
US Drop Forge
Presents
Refinery Processing and
Material Basics

# Presentation Disclosure

US Drop Forge has developed this training aid to better serve our customers on understanding the basic refining process and what grades of materials are used. We do not recommend using this training aid as a basis for design due to the fact that API and ASME Codes govern what materials should be used for certain pressures, temperatures, and allowable stress factors. It should be stated here that each refinery is different. No two refineries in the world are the same, so what might be used on one unit may slightly be different on another unit for the same company. We hope your understanding will make one appreciate why USDF forgings are used in refineries worldwide.

## How much Crude Oil still needs to be processed ?

- The world has 1 Trillion barrels in reserves

- There is estimated 10 Trillion barrels with the plans for exploration in the next 25 years

- Crude Oil was the world's first Trillion Dollar Business

- The largest item in a country's balance of payments

- World's largest commercial shipping tonnage

## Some Common Refinery Daily Yields from Crude Oil :

- 70,000 barrels of Gasoline per day
- 30,000 barrels of Diesel Fuel
- 15,000 barrels of Jet Fuel
- 20,000 barrels of Waxes (Plastics)
- 10,000 barrels of Industrial Coke Fuel
- 2,500 barrels of Benzene
- Butane and Propane by thousands of cubic feet

**The above figures account for a typical United States Refinery. Some could be larger or smaller.**

## Refining all starts with a barrel of Crude Oil :

- One barrel of Crude Oil = 42 Gallons
- All Crude Oil is a mixture of hydrocarbons, water and salts
- Every barrel of Crude yields about 20 Gallons of Gasoline
- The remaining 22 Gallons become some of our every day products

**Some of our daily uses of the 22 Remaining Gallons in the Barrel as byproducts :**

| | | |
|---|---|---|
| mascara | heart valve | crayons |
| ammonia | antiseptics | sneakers |
| telephone | fertilizer | guitar strings |
| volleyballs | detergent | plastic containers |
| rug fibers | floor polish | insect repellent |
| ice chest | bubble gum | life preservers |

Every Barrel of Crude Oil goes through a refining process to break this natural resource down into various forms so it can be used for Gasoline and other important oil byproducts.

These byproducts become forms of Liquidfied Gas, Jet Fuel, Diesel Fuel, Aviation Fuel, Industrial Coke Fuel and Asphalt.

Crude Oil goes through a refining process via distillation towers. In any refinery process, there exists six methods of refining. Each method serves a specific purpose. Each will be discussed in its most basic form.

# Six Refining Methods :

Distillation

Cat Cracking

Hydrocracking

Coking

Alkylation

Reforming

# DISTILLATION

Distillation is a process which separates "heavy" on the "bottom" and "light" on the "top" with byproducts in the middle of the separation process. Crude Oil is cooked through piping in hot furnaces which lead into distillation towers. Inside each tower, separation begins with the top composed of vapors (liquefied gas and gasoline) ; the middle composed of medium weight liquids (kerosene and diesel oil) ; and finally the bottom of the barrel (tar, coke, and asphalt).

# CAT CRACKING

This method is properly called fluid catalytic cracking. The name is derived from using heat and pressure to crack heavy hydrocarbon molecules into lighter molecules. This process literally takes the hydrocarbons from the crude oil and cracks them with a powder catalyst to make very light substances like gasoline and diesel fuel.

# Hydrocracking

This method is the same as cat cracking, but uses a cheaper catalyst form plus "hydrogen gas". The real difference in hydro is that this method uses greater pressure, lower temperatures and induces hydrogen as the main ingredient to break the hydrocarbons into gasoline and jet fuel.

# Coking

This method uses heat and pressure to turn the bottom of the barrel byproducts into industrial fuel which is a hard powder material. This powder can be burned much like coal and is used in power plants as a main source for fueling the steam turbines to produce kilowatt energy which we buy as consumers.

# Alkylation

This method employs rearranging the hydrocarbon molecules from crude oil instead of cracking them. The Alkylation process is best known as "reverse cracking". It yields gasoline and some critical light byproducts which are used to make plastics and aviation fuels.

# Reforming

This is the process which makes the gasoline which we put in our cars and trucks. The reforming is when vapors from the crude oil are obtained before they reach the liquefied propane or butane stage, they are caught and processed with additives to fill our gas tanks.

High Temperature

DISTILLATION TOWER

Liquefied Gas

Gasoline

Jet Fuel

Diesel Fuel

Aviation Fuel

Low Temperature

Industrial Coke, Asphalt

The following Refinery Material uses are typical grades of application. Cautionary measures are restated now, because new materials emerge annually which replace currently used materials. Also, each refinery operates differently even if one company owns two plants and processes the exact product at these two plants, i.e. crude oil from South America might have a higher Hydrogen Sulfide level and crude oil from Middle Eastern Europe might be containing higher Cyanide and Silicon. Therefore, each refinery may operate the unit at different operating flows, temperatures and pressures, even though they make the same petrochemical product. Finally, API/ASTM/ ASME Codes dictate the materials to be used for a given process. So think of this as an orientation!

## Common Materials used throughout a Refinery :

Distillation Feed lines - Carbon Steel (A105,A106,WPB) up to operating temperatures of 1,000 Deg. F.

- Chrome Grades (F11/P11/F22/P22) from 850 to 1200 Deg. F.
- H-Grade Stainless (304H/321H) at over 1,000 Deg. F. with high operating pressures

Furnace Feed lines - Chrome Grades (F5/P5/WP5) above 600 Deg. F.

- Main lines into a coker unit mostly F9/P9/WP9 for stress corrosion cracking resistance at high temperatures and pressures

## More on Common Refinery Materials of Use :

Transportation Lines to Tank Farms or Liquefied Gas Tanks - All A105,A106, A53, WPB

Alkylation Plant Processing - Sulfuric Acid uses A20
- Hydrofluoric Acid uses A400

Coking & Cracking Processing - Mostly T316L Stainless, due to these processes having the presence of cyanide, hydrogen sulfide, and condensing water. The high Moly Stainlesses are used primarily for corrosion resistance purposes

## Hydrocracking Unit Materials in a Refinery :

| | |
|---|---|
| Reactor Forging | - Usually Grades T347 or T321 (Stabilized Stainless) to prevent against Stress Corrosion Cracking during Unit downtime |
| Main Reactor Forging | - H-Grade Stainless such as T304H for Creep Rupture Properties |
| Feed Line Forging | - Usually F22/P22/WP22 for high temp and corrosion purposes. Sometimes Duplex Stainless (2205) if material life is critical between shut down replacing |

Internal Cracking Lines - F5/P5/WP5 or T304 (if Hydrogen Sulfide is heavy in the crude oil)

Hydrogen Feed Lines - F11/P11/WP11 for corrosion resistance and stress/ rupture properties at high pressures/temperatures

Water Condensing Lines - Usually A800H or A825 for corrosion resistance and oxidation reduction from Ammonia, Hydrochloric Acid, and Hydrogen Sulfide mixing with the water during processing

## Typical Examples of Refinery Metals for PVF Products :

Flare Burn Out lines - Grade T310 for resistance to fatigue cracking from flames

Scrubber Lines - Grades A600 and A625 for the corrosion resistance to acid and chloride condensation

Flue Gas Scrubber Lines - Grade 904L for high Chloride attack and increased corrosion

Discharge Lines - Grade A20 for prevention on Stress Corrosion Cracking from Sulfur Dioxide

**US Drop Forge offers all grades of material which are used in a refinery :**

- NACE Materials for Hydrogen Sulfide Services

- Low-Temperature Alloys for cold transmission

- Chrome-Moly for steam and temperature services

- Stainless H-Grades for Creep Rupture Services

- Stainless Grades for Corrosion Services

- Nickel Alloys for Acidic or Extreme Corrosion Services

- Carbon Steels for general services

# US Drop Forge offers other Training :

- Dangers of Material Grade Mixes
- Uses of Chrome-Moly Materials
- Electropolishing Benefits of Stainless Steel

# Refinery Presentation References


- ASME B31.3 Process Piping Code (1996 Addenda) [ASME, New York - 1997]

- Materials Selection for Petroleum Refineries and Gathering Facilities [NACE, Houston - 1998]

- What Went Wrong ? Case Histories of Process Plant Disatsers by Trvor Kletz [Gulf Publishing Company, Houston - 1998]

*If you have any questions or would like us to come out and conduct a more detailed program you can reach us online at http://www.usdropforge.com*

*or*

*call 856-467-0500*

End Presentation