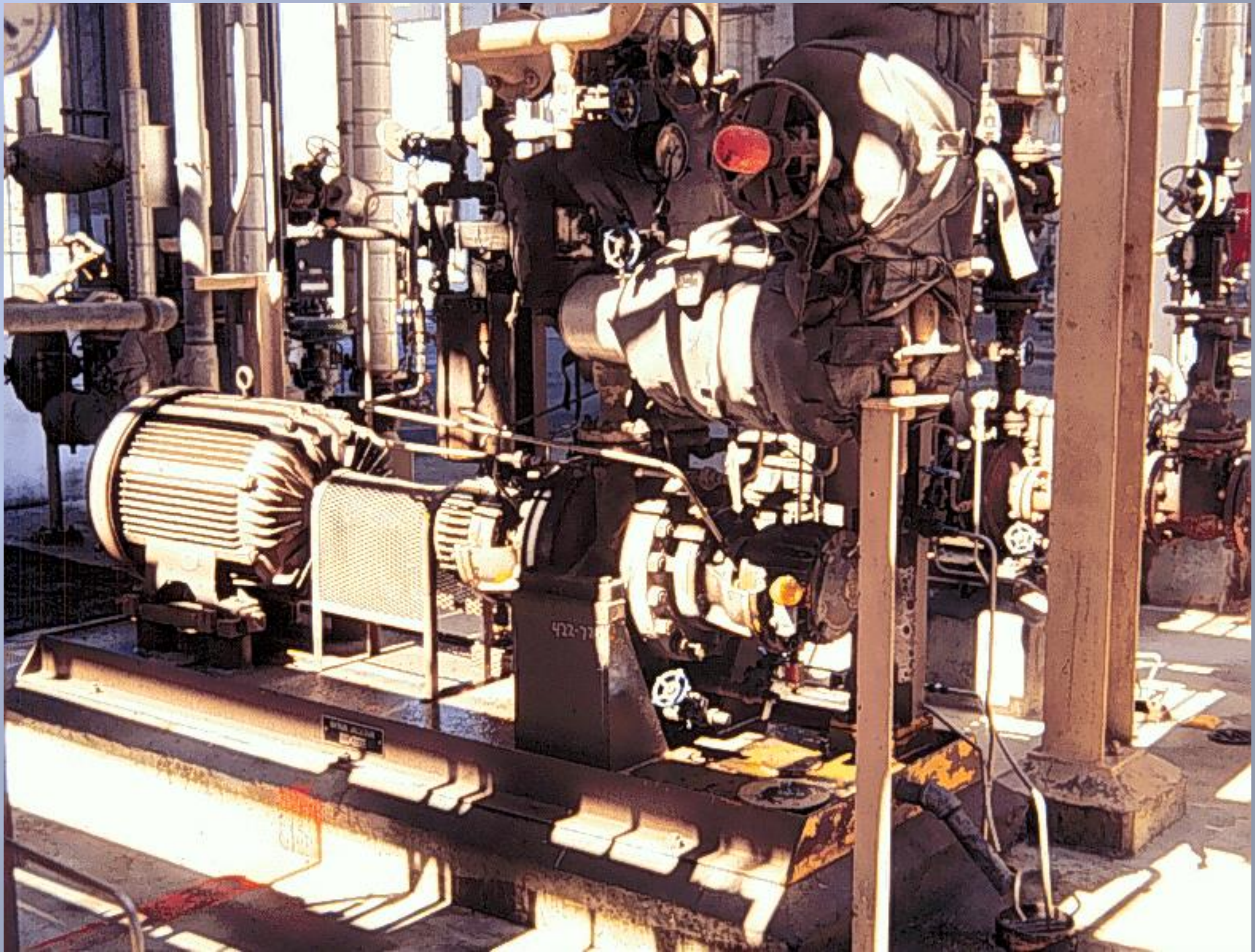



Figure 301.6
Centrifugal Pump

# Control Valve

# Gate Valve

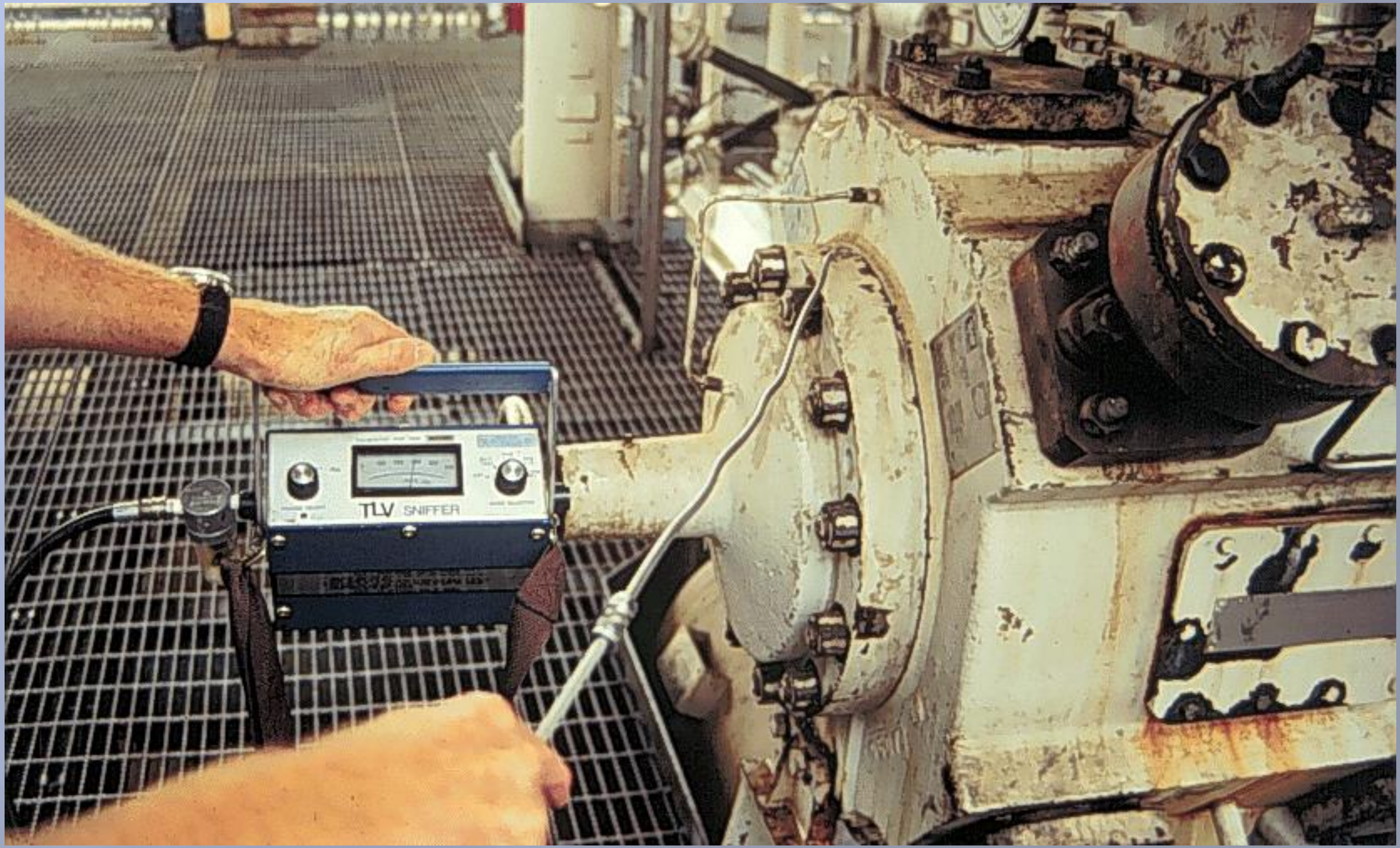
# Centrifugal Pump



# Reciprocating Compressor

# Fugitive VOC Testing with OVA

# Fugitive VOC Testing with TLV



# Fugitive VOC Testing - Leaky Valve

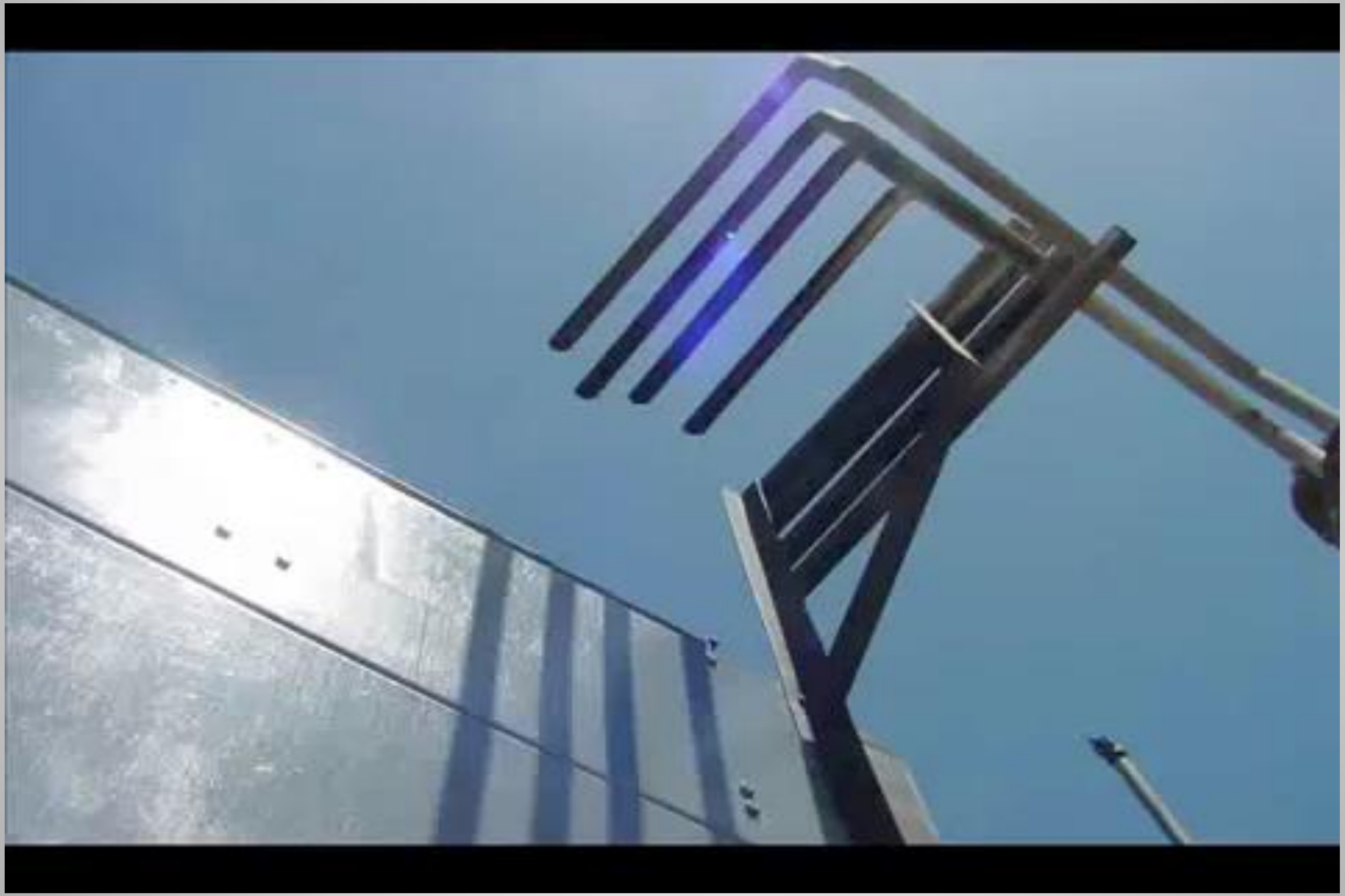
# Fugitive VOC Testing - Valve Tag

# Fugitive VOC Testing - Valve Tag

# Fugitive Leak Screening - FLIR

FLIR stands for forward looking infrared camera – it reads the thermal infrared signature of a plume. Although not a Method 21 device it can be used to screen for leaks quickly.

# FLIR Video of Vent from Centrifugal Pump



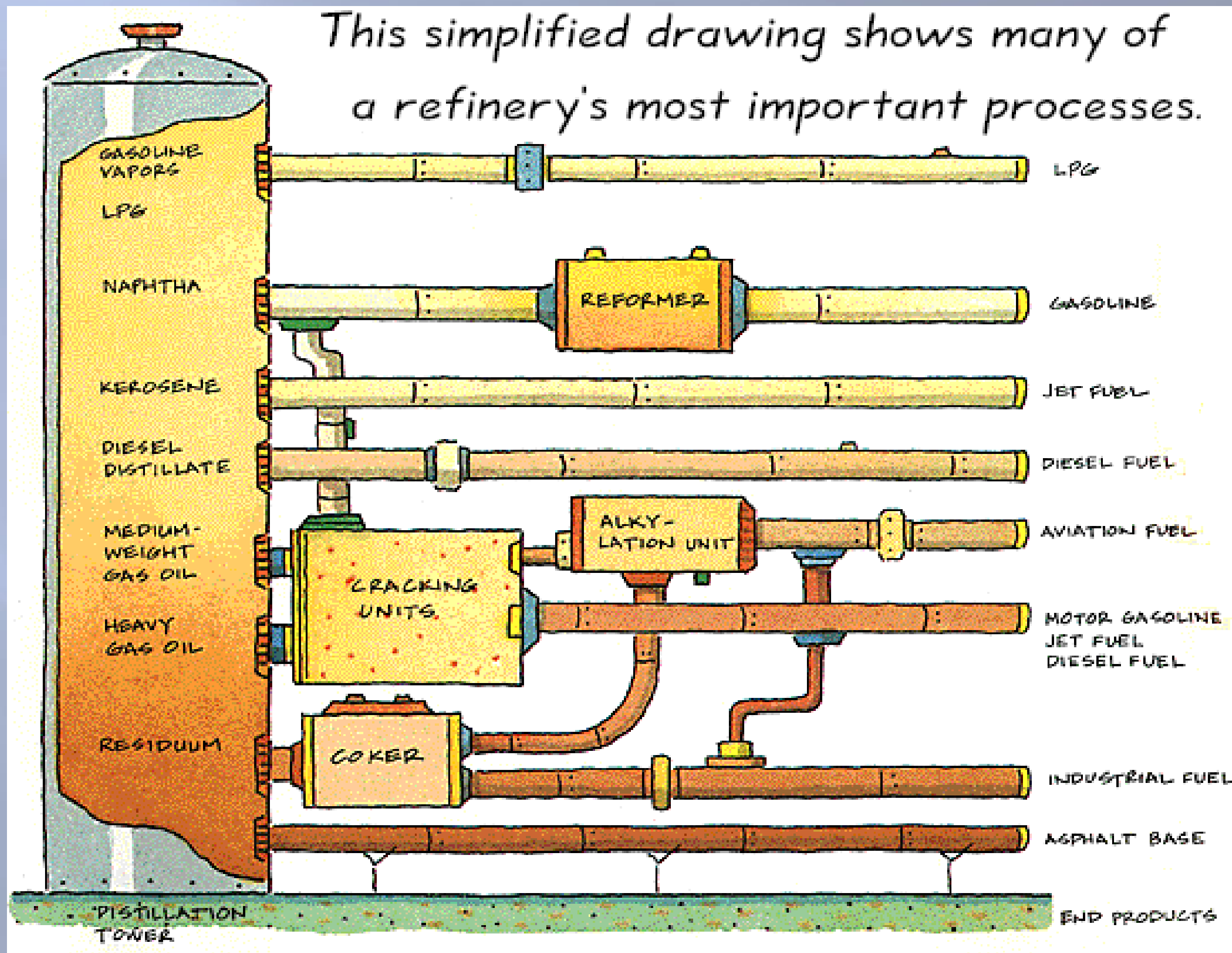
# INSPECTION SAFETY

# Refinery Hazards

- Hydrogen Sulfide ($H_2S$)
- Heat
- Hydrofluoric Acid
- Heights
- Asbestos
- Explosions
- Fires
- Noise
- Sulfur Dioxide


QUESTIONS?
COMMENTS?
CONCERNS?

# FIELD VISIT



This simplified drawing shows many of a refinery's most important processes.
GASOLINE VAPORS
LPG
NAPHTHA
KEROSENE
DIESEL DISTILLATE
MEDIUM-WEIGHT GAS OIL
HEAVY GAS OIL
RESIDUUM
DISTILLATION TOWER
REFORMER
ALKY-LATION UNIT
CRACKING UNITS
COKER
LPG
GASOLINE
JET FUEL
DIESEL FUEL
AVIATION FUEL
MOTOR GASOLINE
JET FUEL
DIESEL FUEL
INDUSTRIAL FUEL
ASPHALT BASE
END PRODUCTS