



**PDHonline Course M557 (8 PDH)**

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# **Oil & Gas Refining - Production and Processes**

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**OIL & GAS REFINING  
PRODUCTION AND PROCESSES**

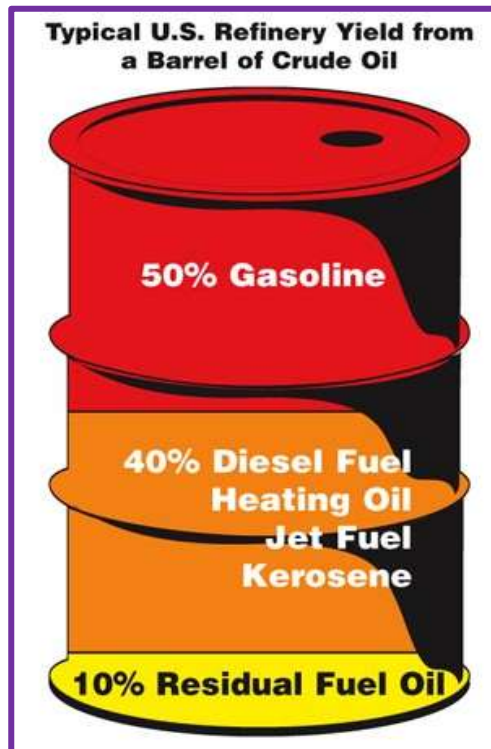
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## I. INTRODUCTION

Refining is a complex series of processes that manufactures finished petroleum products out of crude oil. While refining begins as a simple distillation (by heating and separating), refineries use more sophisticated additional processes and equipment in order to produce the mix of products that the market demands. Generally, this latter effort minimizes the production of heavier, lower value products (for example, residual fuel oil, used to power large ocean ships) in favor of middle distillates (jet fuel, kerosene, home heating oil and diesel fuel) and lighter, higher value products (liquid petroleum gases (LPG), naphtha, and gasoline).

The main objective of refineries is to convert crude oil into useable petroleum products. Typically, one *barrel of crude oil* is approximately 19 gallons of gasoline, nine gallons of distillates (home heating fuel, diesel and kerosene), plus lesser amounts of other refined products such as, jet fuel, liquid petroleum gas and residual oil. To a limited extent, refiners can adjust the refining process to alter the resulting mix of refined products, and to fit changing customer needs.



In the U.S., crude oil is measured on a volumetric basis at a *standard temperature of 60°F*, typically in units of barrels (*1 bbl = 42 gal*), commonly designated as barrel per day (bpd). Outside the U.S., crude oil tends to be measured on a mass basis in units of *metric tons per day*. In general, a small refinery produces 100,000 bpd or less, a middle-size refinery produces 100,000-250,000 bpd, and large refineries (typically integrated with a petrochemical processing facility) produce more than 250,000 bpd.

Aside from the fuels derived from petroleum, such as gasoline, distillate fuel (including home heating oil and diesel), kerosene-type jet fuel, residual fuel oil used in industry, marine transportation and for electric power generation, there are many other non-fuel uses. These include various specialized products for use in the textile, metallurgical, electrical, and several industries. Someone may be surprised to learn about some everyday products that are derived from crude oil, including:

- . Solvents, such as those used in paints, lacquers, and printing inks;
- . Lubricating oils and greases are used for automobile engines, and other machinery;

- . Petroleum (or paraffin) waxes are commonly used in candy making, packaging, candles, matches, and polishes;
- . Petrolatum (petroleum jelly) is blended with paraffin wax in medical products and toiletries;
- . Asphalt is used to pave roads and airports, to surface canals and reservoirs, and to make roofing materials and floor coverings;
- . Petroleum coke is used as a raw material for many carbon and graphite products, including furnace electrodes and liners, and the anodes used in the production of aluminum;
- . Petroleum feedstocks are used for the manufacture of chemicals, synthetic rubber, and a huge variety of plastics.

Nearly every aspect of our modern lifestyle is impacted by oil. Refined oil is used to power our vehicles, to create medicines that keep us healthy, manufacturing plastics, cosmetics, and other personal products that enhance our daily lives. Today, crude oil is refined all over the world. The Jamnagar refinery is the world's largest oil refinery, with an aggregate capacity of 1.24 million barrels per day (bpd). In fact, most of the oil industry's largest refineries are in Asia and South America. However, the practice of refining oil was created in the United States, where it continues to be an important part of the nation's economy.

Refineries that process crude oil into raw material for a thousand of other products are overwhelming to the outside observer, with a multitude of tanks, vessels, pipelines of various sizes, fired heaters, pumps, compressors, instrumentation and control systems. The objective of this course is to give an overview of oil & gas refineries, production, processing and transportation, but does not discuss integrated petrochemical complexes. Each refinery can be designed to process gas and oil of a particular composition, as crude petroleum makes a diverse blend to obtain a feedstock that better matches the refinery's capabilities.

Petroleum may be separated and distributed in downstream processing units, to several other types of components, such as, *paraffins, oleofins, naphthenes, and aromatics* designated as "PONA", very important in the catalyst processing, used in terms of functionality and desired reaction conversion. Various fuel components can be blended into final commercial products that meet particular specifications based on the consumer's location; for example, large urban areas typically have more restrictive pollutant fuel specifications. Intermediate products include *alkylate, isomerate, reformate, cat gas, hydrocracker gas, and coker gas*. Normal *butane* is also added as necessary, to meet certain specifications, which may be different in summer and winter.

The oil and gas industry is usually divided into three major sectors: *upstream (exploration), midstream, and downstream*. The *downstream* sector commonly refers to the refining of petroleum crude oil and the processing and purifying of raw natural gas, as well as the marketing and distribution. These products are typically transported by pipelines to terminals, such as gasoline, kerosene, jet fuel, diesel oil, heating oil, fuel oils, lubricants, waxes, asphalt, natural gas, and liquefied petroleum gas (LPG), ethanol and other biofuels and hundreds of petrochemicals. At the terminals, crude oil, petrochemical feedstocks, liquefied petroleum gases, and raw materials for various products are stored in tanks, where various additives are added, and trucked to commercial distribution stations.

## II. REFINERIES HISTORY:

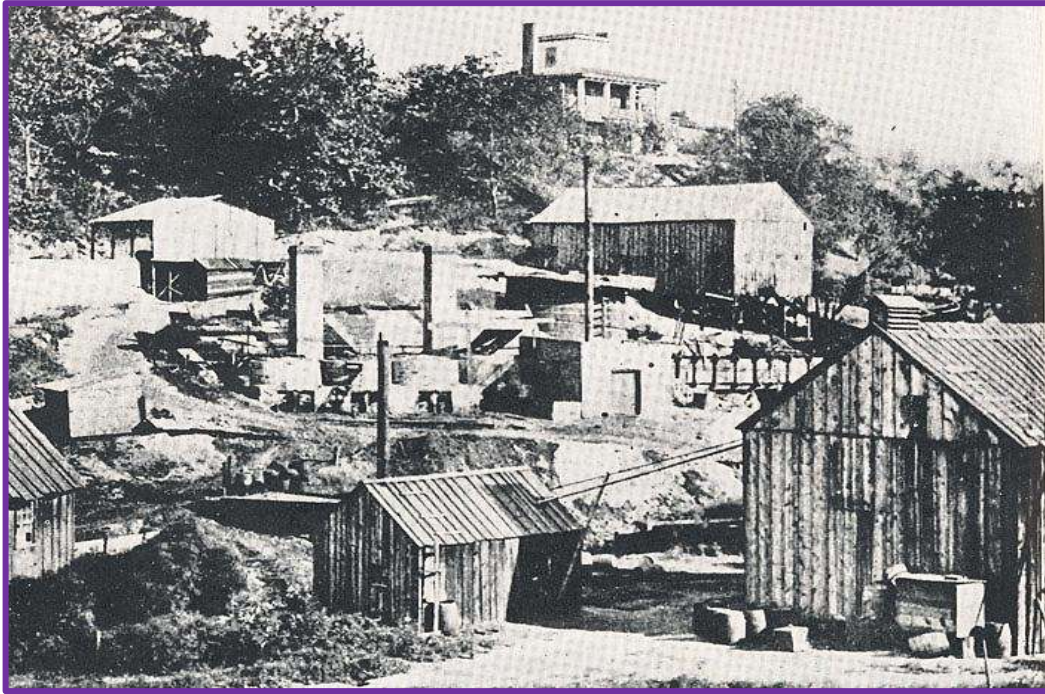
The ninetieth and twentieth centuries have been called the centuries of oil, mainly in the U.S.A. In Southern California, large seeps in Ventura, Santa Barbara, Kern, and Los Angeles counties received the most attention. Interest in oil and gas seeps was stirred in the 1850s and 1860s, in part because one of California's oldest and most-used roads passed along nearly all the seep areas on the western side of the San Joaquin Valley. Interest in oil seeps became widespread after the 1859 discovery of oil in Pennsylvania, when the value of kerosene as an illuminant became known all over the world. In fact, oil exploration began in Northwestern Pennsylvania, in a remote little place called Titusville to be exact, where oil was first extracted via drilling and considered the first oil well.

However, prior to the Pennsylvania activity, a number of California settlers probably collected oil from seeps and roughly distilled it into lamp oil. By 1867, drilling activity had declined. Many California wells capable of producing oil became idled, because over-production in Pennsylvania brought the oil to San Francisco at a price lower than California operators could meet. In 1876, a wellbore designated as "Pico" 4 was completed, and began producing 30 barrels of oil a day from a depth of 300 feet. This exploration was the first truly commercial oil well in the state, so designated due the placement of a state historical monument. The same year, a first true basic oil refinery in the state was built at Newhall to take care of the new production, with a daily capacity of 20 barrels.

These happenings started the changing of candles to kerosene lamps. In Europe, an early wellbore was hand dug in Poland in 1853, and another in nearby Romania in 1857. At around the same time the world's first, but small oil refineries, were opened at Jasło, in Poland, with a larger one being opened at Ploiești, in Romania, shortly after. Romania is the first country in the world to have a refinery of crude oil output officially recorded in international statistics. By the end of the 19th century, in Russia, the Branobel Company in Azerbaijan took the oil production leadership, in Europe.

Back in U.S., the Standard Oil Trust was formed in 1863 by John D. Rockefeller, suggested by Samuel Andrews, a mechanic, which constructed a small oil distillery in 1862. He considered it advantageous to refine crude oil into kerosene and thereafter, from 1865 to 1870, actions and secret transport deals, helped its kerosene price to drop from 58 to 26 cents, disliking competitors, due the company's business practices. In 1870 became the largest corporation in the USA, controlling 10 percent of U.S. petroleum refining. The company was renamed Standard Oil Company, and Rockefeller decided to buy up all the other competition firms, and form them into one large company. When organized in 1870, the company also owned more 2 refineries in Cleveland, Ohio.

New oil exploration in Pennsylvania and Ontario were quickly outpaced by demand, leading to "oil booms" in Ohio, Texas, Oklahoma and California. In 1889, a representative from Standard Oil, Theodore M. Towle, was sent to Whiting to purchase land for a new refinery, due water transportation, Whiting was an ideal site. The company built a twenty-inch pipeline that connected the waters of Lake Michigan with the refinery and shortly after, the construction of the giant storage tanks began. In 1890, on Thanksgiving Day, the first shipment of 125 tank cars of kerosene started to market. At that time the refinery had a charging capacity of about 10,000 barrels of crude oil per day.



Birthplace of Standard Oil. At Walworth Run, Cleveland, Samuel Andrews, a mechanic, built a small oil distillery. In 1862 he persuaded Rockefeller to invest. This is believed to be the first refinery, as photographed in 1870.

In 1911, following the Supreme Court ruling, the company became known as Standard Oil of Cleveland, Ohio, or SOHIO. In 1922, the Standard Oil absorbed the American Oil Company, founded in Baltimore in 1910, and began branding products as Amoco, which later would become its company name. By 1952, Amoco was ranked as the largest domestic oil company. Standard Oil of Indiana officially became Amoco Corporation in 1985, and merged with British Petroleum (BP) in 1998. It was the world's largest industrial merger at the time.

**Oil Refinery Development:** Samuel Martin Kier (1813 - 1874) was an American businessman, a native of southwestern Pennsylvania, and historically, is considered the first person to refine crude oil, in the mid-1840s. That time, wells were mainly drilled for salt water, and occasionally, produced foul-smelling petroleum alongside the brine. In the salt business, the oil had no commercial application and was a nuisance, and drillers have to burn it or allow it to run off into nearby waterways. However, Kier was an entrepreneur, and he believed that he could turn the oily by-product of his salt wells into something of value.

Kier first used the flammable oil produced by his salt wells, to light his salt works at night, but produced an awful smell and a great deal of smoke. Kier knew crude oil would burn and thought that it could make a good and inexpensive lamp oil. In 1849, Kier took samples of his crude oil to Philadelphia where they were analyzed by Professor James C. Booth, a chemist, which agreed that crude oil could be used for illumination, but needed to be distilled or refined to get the best burning fluid.

Thus, in 1850, Kier started experimenting with distillation and became the first person in the U.S. to attempt to use liquid petroleum as a starting material to produce lamp oil. After further experiment-

ing, he discovered an economical way to produce kerosene. Kerosene had been known for some time but was not widely produced and was considered to have little economic value. But at the time whale oil, the principal fuel for lamps in U.S. was becoming increasingly scarce and expensive. His refining experiments were successful and by 1851, Kier produced a product called Carbon Oil, a fuel oil which burned with little smoke and odor, sold for \$1.50 a gallon.

In partnership with John T. Kirkpatrick, Kier created the first U.S. petroleum refinery in Pittsburgh, Pennsylvania. He started with a small one or two-barrel still, but by 1854, he had a larger five-barrel still in operation. When Edwin L. Drake struck oil near Titusville, Pennsylvania in 1859, the market became flooded with oil, and Pittsburgh saw seven new oil refineries come into operation. By the end of the 1860s, there were 58 refineries operating in Pittsburgh alone. Samuel M. Kier spent a great deal of his life trying to make crude oil useful and valuable and along the way he gave birth to the U.S. refining industry.

In 1853, Samuel M. Kier established America's first oil refinery in Pittsburgh, using a five-barrel still, as a marker identifying the "Kier Refinery", and about 1854, was the first oil industry to produce illuminating oil from petroleum. In the early days, Samuel Kier used horizontal cylindrical distilleries that only held 5 to 6 barrels of oil at a time, able to raise the temperature of the oil very slowly. As the temperature rose, they removed the distillates like gasoline for which they had no use, procuring only the lamp oil or kerosene. Over time, other distillates from crude oil became useful, and the refining process evolved.

**Associated Oil Company:** In 1900, W.S. Porter, a pipeline salesman, convinced the presidents of the five largest companies in the Kern River Oil Field and McKittrick oil fields of California, to enter into an agreement, to turn over their oil interests to form a new company in exchange for stocks and bonds for the appraised value of their properties. Securing agreements from 34 other oil companies in the area, the *Associated Oil Company* was incorporated on October, 1901 and on January, 1902 began actively producing and marketing crude oil.



The Standard Oil Company and the Southern Pacific Railroad acquired an interest with the Associated Oil Company, for the purposes of transporting their own oil to the San Francisco Bay area, where the petroleum could be refined and marketed. In 1905, the Matson's Pacific Oil and Transportation Company was acquired. In 1906 the company completed its first eight inch pipe line from the San Joaquin field to Port Costa, and shortly thereafter, this line being inadequate, constructed an eight inch pipe line from the Santa Maria field to its refinery at Gaviota, a distance of about thirty five miles, including the Coalinga-Monterey pipeline and other marine facilities.

In 1907, the Associated Pipe Line Company was formed as a subsidiary of the Associated Oil Company with the Southern Pacific Company providing property along its railroad tracks which ran from the Bakersfield Kern River oil fields to Port Costa, California, later being shipped to China and other parts of the world. In 1913, the *Associated Oil Company* decided to construct a topping plant called the *Avon Refinery* (now the *Golden Eagle Refinery*), on San Francisco Bay on a twenty acre site at Avon, Contra Costa County. It was completed and put in operation in August, 1913, at that time having a capacity of about ten thousand barrels of crude oil a day. On the completion, the refinery launched the production of gasoline and kerosene.

The refinery was named Avon Refinery because it was located within the Avon section of the Southern Pacific Railroad track system, to process heavy crude oil from the southern San Joaquin Valley, to which it was connected by a pipeline. Later, the refinery was acquired in 1920 by the Pacific Oil Company to expand operations in 1923 and 1924, and to include the manufacture of gasoline. By 1925 the Avon Refinery became the first West Coast refinery to produce gasoline with tetraethyl lead additive. The location of Avon refinery was ideal, having deep water shipping facilities and being traversed by both the Southern Pacific and Santa Fe railroads.

In 1926, the *Associated Oil Company* was sold to a new holding company, the Tide Water Associated Oil Company. Tide Water was founded in New York City in 1887, and by 1920 was selling gasoline, oil and other products on the East Coast under its *Tydol* brand. In 1926, control of Tide Water Oil passed to a new holding company, the *Tide Water Associated Oil Company*, which acquired the control of the *Associated Oil Company*. In 1936, the separate companies, Associated Oil Company and Tide Water, were dissolved into a new holding company, now renamed *Tidewater Associated Oil Company*. Associated J. Paul Getty's purchase of Mission in 1937 set the stage for the birth of Tidewater as a major national player in the oil industry.

The company, currently known as Aloha Petroleum, Ltd. (Aloha), also began its history in Hawaii back in the early 1920s controlled by Associated Oil, as a division of Tidewater Oil then, owned by J. Paul Getty. The petroleum products for its Associated Oil stations were brought from the mainland aboard the famous ship Falls of Clyde, which is now permanently docked and displayed at the Hawaii Maritime Museum in Honolulu.

In the mid 1950's, Tidewater Oil needed a plan to deal with the advent of supertankers and hyper-tankers to transport oil and gasoline in and out of the Avon refinery. These much larger draft vessels could enter San Francisco Bay, but not the shallower waters beyond the Carquinez straits. The plan involved a system of "lightering" the ships by offloading a portion of their cargo into smaller tankers

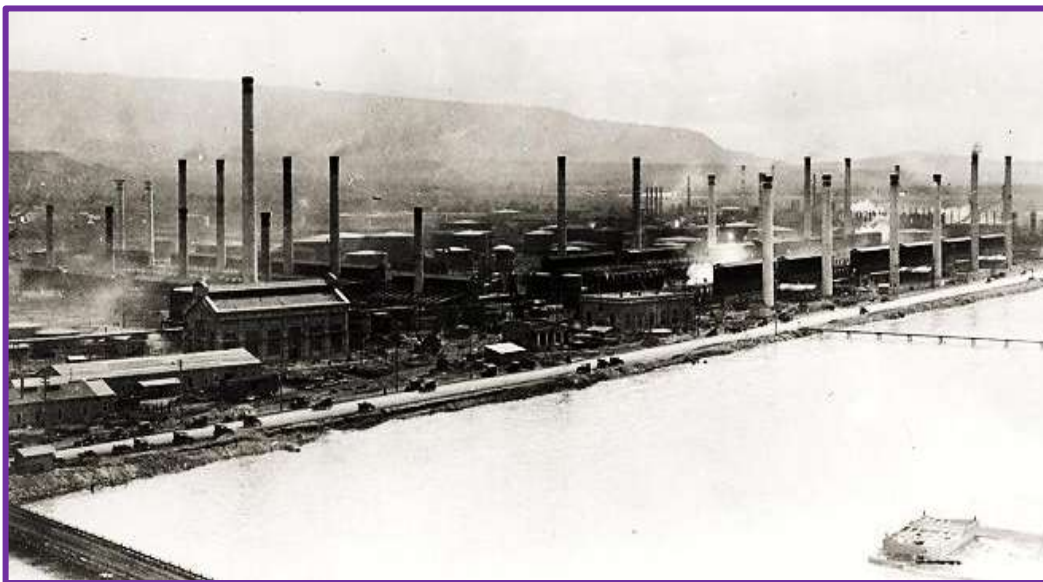


thereby raising the draft of the super-tankers sufficiently to allow them to continue to the wharf. This system, developed in 1957 is still in effect, and supertankers that have too deep a draft are still "lightered" to this day.

The Avon Refinery development study, was created when the Tidewater Oil Company was considering expansion options at the plant, containing maps, charts, tables, drawings, foldouts, economic data and recommendations for the problems of lightering ships in the channel prior to their transit up to the existing wharf facilities. Later, Avon Refinery became the Golden Eagle Refinery, with a processing capacity of 166,000 barrels of crude per day, making mostly automotive fuels, including the lesser polluting California Air Resources Board gasoline and diesel fuels. It is now owned by Tesoro, of San Antonio, TX, and had previously been owned by Tosco and Ultramar Diamond Shamrock.

**Wyoming Oil Industry:** In 1866, John C. Fiere, an employee of Fort Bridger Sutler, reported to his boss that he had found oil nearby. He had experience in the Pennsylvania oil fields and offered to develop the oil spring commercially. Therefore, in the 1890s, significant oil strikes were made in northern Natrona County. Investors that would like to have nearby supplies of crude oil underwrote a construction of the Wyoming's first refinery, in 1895. Pennsylvania investors formed an oil industry in *Casper, Wyoming*, and named it the *Pennsylvania Refinery*. They also struck oil at what became known as the *Shannon Field* north of Casper.

In 1917, five refineries were operating in the state, including small operations at Greybull and Cowley. By 1923, Casper alone boasted five refineries; the tiny *Pennsylvania Oil and Gas Company* facility on South Center Street built in 1895; the *Belgo-American* refinery later known as the *Midwest Refinery* built east of Highland Cemetery in 1903; the giant *Standard Oil* refinery in southwest Casper, opened in March 1914 and expanded in 1922 into the largest gasoline-producing refinery in the world; the *Texaco* refinery, three miles east of Casper that opened in 1923; and the small *White Eagle* refinery opened the same year.



Standard Oil refinery on the North Platte River, Casper, Wyoming, 1920s.

**Tulsa “Oil Capital of the World”:** In 1905, two years before Oklahoma becomes a state, oil is discovered in south of Tulsa. The Glenn Pool discovery became the greatest oilfield in America at the time, and lead Tulsa to become the “Oil Capital of the World.” Daily production soon exceeded 120,000 barrels, exceeding the Tulsa County’s earlier “Red Fork Gusher”, and the giant Spindletop Hill discovery near Beaumont, Texas, four years earlier. The Ida Glenn No. 1 well is named for the Creek Indian woman, from whom oilmen had leased 160 acres. By the time, in 1907, Glenn Pool made Oklahoma the America’s biggest oil producing state.

Harry Ford Sinclair (1876-1956), later the founder of the Sinclair Oil and Refining Company, and J. Paul Getty, receive their initial start during the Glenn Pool boom, as noted by the Oklahoma Historical Society. The Oklahoma Natural Gas Company is founded, and in 1907 builds a pipeline from the Glenn Pool to provide gas to Oklahoma City. “It was Oklahoma’s first major oilfield, and the richest field the world had yet seen,” explains Norman Hyne, professor of petroleum geology at the University of Tulsa. “Unlike the thick, sour oil from Spindletop, the famous 1901 Texas discovery that had already played out, this oil was light and sweet, just right to refine into gasoline and kerosene”.

The reservoir was shallow, less than 1,500 feet deep, and the well within the range of the cable tool drilling rigs of that time. The giant field produced 325.5 million barrels of oil by 1986, with annual royalties of almost one million dollars paid to Creek Indians who held 160-acre allotments in the field. It is said that more money was made on the Glenn Pool oil field, than the California gold rush and Colorado silver rush combined. The field today uses enhanced recovery technologies to continue to produce oil. In April 2008, a monument was unveiled in Glenpool’s Black Gold Park by the Glenn Pool Oil Field Commission.

**Texas Oil Industry:** In 1901, the world famous Lucas gusher shot a stream of black crude oil high above the derrick, under the hill on Spindle Top Heights, later known simply as Spindletop. The geyser of oil flowed out of the 6-inch casing pipe for ten days at a rate of 70,000 to 100,000 barrels per day. The Hamill brothers successfully capped the gusher, and therefore, an oil boom like no other witnessed swelled the size of Beaumont from 8,000 residents to more than 50,000 in a few months. Investors and men of vision rushed to Beaumont to see if they could take advantage of the new oil discovery. By the end of 1901, there were over 100 wells at Spindletop many of them located on small "doormat" pieces of land, barely large enough for the derrick and drilling equipment.

The most significant company that started during the Spindletop oil boom was The Texas Company. This new company was formed primarily by the efforts of two industrialists, J. S. Cullinan and Arnold Schlaet. Other two enterprising Texans, former Texas Governor J. S. Hogg and J. W. Swayne, were very active in the Spindletop development under the business name of Hogg-Swayne Syndicate, however, did not have a market for their oil or a method of getting it to a point of shipment. Then, they acquired lands for a pumping station near Spindletop, and for a refinery at Port Arthur.

Next, they also constructed storage tanks and started to lay a pipeline to Port Arthur, where Spindletop crude oil could be loaded in barges or ships. Early in 1902, the company entered into negotiations for erection of a loading dock at Port Arthur Terminal. The Texas Company’s first pipeline from Spindletop was completed to reach the railway loading stations of Garrison and Nederland on May,

and to Port Arthur in August, 1902. In September, 1902, The Texas Company's supply of crude oil was cut off, when the Spindletop wells suddenly stopped flowing, after the field caught fire. The Texas Company had an option to purchase the 865-acre about 20 miles northwest of Spindletop for \$1,000,000. The option was about to expire when the third and last test well blew in a gusher on January, 1903. The company paid, getting money from partners, and this new, abundant supply of crude oil saved the company from bankruptcy.

From 1935 to 1940, there was a rapid increase in the quality, as well as the quantity, of lubricating oils manufactured at Port Arthur Works, when numerous technical changes were made to overcome capacity limitations and to increase the capacity of all of equipment. The gas produced in the cracking operation contained large quantities of propylene and butylene. A Polymerization Unit was built in 1936 to convert (polymerize) these gases into motor gasoline. This unit was converted to computer control in the late 1950's, and was the first unit in the world to use computer control.

In 1944, The Texas Company and American Cyanamid Co. organized a new company, the *Jefferson Chemical Co., Inc.*, constructed in Groves. The Jefferson Chemical plant was completed in late 1947, to convert refinery gases into basic chemicals for the plastics industries. The Texaco ethylene glycol for automotive antifreeze was introduced in 1948. In 1952, Port Arthur Works installed underground storage for butanes at Sour Lake, Texas. The underground storage consisted of a cavity washed out of a salt dome (a type of structural dome formed when a thick bed of evaporite minerals, such as salt, or halite, intrudes vertically into surrounding rock strata).

Due to the increased octane level of gasoline motors, a *Catalytic Reforming Unit* was constructed and started up in July, 1954. Many changes have taken place at the Port Arthur Refinery in the last years through efforts to streamline operations, shift product distribution, and improve the efficiency of the refinery. The Texas Company was renamed Texaco, Inc., in 1959. In 2001, Chevron acquired the assets of Texaco to form a new company, Chevron-Texaco. In 1989, Saudi Refining, Inc. purchased 50% of Texaco's Port Arthur refinery as part of a joint venture with Texaco.

Later, a new alliance between Texaco, Shell Oil Co., and Saudi Aramco were formed. This new alliance was called Motiva Enterprises LLC. From a dream of a few men, the Port Arthur Works company was instrumental in establishing a major international oil company, Texaco, the last company to survive the great Spindletop oil boom.

Texas City, is a city in Galveston County in the state of Texas acquired its first major industry when the Texas City Refining Company purchased in July, 1908, the site on which was constructed what was then considered a large and complete oil refinery, one of the earliest in Texas. For several years it was the only Texas refinery capable of producing the byproducts wax and lubricating oil. Some of the original buildings are still in use on the several times enlarged site, later occupied by the Sid Richardson Refining Co.

**First Oil and Kerosene Pipelines:** In U.S., about 1860, the village of Titusville, Pennsylvania was the only town along the Oil Creek Valley (see "Colonel" Edwin Drake history). The railroad had not yet reached Titusville; the town's only connection to the outside world was the stagecoach that visit-

ed from Erie, Pennsylvania twice a week. Farmland and dense woods with few proper roads dominated the rest of the rural valley. Thus, in 1862, the first oil discoveries were transported to rail stations by teamsters using converted whiskey barrels with wagon and horses, which was the first method that early oil producers used to transport their oil.

Teamsters were hired by drillers to haul oil from the drilling sites to rivers, railroads, or refineries. Teamsters dictated the price to haul wooden barrels of oil around the region, depending on road and weather conditions. From the very beginning, transportation was essential with the Teamsters holding the first regional monopoly position. They charged more to move a barrel of oil 5 miles by horse than the entire rail freight charge from Pennsylvania to New York City.

Like previous pipeliners, Samuel Van Syckel (1842- ) was motivated by the often ruinously high prices charged by the teamsters to haul a wagon loaded with oil barrels to a distant, or even nearby a place, which could be a small refinery, a storage tank, a railroad yard, canal, a river bank (deep water), a city or to some other intermediate sales point. Pre-pipeline price was always swinging in the first five years of the oil industry, and saw the price of crude oil fall to less than 10 cents a barrel while an empty new barrel could cost as much as \$3.25.

The Pithole (a place in the foothills of the Appalachian Mountains) field was discovered in 1865, lying some five miles southeast of Miller Farm station, in wilderness, with no roads and difficult terrain. The teamsters soon priced themselves out of the picture for Pithole haulage, and Van Syckel was eager to get that oil moving. A pipeline was the answer and Van Syckel, became very determined to lay a pipeline, however, his idea was subject of much ridicule by his fellow oilmen, and attacked by teamsters, as they were threatened by this new transportation system.

In 1865, Van Syckel with a credit from the First National Bank of Titusville, went on with his idea and laid about 5 miles of two-inch wrought iron pipe in 15 foot joints from Miller Farm RR Station on the west side of Oil Creek in a southeast direction to Pithole. This was in hilly terrain of about 400 feet relief, but over half of that was in the descent from the flanking ridge to Oil Creek. The pipeline was wrought iron, 2 inches in diameter and lap-welded by William Snow, a Van Syckel's engineer who determined the specifications of the pipe, and the manner of laying it. Van Syckel installed three Reed and Cogswell steam pumps, two of these in the Pithole field and the other nearby.

These steam pumps pushed the oil at a rate of 81 barrels per hour to Miller Farm beginning October 10, 1865. A fourth pump was installed at a later date at the Cherry Run crossing increasing the delivery of crude oil by 25 percent bringing the line's 24 hour delivery to 2500 barrels. Mechanical problems were minor and could be easily fixed. Many teamsters were suddenly out of work, and the skeptical oilmen turned sheepish, but most of them took up the pipeline business.

In late 1871 by Tom Scott, the president of the powerful Pennsylvania Railroad, the South Improvement Company (S.I.C.) made a secret alliance between the railroads and a select group of large refiners, including the Standard Oil founded by John D. Rockefeller, which aimed a trust by "destructive" price-cutting. According to the pact, the railroads would raise their rates, but would agree to pay rebates to Rockefeller and other large refiners, thus securing their steady business.