

# **Petroleum Products:**

## **Refining and Distillation**

**(Lubricants, Waxes and Petrochemicals)**

**Manufacture of Crude Oil, Gasoline,  
Kerosene, Absorbent, Oils, and Fuels  
Oils, Petroleum Asphalts**

# Introduction

The most dynamic industry of the century is the petroleum and petrochemicals industry. It has taken the fundamental knowledge of chemistry and chemical engineering and transformed itself from a simple processing industry for fuel and lubricants to an extremely complex chemical process industry which has branched out into synthetic rubber, plastics, fertilizers and many other fields. Petroleum (crude oil) is a mixture of different hydrocarbons. Many useful products can be made from these hydrocarbons. The fractions are separated from one another using a process called fractional distillation.

**This process is based on the principle that different substances boil at different temperatures. The applications of distillation in petroleum industry are quite varied. The assaying of crude oils and the evaluation many petroleum products depend on distillation. Petroleum products obtained from processes such as distillation often need supplementary purification. Refining is a process of purification of products by means of chemical process. Chemical engineering and petroleum processing have in a very real sense grown up together.**

Studies on fluid flow, heat transfer, distillation, absorption, and the like were undertaken and applied to wide variety of materials because of need in the petroleum processing field. The largest share of oil products is used as energy carriers: various grades of fuel oil and gasoline. Heavier (less volatile) fractions can also be used to produce asphalt, tar, paraffin wax, lubricating and other heavy oils. Refineries also produce other chemicals, some of which are used in chemical processes to produce plastics and other useful materials.

Hydrogen and carbon in the form of petroleum coke may also be produced as petroleum products. Petrochemicals have a vast variety of uses. The use of petroleum hydrocarbons to make synthesis gas has made petroleum and natural gas the world main source of ammonia, the source of almost all nitrogen fertilizers. While petroleum product demand in the western world is relatively stagnant, for developing countries, particularly those in Asia, demand is booming. It is all about growing populations and their escalating need for energy.

The marketing of some products had been privatised, partly or wholly, such as LPG, lubricants, kerosene and bitumen. Products used mainly by the automobile industry (diesel and petrol) are marketed through the four public sector companies: Indian Oil (IOC), Hindustan Petroleum Corporation (HPC), Bharat Petroleum (BPC) and IBP (now acquired by IOC under the disinvestment programme of the government with their countrywide network). Expansion notwithstanding, the demand for petroproducts is expected to grow at around 4.5% annually in the coming years. Under the new policy with administered price mechanism abrogated, the oil majors like Shell, Exxon or British Petroleum-Ameco were allowed to sell petrol or diesel to Indian consumers provided they agreed to invest at least Rs. 20 bn over a specified period.

Of the refinery products, the middle distillates used to be in short supply, but are now in surplus. Of the total 55% of middle distillates, a share of 39% is high speed diesel oil (HSDO) and 10% is superior kerosene oil (SKO). Light distillates, which constitute more than 27% of the petroleum products, cover LPG (5%), motor spirit (10%) and naphtha (9%). Heavy distillates consist mainly of furnace oil (7.5%) and LSHS/HHS (4.5%).

Petroleum is a complex mixture of organic liquids called crude oil and natural gas, which occurs naturally in the ground and was formed millions of years ago. The refining process begins with crude oil. Crude oil is unrefined liquid petroleum, which ranges in color from yellow to black, and may have a paraffin, asphalt or mixed base. Crude oil is composed of thousands of different chemical compounds called hydrocarbons, all with different boiling points.



The first processing unit in the refinery is desalination. Crude oil contains various salts and impurities that can be harmful for the other processing units. All the impurities are not removed from the crude oil in desalination unit. Crude oil is processed into a distillation column and separated into different components on the basis of boiling point. The component with low boiling points goes to the top of the tower and the one with the highest boiling point remains at the bottom of the distillation tower. The products from a crude distillation unit from top to bottom are liquefied petroleum gas (LPG), naphtha, gasoline, kerosene, diesel oils, fuel oil and residue. These products are further processed in various units to remove impurities such as sulfur and nitrogen.



Petroleum refineries are large, capital-intensive manufacturing facilities with extremely complex processing schemes. More than 660 refineries, in 116 countries, are currently in operation, producing more than 85 million barrels of refined products per day. Each refinery has a unique physical configuration, as well as unique operating characteristics and economics.

Rising crude oil prices powered revenue growth as refiners have passed costs down the distribution line. Since 2011, profit has steadily recovered in line with improving demand, while low domestic oil prices further bolstered margins. In 2016, profit is anticipated to rise slightly, though it remains below historic levels. This industry is anticipated to recover over the next five years as fuel prices rise and consumption increases.

India remains one of the least-explored countries in the world, with a well density among the lowest in the world. With the annual demand crossing above 100 million tonne, India is the fourth largest oil consumption zone in Asia, even though on a per capita basis the consumption around 0.1 tonne, the lowest in the region- This makes the prospects of the Indian Oil industry even more exciting.

Some of the fundamental of the book are the nature of petroleum, crude oil processing, distillation in the petroleum industry, refining of lubricating oils, petrolatum, and waxes, residue fluidized catalytic cracking, chemical thermodynamics of petroleum , benefits of biodiesel produced from vegetable oil, petroleum products used as fuel oils, manufacture of asphalt from petroleum, petroleum waxes, chlorinated waxes, synthesis gas etc.

**The book presents information and data which will help oil companies, large scale users of commercial petroleum products in efficient storage, handling and utilization of these products. Different formulae, processes for the production of petroleum products are given in this book. This will be very useful book for new entrepreneurs, existing units, technocrats, researchers, institutional libraries etc.**

# Table of Contents

## 1. Introduction

Historical

The Nature of Petroleum

Largest Energy Supplier

Origin

Constituents of Petroleum

Aliphatics, or open chain Hydrocarbons

Ring Compounds

Lesser Components

## 2 Crude Oil Processing

Fundamentals

Ideal Solutions

Real Solutions

Critical Phenomena

Chemical Dissimilarity

Azeotropism

**Immiscibility**  
**Ordinary Distillation**  
**Steam Distillation**  
**Extractive Distillation**  
**Absorption**  
**Process Equipment**  
**Single Stage**  
**Plate Columns**  
**Differential Columns**  
**Wetted Wall**  
**Rotary**  
**Packed**  
**Distillation in the Petroleum Industry**  
**Analytical Applications**  
**Single stage Processes**  
**Multistage Processes**  
**Manufacturing Applications**  
**Primary Distillation**  
**Process feed Preparation**  
**Product Fractionation**  
**Combination Processing.**





### **3. Refining**

**Refining by Chemical Methods**

**Sulfuric Acid Treating**

**Reactions with Hydrocarbons**

**Paraffinic and Naphthenic Hydrocarbons**

**Aromatics**

**Olefins**

**Manner and Effects of Treating**

**Refining by Physical Methods**

**Bauxite.**

**Fullers Earth (Attapulgit, Floridin, Florida Earth)**

**Acid activated Bentonite**

**Magnesol**

**Florisil**

**Silica Gel**

**Carbon**

**Alumina**

**Commercial Applications**

**Separation of Classes of Hydrocarbons**

**Refining of Lubricating Oils, Petrolatums, and Waxes**



Stabilizing Gasolines  
Regeneration of Adsorbents  
Solvent Refining Processes  
Aromatics Recovery  
Refining Lubricating Oil Stocks.  
Separation of Wax  
Propane Deasphalting

## 4. Cracking

Introduction  
Catalytic Cracking  
Residue Fluidized Catalytic Cracking (RFCC or RCC)  
Hydrocracking  
FCC versus HCU  
Reforming  
Thermal Reforming  
Catalytic Reforming  
Isomerization  
Hydrocracking  
Operating Variables

## 5. Chemical Thermodynamics of Petroleum Hydrocarbons

Introduction

Fundamental Relationships

The Standard Free Energy and Equilibrium

Status of Thermodynamic Data

Applications to Petroleum Processing

General Considerations

Aromatization of Paraffins and Naphthenes

Isomerization of n Butane

## 6. Gasoline

Introduction

Composition, Manufacture, and use of Gasoline

Volatility of Gasoline

Air Fuel Mixtures and Combustion

Phenomena of Knocking

Ethyl Alcohol as an IC Engine Fuel

Alcohols as auto fuels

Issues not in favour of Alcohol

Blending Alcohol and Gasoline

## **7. Diesel Fuels**

Diesel Combustion

Ignition Quality

## **8. Bio Diesel**

Introduction

Disadvantages of Vegetable Oil as Diesel Fuel

Benefits of Biodiesel Produced from Vegetable Oil

Disadvantages of Biodiesel produced from Vegetable Oil

Biodiesel Production from various vegetable oils on

Different Countries

Country Source of biodiesel

Economics of Biodiesel Project

Tax Incentives in Developed Countries

World Production Level of Biodiesel

Price in USA

Projected Indian Demand Scenario For Biodiesel

Average annual CAGR for High Speed Diesel



Demand for Biodiesel  
Potential Indian Demand for Biodiesel  
Choice of Jatropha  
Cultivation Practices of Jatropha Plant  
Soil Condition:  
Conditions for growth:  
Cultivation practices and yield  
Jatropha Oil Content  
Eco Friendly Biodiesel  
Rich Resources  
Vigorous Pursuit  
Fulfilling basic criteria  
Advantages  
Feed stock

## **9. Kerosene, Absorbent, Oils, and Fuels Oils**

Kerosene  
Chemical Properties  
Physical Properties  
Manufacture

Testing Methods  
Miscellaneous Uses  
Absorbent Oils  
Fuel Oils  
Combustion of Fuel Oils  
Petroleum Products Used as Fuel Oils  
Certain Unusual Crude Oils  
Crude Oil Residua  
Gas Oils, Distillate Fuel Oils.

## **10. Lubrication and Lubricants**

Friction and Lubrication

## **11. Waxes**

Beeswax  
Carnauba Wax  
Spermaceti  
Ozocerite  
Paraffin Wax



Montan Wax  
Candelilla Wax  
Synthetic Waxes  
Petroleum Waxes  
Chemical Properties and Composition  
Crystallization of Wax  
Dewaxing of Heavy Oils

## **12. Petroleum Asphalts**

Chemical and Physical Composition  
Chemical composition  
Mineral Oil  
Resins  
Asphaltenes  
Carbenes and Carboids  
Possible Structures of the Nuclei in Resins, and Asphaltenes  
Physical Constitution  
Physical Properties and Tests  
Manufacture of Asphalt from Petroleum

Residual or Straight run Asphalts

Air blown Asphalts

Uses of Asphalts

Road Oils

Asphalt Emulsions

Solid Asphalts.

### **13. Miscellaneous Petroleum Products and Derived Products**

Miscellaneous Petroleum Products

White Oils

Industrial Naphtha Solvents

Paints, Varnishes and Lacquers

Dry Cleaning

Cutback Asphalt

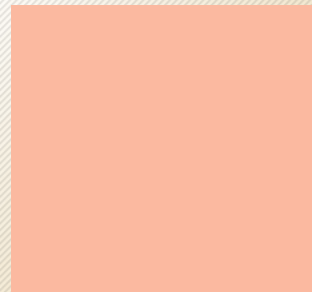
Rubber

Miscellaneous

Petroleum Insecticides

By Products

**Petroleum Coke**  
**Sulfuric Acid Sludge**  
**Petroleum Sulfonic Acids**  
**Chemicals Derived from Petroleum**  
**Acetylene**  
**Chemicals Derived from Olefinic Hydrocarbons.**  
**Alcohols**  
**Ethyl Alcohol**  
**Isopropyl Alcohol**  
**Secondary Butyl Alcohol**  
**Tertiary Alcohols**  
**Higher Alcohols**  
**Glycols And Glycerol**  
**Addition of Halogenes**  
**Polymers**  
**Oxidation Products**  
**Miscellaneous Products**  
**Chemicals Derived from Paraffinic Hydrocarbons**  
**Chlorination Products**



Nitration Products  
Oxidation Products.  
Chemicals Derived from Aromatic Hydro carbons  
Hydrogen  
Carbon Blacks  
Fischer Tropsch Process and Products

## 14. Propylene

Introduction  
Polypropylene  
Propylene Trimer and Tetramer  
Acrylonitrile  
Acrylic Fibers  
Acrylamide  
Other Acrylonitrile Derivatives  
Acetonitrile  
Allyl Chloride  
Epichlorohydrin  
Epoxy Resins  
Other Epichlorohydrin Derivatives

Allyl Alcohol Derivatives  
Diallyl Amine  
1,2 Dibromo 3 Chloropropane  
Dichloropropanes, Dichloropropenes  
Acrolein  
Methionine  
1,2,6 Hexane Triol  
Glutaraldehyde  
Propylene Oxide  
Propylene Glycol  
Polyethers  
Dipropylene Glycol  
Higher Propylene Glycols  
Isopropanolamines  
Propylene Carbonate  
1,3 Propylene Diamine  
Polypropylene Oxide Elastomers  
Isopropanol  
Acetone





Diacetone Alcohol (DAA)  
Methyl Isobutyl Ketone (MIBK)  
Hexylene Glycol  
Methyl Isobutyl Carbinol (MIBC)  
Isopropylamines  
Isoprene

## 15. Synthesis Gas

Introduction

Mettiane reforming

Naphtha reforming

Fuel oil partial oxidation

Reformer off gas purification by low temperature fractionation

Topsfe SEA autothermal process using naphtha

Ammonia

Nitrogen Fertilizers

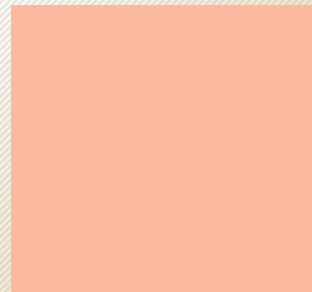
Mixed Fertilizers

Urea

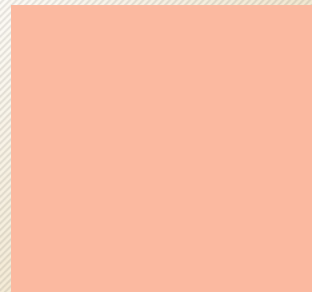
Urea formaldehyde resins



**Sulfamic acid**  
**Melamine**  
**Nitric Acid**  
**Ammonium nitrate**  
**Potassium nitrate**  
**Nitroparaffins**  
**Ammonium Phosphates**  
**Ammonium Sulfate**  
**Ammonium Chloride**  
**Hydrazine**  
**Carbon Dioxide**  
**Methanol**  
**Formaldehyde**  
**Hexamethylene tetramine**  
**Pentaerythritol**  
**Polyacetals**  
**Glycolic acid**  
**Textile finishes**  
**Methylamines**  
**Monomethylamine**



Dimethylamine  
Trimethylamine  
Methyl Chloride  
Silicones  
Methyl cellulose  
Arsenicals  
Tetramethyl lead  
Dimethylsulfate  
Methyl Glucoside  
Methyl Bromide  
OXO Chemicals  
n Butyraldehyde  
Ethyl 1, 3 hexanediol  
Trimethylolpropane  
Butyric acid  
Butyraldehyde  
Isobutanol  
Isobutyric acid  
Neopentyl glycol  
Pantothenic acid



Octanols  
Octoic acid  
Propionic acid  
n Propanol  
Heavy Oxo Chemicals  
PHOSGENE  
Diisocyanates  
Polycarbonates  
Chlorinated Isocyanurics  
Substituted Urea, Carbamate and Thiocarbamate Pesticides  
Other Phosgene Derivatives  
FORMIC ACID  
Oxalic Acid  
NEO ACIDS  
PURE HYDROGEN  
Hydrogenated Fats and Oils  
Tetrahydrofuran  
Sorbitol

Hydrogen Peroxide  
Organic Peroxides  
Other hydrogen peroxide derivatives  
Furfuryl Alcohol  
Fatty Alcohols  
Fatty Nitriles and Amines

## **16. Other Petrochemicals**

Petroleum Waxes  
Chlorinated Waxes  
n Paraffins  
Detergent Raw Materials  
Carbon Black  
Cresols  
Synthetic p Cresol  
Synthetic o Cresol  
Tricresyl Phosphate  
Cyclopentadiene  
Petroleum Resins

Naphthenic Acids  
Hydrogen Sulfide  
Sulfur  
Phosphorus Pentasulfide  
Mercaptans  
Thioglycolic Acid  
Thiourea  
Dimethyl Sulfoxide



**Niir Project Consultancy Services (NPCS)**  
**can provide Process Technology Book on**  
**Distillation and Refining of Petroleum Products**  
**(Lubricants, Waxes and Petrochemicals)**

**See more**

**<http://goo.gl/hFbfk3>**

**<http://goo.gl/kdbj7r>**

**<http://goo.gl/N4POyi>**



*Visit us at*

[www.entrepreneurindia.co](http://www.entrepreneurindia.co)

***Take a look at  
NIIR PROJECT CONSULTANCY SERVICES  
on #Streetview***

**<https://goo.gl/VstWkd>**

# *Locate us on Google Maps*

**<https://goo.gl/maps/BKkUtq9gevT2>**

# Contact us

**Niir Project Consultancy Services**

**106-E, Kamla Nagar, New Delhi-110007, India.**

**Email: [npcs.ei@gmail.com](mailto:npcs.ei@gmail.com) , [info@entrepreneurindia.co](mailto:info@entrepreneurindia.co)**

**Tel: +91-11-23843955, 23845654, 23845886**

**Mobile: +91-9811043595**

**Fax: +91-11-23841561**

**Website :**

**[www.niir.org](http://www.niir.org)**

**[www.entrepreneurindia.co](http://www.entrepreneurindia.co)**

**Take a look at NIIR PROJECT CONSULTANCY SERVICES on #StreetView**

**<https://goo.gl/VstWkd>**



# ***Niir PROJECT CONSULTANCY SERVICES***

**An ISO 9001:2008 Company**

# Who are we?

- *One of the leading reliable names in industrial world for providing the most comprehensive technical consulting services*
- *We adopt a systematic approach to provide the strong fundamental support needed for the effective delivery of services to our Clients' in India & abroad*



# What do we offer?

- *Project Identification*
- *Detailed Project Reports/Pre-feasibility Reports*
- *Business Plan*
- *Industry Trends*
- *Market Research Reports*
- *Technology Books and Directory*
- *Databases on CD-ROM*
- *Laboratory Testing Services*
- *Turnkey Project Consultancy/Solutions*
- *Entrepreneur India (An Industrial Monthly Journal)*

# How are we different ?

- *We have two decades long experience in project consultancy and market research field*
- *We empower our customers with the prerequisite know-how to take sound business decisions*
- *We help catalyze business growth by providing distinctive and profound market analysis*
- *We serve a wide array of customers , from individual entrepreneurs to Corporations and Foreign Investors*
- *We use authentic & reliable sources to ensure business precision*



# Our Approach

**Requirement collection**



**Thorough analysis of the project**



**Economic feasibility study of the Project**



**Market potential survey/research**



**Report Compilation**

# Who do we serve?

- *Public-sector Companies*
- *Corporates*
- *Government Undertakings*
- *Individual Entrepreneurs*
- *NRI's*
- *Foreign Investors*
- *Non-profit Organizations, NBFC's*
- *Educational Institutions*
- *Embassies & Consulates*
- *Consultancies*
- *Industry / trade associations*



# Sectors We Cover

- *Ayurvedic And Herbal Medicines, Herbal Cosmetics*
- *Alcoholic And Non Alcoholic Beverages, Drinks*
- *Adhesives, Industrial Adhesive, Sealants, Glues, Gum & Resin*
- *Activated Carbon & Activated Charcoal*
- *Aluminium And Aluminium Extrusion Profiles & Sections,*
- *Bio-fertilizers And Biotechnology*
- *Breakfast Snacks And Cereal Food*
- *Bicycle Tyres & Tubes, Bicycle Parts, Bicycle Assembling*



- *Bamboo And Cane Based Projects*
- *Building Materials And Construction Projects*
- *Biodegradable & Bioplastic Based Projects*
- *Chemicals (Organic And Inorganic)*
- *Confectionery, Bakery/Baking And Other Food*
- *Cereal Processing*
- *Coconut And Coconut Based Products*
- *Cold Storage For Fruits & Vegetables*
- *Coal & Coal Byproduct*

- *Copper & Copper Based Projects*
- *Dairy/Milk Processing*
- *Disinfectants, Pesticides, Insecticides, Mosquito Repellents,*
- *Electrical, Electronic And Computer based Projects*
- *Essential Oils, Oils & Fats And Allied*
- *Engineering Goods*
- *Fibre Glass & Float Glass*
- *Fast Moving Consumer Goods*
- *Food, Bakery, Agro Processing*

- *Fruits & Vegetables Processing*
- *Ferro Alloys Based Projects*
- *Fertilizers & Biofertilizers*
- *Ginger & Ginger Based Projects*
- *Herbs And Medicinal Cultivation And Jatropha (Biofuel)*
- *Hotel & Hospitality Projects*
- *Hospital Based Projects*
- *Herbal Based Projects*
- *Inks, Stationery And Export Industries*

- *Infrastructure Projects*
- *Jute & Jute Based Products*
- *Leather And Leather Based Projects*
- *Leisure & Entertainment Based Projects*
- *Livestock Farming Of Birds & Animals*
- *Minerals And Minerals*
- *Maize Processing(Wet Milling) & Maize Based Projects*
- *Medical Plastics, Disposables Plastic Syringe, Blood Bags*
- *Organic Farming, Neem Products Etc.*

# Sectors We Cover *Cont...*

- *Paints, Pigments, Varnish & Lacquer*
- *Paper And Paper Board, Paper Recycling Projects*
- *Printing Inks*
- *Packaging Based Projects*
- *Perfumes, Cosmetics And Flavours*
- *Power Generation Based Projects & Renewable Energy Based Projects*
- *Pharmaceuticals And Drugs*
- *Plantations, Farming And Cultivations*
- *Plastic Film, Plastic Waste And Plastic Compounds*
- *Plastic, PVC, PET, HDPE, LDPE Etc.*



## Sectors We Cover *Cont...*

- *Potato And Potato Based Projects*
- *Printing And Packaging*
- *Real Estate, Leisure And Hospitality*
- *Rubber And Rubber Products*
- *Soaps And Detergents*
- *Stationary Products*
- *Spices And Snacks Food*
- *Steel & Steel Products*
- *Textile Auxiliary And Chemicals*



# Sectors We Cover *Cont...*

- *Township & Residential Complex*
- *Textiles And Readymade Garments*
- *Waste Management & Recycling*
- *Wood & Wood Products*
- *Water Industry(Packaged Drinking Water & Mineral Water)*
- *Wire & Cable*



# Contact us

**Niir Project Consultancy Services**

**106-E, Kamla Nagar, New Delhi-110007, India.**

**Email: [npcs.ei@gmail.com](mailto:npcs.ei@gmail.com) , [info@entrepreneurindia.co](mailto:info@entrepreneurindia.co)**

**Tel: +91-11-23843955, 23845654, 23845886**

**Mobile: +91-9811043595**

**Fax: +91-11-23841561**

**Website :**

**[www.niir.org](http://www.niir.org)**

**[www.entrepreneurindia.co](http://www.entrepreneurindia.co)**

**Take a look at NIIR PROJECT CONSULTANCY SERVICES on #StreetView**

**<https://goo.gl/VstWkd>**

# Follow Us



➤ <https://www.linkedin.com/company/niir-project-consultancy-services>



➤ <https://www.facebook.com/NIIR.ORG>



➤ <https://www.youtube.com/user/NIIRproject>



➤ <https://plus.google.com/+EntrepreneurIndiaNewDelhi>



➤ [https://twitter.com/npcs\\_in](https://twitter.com/npcs_in)



➤ <https://www.pinterest.com/npcsindia/>



# THANK YOU!!!

For more information,  
visit us at:

[www.entrepreneurindia.co](http://www.entrepreneurindia.co)