OIL

1 **Oil** HAS BEEN FORMING FOR MILLIONS OF YEARS FROM THE REMAINS OF PLANTS AND ANIMALS THAT DIED AND SETTLED TO THE BOTTOM OF ANCIENT SEAS. AS THE EARTHS CRUST CHANGED, MOUNTAINS FORMED AND THE ORGANIC MATERIAL WAS COVERED BY LAYERS OF SEDIMENT.

OVER THE EONS OF TIME, THE WEIGHT FROM THE LAYERS CAUSED HEAT AND PRESSURE THAT HELPED CHANGE THE ORGANIC MATERIAL INTO OIL

2 **WHEN** THE LAYERS OF THE EARTH'S CRUST MOVED, DIFFERENT TYPES OF STRUCTURES WERE FORMED THAT COULD TRAP OIL. THESE "TRAPS" CAN BE LAYERS THAT ARE ARCHED OR BROKEN ... ON LAND OR BENEATH THE SEA. THE OIL IS SOMETIMES HELD IN PLACE BY "CAP ROCK" WHICH IS SO HARD OR DENSE THAT OIL CANT MOVE THROUGH IT.

Oil Field

3 **THE** SEARCH FOR OIL BEGINS BY LOOKING FOR ROCK TYPES AND STRUCTURES WHERE OIL MAY BE FOUND. MANY TYPES OF SCIENTIFIC INSTRUMENTS ARE USED AND SAMPLES OF THE ROCK ARE OBTAINED BY DRILLING DEEP INTO ROCK LAYERS. WHEN THE PROSPECTS OF OIL ARE GOOD, A DRILLING RIG IS ERECTED AND THE SEARCH BEGINS. IF OIL IS FOUND IT MAY RISE TO THE SURFACE BECAUSE OF PRESSURE OR IT MAY NEED TO BE PUMPED OUT. THIS "CRUDE OIL" IS MOVED BY PIPELINE, TANK TRUCK, RAILROAD, BARGE OR SHIP TO REFINERIES WHERE IT IS PROCESSED INTO MANY USEFUL PRODUCTS.

4 **FROM** THE REFINERIES, MOST OIL PRODUCTS GO TO STORAGE TERMINALS OR BULK PLANTS. BULK OIL PLANTS SELL TO CUSTOMERS WHO USE OIL PRODUCTS THEMSELVES OR TO RETAILERS WHO SELL THE PRODUCTS AT SERVICE STATIONS AND HEATING FUEL DEALERS.

5 **OIL** IS A MAJOR SOURCE OF ENERGY IN THE U.S.A. OUR TRANSPORTATION SYSTEM DEPENDS ON IT AND WE USE PRODUCTS FROM IT SUCH AS PLASTICS AND CLOTHING EVERYDAY. IT WILL BE ONE OF OUR MOST IMPORTANT SOURCES OF ENERGY FOR YEARS TO COME!

Oil Refinery

GAS STATION

GAS

XYZ OIL CO

PLASTICS CO.

ABC

STORAGE

STORAGE TERMINAL

OIL

USA - OIL

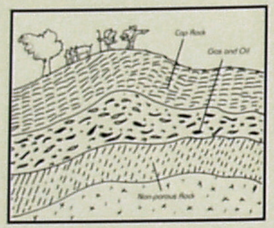
MAP

Getting to Know Oil

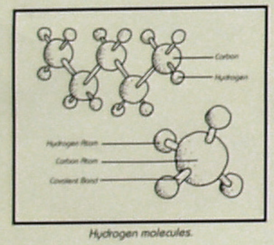
What is Oil?

Oil is naturally occurring and is often referred to as petroleum. Crude oil, or "crude," is unrefined oil or petroleum.

Oil is a mixture of hydrogen and carbon compounds referred to as hydrocarbons. Thousands of different hydrocarbons make up crude oil. The simplest or basic hydrocarbon unit (molecule) is methane or natural gas (CH_4). Hydrocarbons occur as liquids, gases or as solids like gilsonite. The longer hydrocarbon chains are more likely to be liquids.



A typical trap formation.



Hydrogen molecules.

It is thought that petroleum originates from tiny marine plants and animals that inhabited the earth in prehistoric times. Through time, the tiny marine plants and animals were buried by ocean sand and silt, known today as marine sediments. Over time, the pressure and heat transformed the biotic material into petroleum.

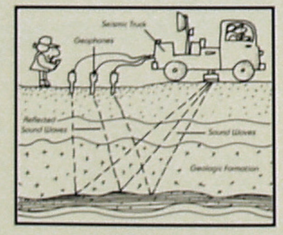
As the biotic material changed from a solid to a gas or a liquid, it began to migrate, being propelled by water or capillary action through the porous marine sediments. In some instances, the petroleum migrated to the earth's surface. Petroleum migrates upwards until it is trapped by a non-porous rock structure called a cap. This specific geologic formation is referred to as a "trap." It is these subterranean traps that are sought by the oil industry. Petroleum then is associated with porous sedimentary rock layers and fossilized marine life.

How Is Oil Located?

One of the most accurate exploration methods is seismic technology. In seismic technology, sound waves, created by explosives detonated either on the earth's surface or underground, are sent into the earth and are reflected back by the rock layers. The reflected sound waves are recorded by seismographs. Seismographs are similar to instruments used to measure earthquakes. The reflected sound waves are received by geophones, which transmit the sound waves to a seismograph located in a truck. The particular rate at which the sound waves are reflected back create a picture of the underground geology and possible location of oil traps.

When Did the Oil Industry Start?

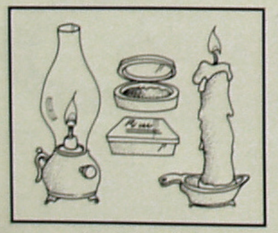
In August of 1859, at Titusville, Pennsylvania, Edwin Drake drilled the first oil well. Prior to Drake's drilling success, oil seeping from the ground had been used for making candles, direct burning for the generation of light, and in medicines. However, by the mid 1850s, the supply of oil seeping from the ground was insufficient to meet demands, and the first "energy crisis" was born. The "energy crisis" stimulated Drake's adventuresome effort, organized by the Pennsylvania Rock Oil Company. The discovery of petroleum at 69-1/2 feet below the surface of the earth at Oil Creek, was significant in that it demonstrated the practicality of drilling for petroleum.



Seismic technology.

Even after the seismic picture is assimilated and analyzed by geophysicists, there is no guarantee of discovering oil. At best, the seismic picture can provide only a guess as to what lies beneath us.

Occasionally, oil companies drill for oil in areas where oil or natural gas has not been discovered. Wells drilled in this fashion are known as "wildcat" wells.



Uses of oil in the 1800's.

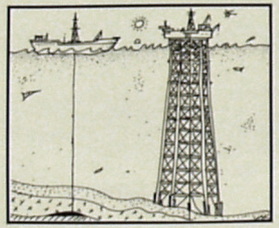
What Processes Are Involved In Oil Drilling?

Before exploration can begin, energy companies need to obtain permits and drilling rights from landowners. Leases might be purchased, or a development agreement reached, with the landowner often receiving royalties if oil is discovered.

Before drilling equipment can be brought on site, preparatory work is required, such as road building, land clearing or housing development for workers.

Drake used a rig that punched or pounded a hole 69-1/2 feet deep. The pounding pulverized the rock and soil, which was removed by flushing the hole with water. Today's primary form of drilling is rotary drilling. Drill bits are used to grind or bore through the rock. As the drill bit is lowered into the earth, pipe stems are added to the top. Drilling usually runs 24 hours per day until the well is completed. The average well today runs 5,000 feet deep. On the Overthrust Belt (Utah and Wyoming), it is common to find wells drilled between 8,000 and 15,000 feet deep because of the folded and faulted rock layers.

Most onshore rigs are portable and include tall derricks that handle the tools and equipment that descend into the well. Offshore drilling may be done from bottom-based platforms, drill ships, or submersible platforms. Each off-shore rig is self-contained with its own set of equipment. Workers and suppliers are ferried by boat or helicopter to the rig.



Submersible platform and drill ship.

An important part of the drilling process is the "mud," a mixture of water, clay and chemical additives,which is pumped into the well during drilling. This constantly circulating liquid cools the drill bit and carries debris out of the well. It also prevents the drilled area from collapsing around the drill pipe and serves to control the natural pressures within the well.

Drilling isn't cheap. The average cost of a well in 1990, according to the American Petroleum Institute, was $321,800 for onshore sites and over $3.1 million for offshore wells. Drilling is usually unsuccessful, with eight out of ten wells coming up dry. Dry wells are referred to as "dusters." Only one out of ten wells is commercially productible.

How is Crude Oil Refined?

At a refinery, crude oil is distilled or separated into its components or fractions. Distillation involves boiling the petroleum, drawing off the vapors, and then condensing the vapors. The different hydrocarbon compounds that make up petroleum vaporize at different temperatures, thus when they are condensed, they separate out into different fractions. Fractions represent the diverse range of products that can be obtained from petroleum.

In 1913, two chemists, William M. Burton and Robert E. Humphreys, developed a new method of refining petroleum, called thermal cracking. Thermal cracking increases the yield of gasoline from crude oil by altering the molecular structure of the hydrocarbons within the crude.

Thermal cracking involves the application of intense heat and pressure to the crude oil, causing the larger molecules to break into smaller molecules, including gasoline. Thermal cracking showed the diversity of products that could be obtained from petroleum. Catalytic cracking was introduced in the 1930s and utilized a solid material, such as sand grains as a catalyst in the refining process. Catalysts are substances that accelerate changes in other substances without changing themselves. Additional advances have since occurred.

What Is Enhanced Recovery?

Approximately 40 to 60 percent of the petroleum remains underground after initial pumping because of inadequate pressure to force the petroleum to the surface. Enhanced recovery techniques are aimed at freeing much of this remaining petroleum. Enhanced recovery involves the injection of gases, usually carbon dioxide (CO_2), water, or chemicals into the underground reservoir to build up pressure. The increased pressure causes the petroleum to migrate towards developed wells.

Where Do We Obtain Oil?

Oil discoveries in the U. S. since the first oil embargo are numerous. They include the Overthrust Belt of Utah and Wyoming, the Louisiana Trench and its subsequent development into the Gulf of Mexico, and fields off the coasts of Texas and California, as well as new fields in Arctic Alaska.

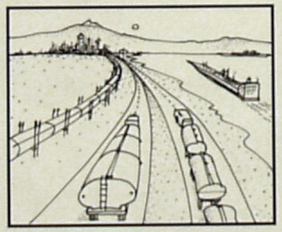
Oil or natural gas is produced in 33 of the 50 states. The top oil producing states in 1991 were Texas, Alaska, Louisiana and California.

As of late 1992, the C.I.S. (formerly the Soviet Union) continues to be the largest oil producer in the world, producing over 9.9 million barrels per day (mbpd); followed by Saudi Arabia at 8.2 mbpd; the U.S. at 7.4 mbpd; and Mexico, Venezuela and China each over 2 mbpd.

The United States is the third largest oil producing nation and the greatest petroleum consumer in the world.

Gushers - What Caused Them?

After petroleum is discovered, the underground pressure forces it to the surface. The days of the "gushers," when oil would explode to the surface, are gone. Each well now contains blowout preventers which automatically shut off the flow of gas or oil should well pressure change, preventing gushers, protecting the environment, and preserving the precious fuel.



Transporting oil to markets and consumers.

How Is Oil Transported To Market?

Three-fourths of the domestic crude oil and a third of the refined products in the United States are transported by pipeline. Over 204,000 miles of gathering and trunk pipelines connect production sites with refineries and the petroleum market.

Crude from the Overthrust Belt (Utah and Wyoming) is transported by pipeline to refineries serving the Midwest and Western markets. Other major pipelines run between Texas and the Northeastern United States.

Probably the most famous pipeline is the Trans-Alaska pipeline which carries crude from the north slope of Alaska to Valdez in Southern Alaska. The trans Alaska pipeline is 15,800 miles long and transports 1.7 million barrels per day, approaching 25 percent of the nation's oil.

Much of the foreign crude used in the United States is brought to American ports by tankers. Some of these tankers are over a thousand feet long and have a capacity to transport more than two million barrels of crude.

On a regional basis, trucks and railroad cars haul petroleum products to consumers or industries that develop and manufacture petroleum related products.

Oil and gas fields in the U.S.

How Is Oil Used?

Oil has become an integral part of our society. Much of our high standard of living can be traced to the use of petroleum.

At the turn of the century, it was relatively simple to pinpoint the major uses of petroleum. Grease was the major lubricant, and kerosene the major illuminant. Coal, eventually to be displaced by petroleum, was the major energy source for heating.

In the 1900s, America become the land of the horseless carriage. The advent of the internal combustion engine to propel the automobile provided a use for what had been a waste product at the refinery, gasoline. Gasoline quickly become an important product of petroleum as automakers adopted engines to utilize this practical fuel.

Today, about 6,000 products are produced, entirely or in part, from petroleum. Among the products derived from petroleum are gasoline, aviation gasoline, jet fuels (highly-refined kerosene), kerosene (now used mostly for cooking, space heaters and farm equipment), diesel fuels (for heavy equipment), fuel oils (for residential and commercial heating, manufacturing processes, and industrial steam and electric generation), petroleum coke (almost pure carbon which burns with little or no ash), and liquefied petroleum gas (primarily propanes and butanes obtained from refined natural gas). Other products include lubricating oils, greases, waxes, asphalt, nylon stockings, plastics, fertilizers, shoe polish, washing powders, medicines, photographic film, pesticides, insecticides, and waxed paper.

Annual Yields from a Barrel of Crude Oil

(1 Barrel of oil Contains 42 Gallons)

Product	Gallons Per Barrel	% Yield
Leaded Gasoline	6.8	16.4
Unleaded Gasoline	13.3	32.4
Distillate Fuel Oil	5.0	12.1
Residual Fuel Oil	3.0	7.1
Jet Fuel	1.4	3.5
Petrochemical Feedstocks	1.3	3.0
Asphalt and Road Oil	2.2	5.4
Still Gas (Refinery Gas)	2.0	4.7
Coke	1.1	2.7
Liquefied Gases	0.3	0.7
Lubricants	0.2	0.5
Kerosene	0.3	0.8
Miscellaneous	0.1	0.2
Special Naphthas	0.2	0.4
Wax	0.1	0.3
Processing Gain	1.8	4.5
Totals	42.0	100.0

NOTES

(1) Leaded and unleaded gasoline includes both motor and aviation gasoline.

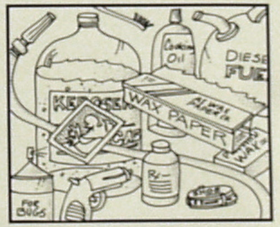
(2) Jet fuel includes both naphtha-type and kerosene-type fuel.

(3) Distillate fuel oil includes home-heating and diesel fuel, as well as No. 1 and No. 4 commercial fuel oils.

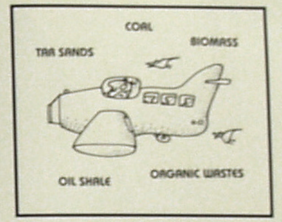
(4) Still gas (refinery gas) is that gas produced in refineries during the refining and cracking processes.

(5) Processing gain represents the amount by which total refinery output is greater than total input for a given period. The difference is due to the processing of crude oil into products which, in total, have less weight than the crude oil processed. Therefore, in terms of volume (barrels), the total output of products is greater than the input.

Source:
Percentage yield, U.S. Energy Information Administration, DOE 0615(92). Gallons per barrel computed by American Petroleum Institute.



Many uses of oil.



Sources of synthetic fuel.

What Are Synthetic Fuels?

Declining United States Petroleum reserves and the insecurity of imported petroleum supplies have prompted renewed interest in synthetic fuels. Synthetic fuels are oil and natural gas produced from alternative sources such as: tar sands, oil shale, coal, biomass and organic wastes. Tremendous quantities of oil and gas are potentially available from these alternative sources if environmental impacts and high production costs can be reduced.

Tar sands are sandstone deposits that contain bitumen, a substance that can be refined into a synthetic crude oil. There are an estimated 30 billion barrels of crude oil equivalent contained in the extensive tar sand deposits of Utah.

The potential synthetic oil yield from oil shale is staggering. There are an estimated 600 billion barrels of potentially recoverable oil from the extensive oil shale deposits in the United States. The richest of the United States deposits are found in Utah, Wyoming and Colorado.

Recovery of synthetic oil and gas from these resources requires extensive amounts of water and electricity, and the spent sand or shale must be properly disposed of after the synthetic oil and gas have been removed from the ore. These issues, as well as other environmental and economic considerations, make production of synthetic fuels from these sources uneconomical at this time. The single largest factor in the viability of synthetic fuels development is the world price of oil.

What Environmental Safeguards Exist?

The oil industry is regulated by laws aimed at making water safe to drink, air safe to breathe, and ground free from pollution. The major laws include the Federal Water Pollution Control Act, the Clean Air Act, the National Environment Policy Act, and the Federal Land Management and Policy Act. These laws govern the amount of emissions that can enter the atmosphere from refineries and road building, the amount of pollutants that can be discharged into waters, as well as the restoration of land after drilling operations cease.

Energy companies conscientiously strive to maintain a quality environment, but accidents can occur. The super tanker, Valdez, was carrying 50 million gallons of oil when it ran aground in Prince William Sound, Alaska, in March of 1989. Within three days, the oil that had not evaporated had reached the shorelines. As unfortunate as that accident was, however, a great deal was learned from it. Scientists used cold and warm water flushing to clean the shorelines. In addition, they studied methods which would accelerate natural processes. The most successful was bioremediation. This process involves applying a granular or liquid compound, made up of fertilizers and nutrients, to the affected areas. This compound stimulates the growth of native bacteria that naturally ingest the hydrocarbons found in oil. As time went on, scientists also discovered the effectiveness of Mother Nature in returning the environment to its original condition through evaporation, wave action and natural bacterial action. Within two years, Prince William Sound showed almost no negative effect of the oil spill. Bioremediation technology is now being applied to hazardous waste and pollution management. In addition, many tankers like the Valdez are now built with double hulls to avoid an accident of this kind occurring in the future.

More subtle examples of the damage that can occur to the environment involve the combustion of petroleum. Automobiles, the primary petroleum consumer in the country, emit carbon monoxide, carbon dioxide, and sulfur into the atmosphere from the combustion of petroleum. Industry and homes also emit sulfur when fuel oils are combusted.

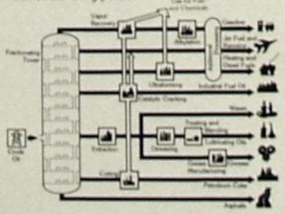
How Does Oil Affect Our Economy?

Currently 45.6 percent of the oil consumed in the U.S. is imported. This very aspect results in a strain on the economy and ties the U.S. into global affairs.

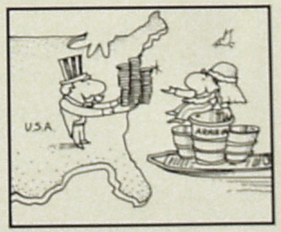
The importation of foreign crude results in an exportation of American dollars—to the tune of over 50 billion dollars per year. The imported crude also results in a staggering 40 billion dollars plus trade deficit. Money that could be spent to employ Americans and purchase U.S. goods and services is sent abroad.

The cost of petroleum imports has greatly fluctuated. In 1991, the refiner acquisition cost of a standard barrel (a barrel contains 42 gallons) of foreign crude was $18.70. Today, the domestic refiner acquisition of a barrel of crude is $19.33. As the price of petroleum increases, so does the price of products produced from petroleum.

American dependence on foreign oil was at its highest in the 1970s when it was at 47.7 percent. At this time, several events occurred illustrating how intimately involved petroleum is in our lives. Political tensions in the 1973 Middle East war resulted in the first oil embargo. The Organization of Arab Petroleum Exporting Countries (OAPEC) temporarily shut down exports to countries sympathetic to Israel. However, the embargo had little effect on oil supply, as U.S. oil companies were able to supplement Arab oil with oil from Iran and other nations. The real cause of the oil shortage was the decision of the Organization of Petroleum Exporting Countries (OPEC) to reduce oil exports. OPEC is an organization of countries in the Middle East, North Africa, and South America whose goal is to develop common oil-marketing policies.



Conversion of crude oil into useful products.



Oil comes in--money goes out.

The Oil Glut - Where Did It Come From?

The oil embargoes set in motion a massive oil exploration program throughout the U.S. and the world. The increase in price and decrease in supply, also due to the oil embargoes, triggered energy conservation. Oil consumption also decreased due to the recession. These situations of the 1970s resulted in the petroleum glut of the 1980s.

Under the impact of conservation and higher prices, the U.S. reduced its imports of petroleum from a peak of nearly 9 million barrels per day (mbpd) in 1977 to 4.9 mbpd in 1983. In 1991, however, that figure increased to 7.6 mbpd.

In 1974, the average American automobile got 14.2 miles per gallon (mpg). By 1980, the average had risen to 23.4 mpg. In the 1980s, Federal law required that the auto industries automobile fleet (all makes and models produced by an automobile company) average 27.5 mpg by 1985. Now the Corporate Average Fuel Economy (CAFE) laws outline a standard of 34 mpg by 1995 and 40 mpg by 2001. One way to accomplish this is to manufacture lighter weight vehicles by replacing the heavier metals presently used in the engine and other parts with aluminum and magnesium alloys.

What Is Our Oil Future?

The United States' appetite for oil ranks us as the world's largest consumer of oil, yet we have less than 3 percent of the world's proved reserves. Our dependence on foreign oil is reaching the level of the 1970s, and most experts predict that more than half of our nation's oil will be imported by the mid-1990s. As we become more dependent on foreign countries for our oil needs, the probability increases of having a repeat of the energy and economic problems we faced in the 1970s.

Oil is a limited resource, and by the year 2000, our oil reserves could be almost entirely depleted unless we, as a nation, take steps to provide for our oil future. These steps should include:

- **Conservation** - each of us should plan and use energy wisely.
- **Research** - continue the development of alternative forms of energy such as solar, the development and use of synthetic fuels, and the development of more energy efficient cars and machines that use oil and other forms of energy.
- **Recycling** - continue the recycling of petroleum products and waste as well as develop new methods, means and technology for the handling, transporting and eventual recycling of these materials.
- **Exploration** - our nation needs to continue to explore and find "undiscovered oil resources" as well as find the economic and technical means to get more oil from the "identified resources" which we currently have.

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