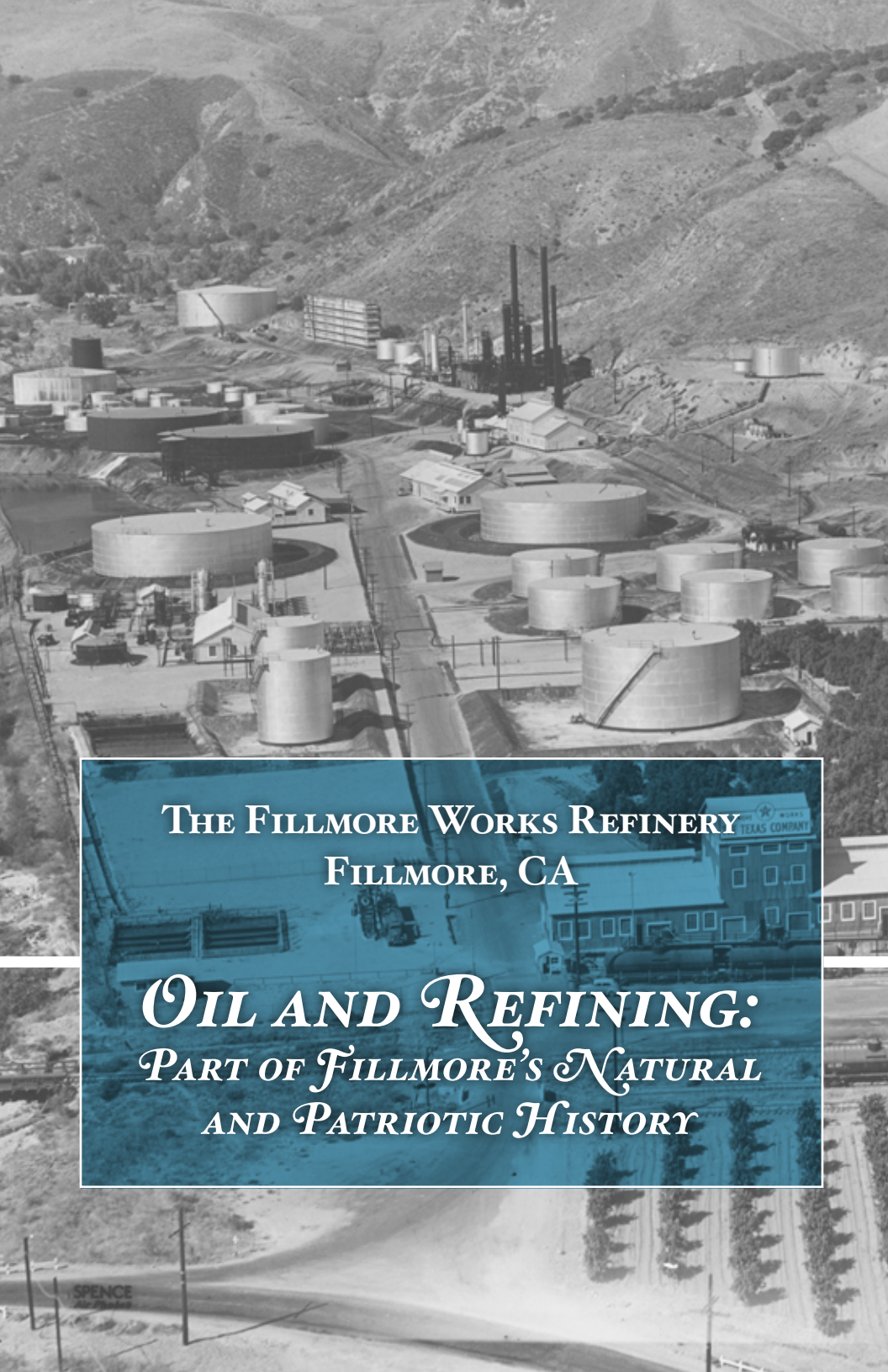


The Fillmore Works Refinery
Fillmore, CA

Oil and Refining:
Part of Fillmore's Natural and Patriotic History

Research for this booklet was provided by Greg Kipp, Geomega, Inc.

Photo Credits:

Fillmore Historical Museum, historic Texaco photos
Museum of Ventura County, page 6
Los Angeles Public Library, page 10
Port of Los Angeles, page 15
Chevron Retirees Association Global Affiliates, pages 15, 21
National Archive of Records Administration, various military photos

Table of Contents

Fillmore's Natural Oil History

Natural Oil

Oil formed in Monterey Formation flows to Sespe Formation and natural seeps

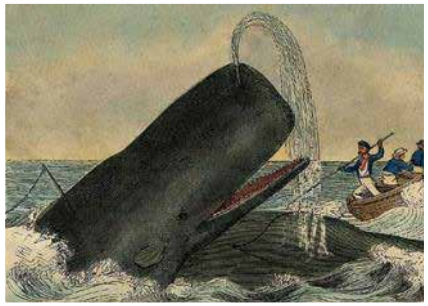
Coastal first nations used oil for 7,500 years.

Coastal first nations (e.g. Chumash) used natural seeps for face/body paints, waterproofing canoes and baskets, art, and chewing gum.

European settlers used seeps for roofing and general waterproofing.

The early oil boom: smokeless kerosene

EARLY CIVILIZATION
Animal oils and tallow

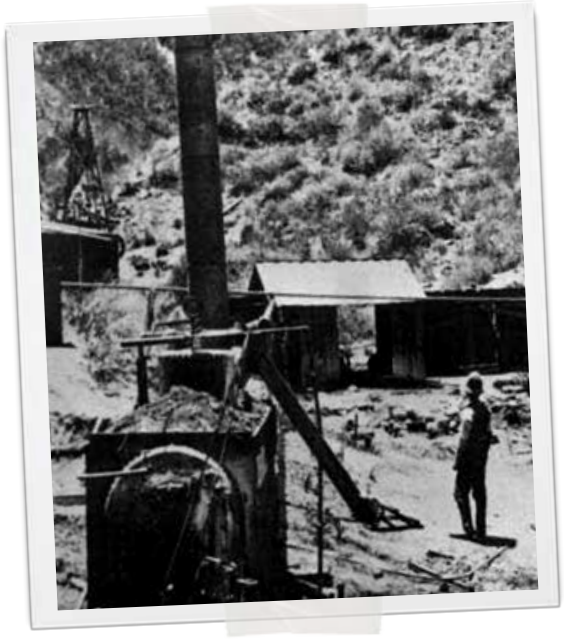


1850's
Kerosene lamps

1879
Thomas Edison and the light bulb

Simple Beginnings

California Oil Rush Starts near Fillmore



- 1877: First viable well in California
- Pico Canyon Well #4 about 20 miles east of Fillmore
- Becomes Pacific Coast Oil Company and later Standard Oil Company of California
- Gold miners become oil workers
- Standard Oil establishes small diameter pipeline near Fillmore
- Simple distillation focused on kerosene for lighting

Gold miners become oil workers.

Southern Pacific Railroad, Oil and Fillmore

- Railroads, oil, pipelines, and refining become intimately linked
- Oil producers generally dependent on pipeline and rail companies to reach markets
- Prices set at well by pipeline owners
- Light oil discoveries near Fillmore spawn independent refining

Early Fillmore Oil Companies

White Oil Company • Montebello Oil Company • Ventura Refining

Wendell P. Hammon, founder of Ventura Refining Company and owner of Montebello Oil.

- Gas engines at well fields
- Ten 650 gallon-sized delivery trucks
- Rail exports in World War I

Montebello Oil - Ventura Refining (Fillmore): Simple Distillation and Fractionation

- Ventura Oil Lands Company deeded the land to Ventura Refining Company in 1915
- Refinery fully built by 1919

Historical fractionation towers and stills.

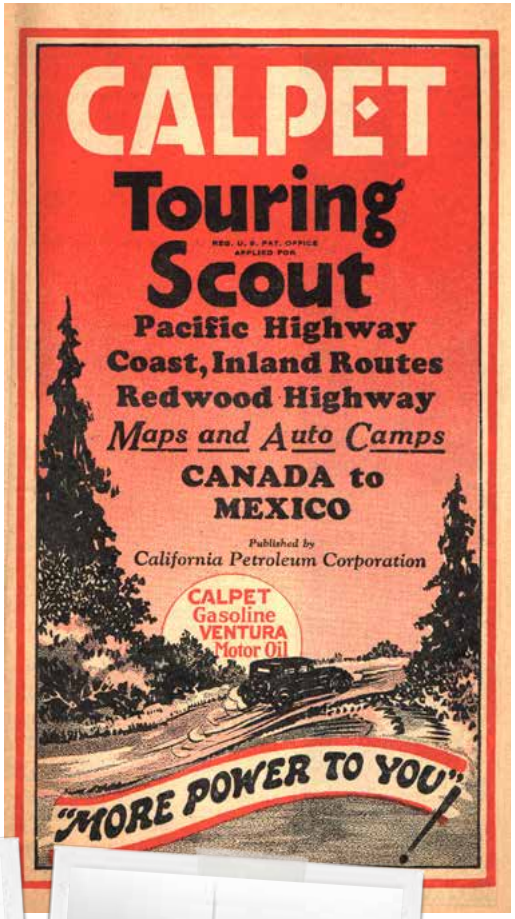
Changes in the mid-1920s

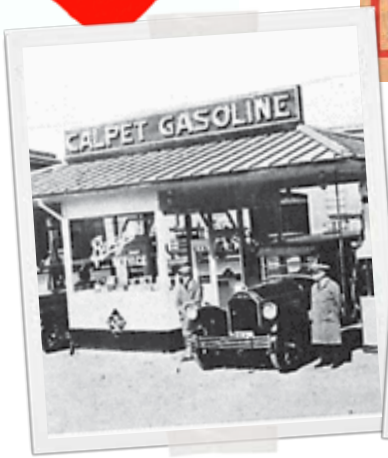
- Heavier oil discoveries (e.g Santa Clara Valley fields) required more distillation
- Automobiles required more and better refined gasoline
- Rail and shipping transitioned from coal to oil
- California oil glut demanded efficiency and access to port for exporting
- Prohibition shifted distillation experts to oil refining
- Aging founder of Ventura Refining Company and new strict product quality requirements likely motivated sale to California Petroleum (CalPet)

Ventura Refining, Fillmore
September 1924

California Petroleum (CalPet) 1926-1928

- CalPet acquired Ventura Refining and Montebello Oil Company
- Began Wilmington (CA) Refinery
- Opened retail stations
- Exported from Berths 171-174 in Los Angeles
- CalPet not known for refining advancements - but market demanded ethyl and aviation fuels





Texaco and Advancement of Aviation Fuel

Texaco (Texas Company)

- Texas Company acquired CalPet in 1928, including refineries in Fillmore and Wilmington
- First petroleum company to market in all "48" states
- Capable of handling production from the Santa Clara Valley and other sour oil fields

1931 Fillmore Works: Advanced refining for the time

Early Texaco enhancements to Fillmore works

- Ventura Refinery became Fillmore Works
- Pressure stills for thermal cracking
- Agitators for sulfur removal
- Ethyl building for addition of tetraethyllead
- Better fractionation

Texaco Aviation

1911 Texaco became a pioneer in aviation fuel and aviation itself First coast to coast flight used Texaco lube

1911 Established aviation department and obtained first plane; "Spokane Sun God" 7,200-mile flight broke world mileage record on Texaco fuel/lube

1927 Texaco partnered with Lockheed Aircraft Company in Burbank to build "Texaco 5," which broke the transcontinental speed record straight from the factory

Texaco Aviation

Frank Hawks

- Frank Hawks, head of Texaco Aviation, dubbed "The fastest man alive"
- Numerous world speed records in Texaco planes on Texaco fuel/lube, many originating in Burbank

1920

- Gave Amelia Earhart her first flight

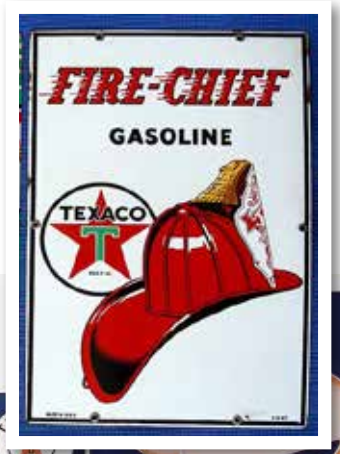
1931

- Texaco 13 "Mystery Ship" set hundreds of speed and distance records worldwide

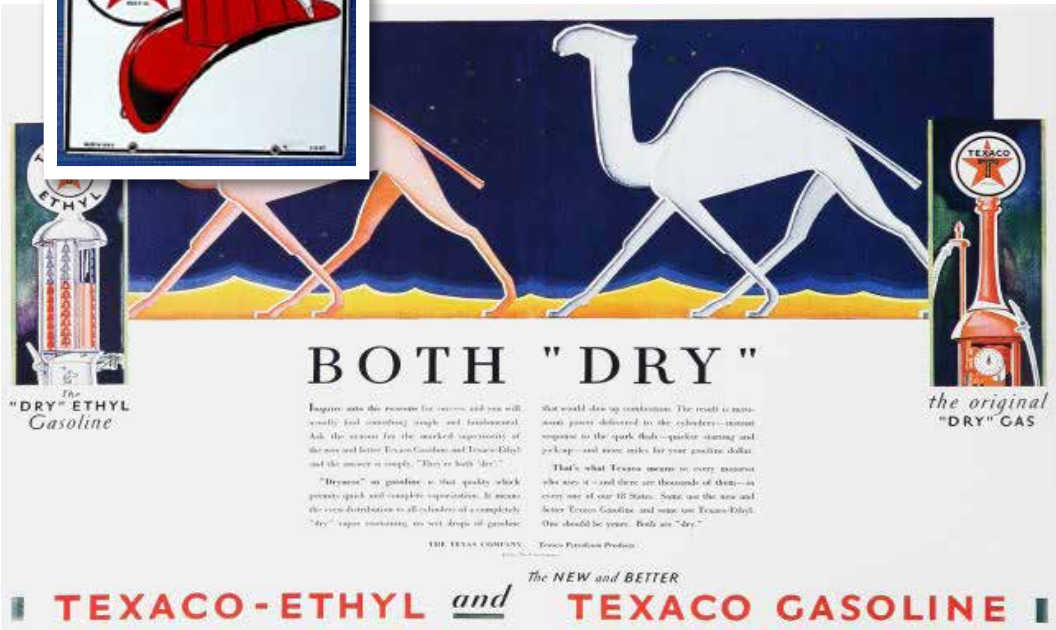
1932

- "Texaco 11" built by Northrop Aviation Corporation
- Sioux Nations honored Hawks, appointing him chief
- Plane and Texaco premium fuels branded as "Sky Chief"

Petroleum quality and engine performance

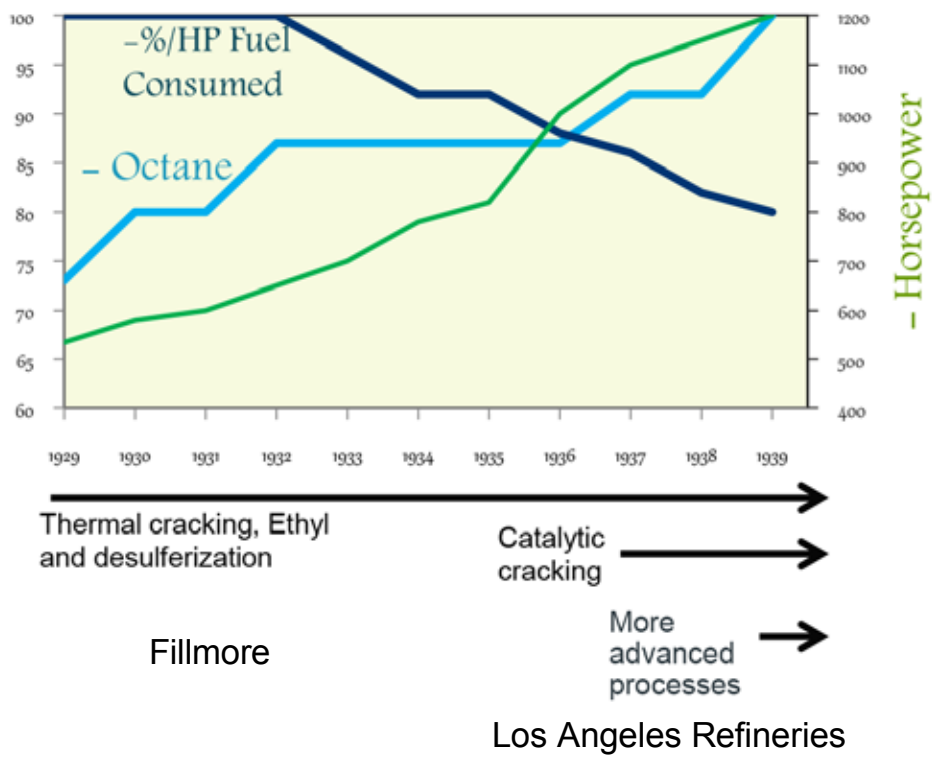


- Tighter refining controls produced fuels that volatilize completely, also known as a "dry" gas
- Better fractionation produced higher octane
- Tetraethyllead or Ethyl provided anti-knock and better engine lubrication
- Desulfurization increased Ethyl's octane boost
- Better octane supported higher compression and more power
- Dewaxed paraffin lube oils provided better lubricity, temperature performance, and less engine sludge



Petroleum quality and engine performance

- Ethyl (4 cc/gal) produced 87 octane on well-refined straight run and thermal cracked naphtha
- Catalytic crackers in Los Angeles refineries produced higher octane aromatics and branched hydrocarbons
- Alkylation produced iso-octane at Wilmington from cat cracker light feeds for very high octane in WWII
- Light alkenes promoted polymerization (propylene at Fillmore in 1942)



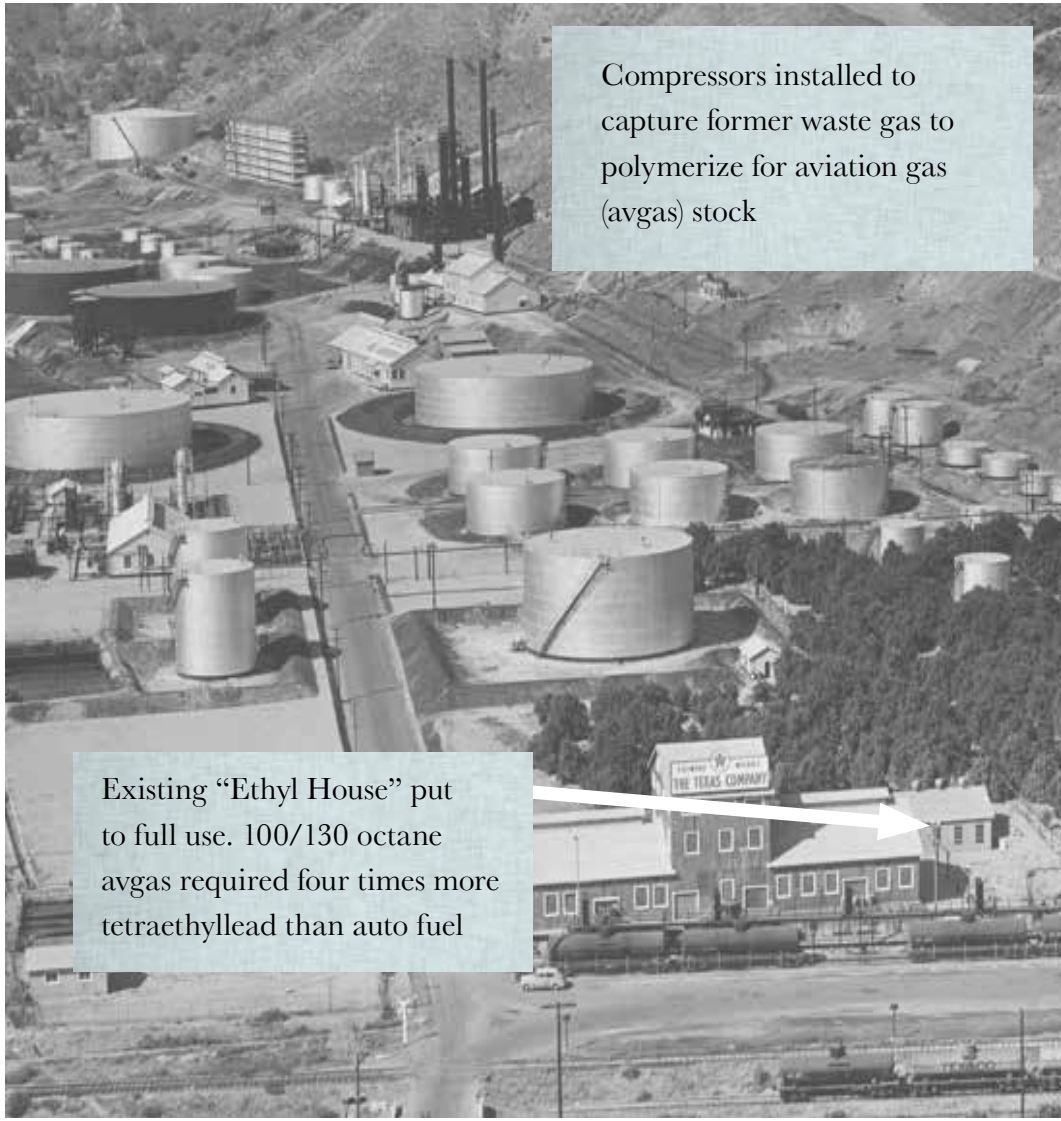
WWII Production and Advancements

WWII: War Department Exerts Control on Refining

- Office of Petroleum Coordination for War created
- Dec 2, 1942 "Petroleum Administration for War" by executive order
- Sharing of technology a complete reversal of Sherman Act anti-trust policies
- Rapid construction of alkylation, isomerization, and polymerization units to increase production and quality of aviation fuel

- Extensive blending of stocks between refineries and companies produced iso-octane at Wilmington from cat cracker light feeds for very high octane in WWII
- Commercial tankers and crews put to military use

WWII: Expansion of Fillmore

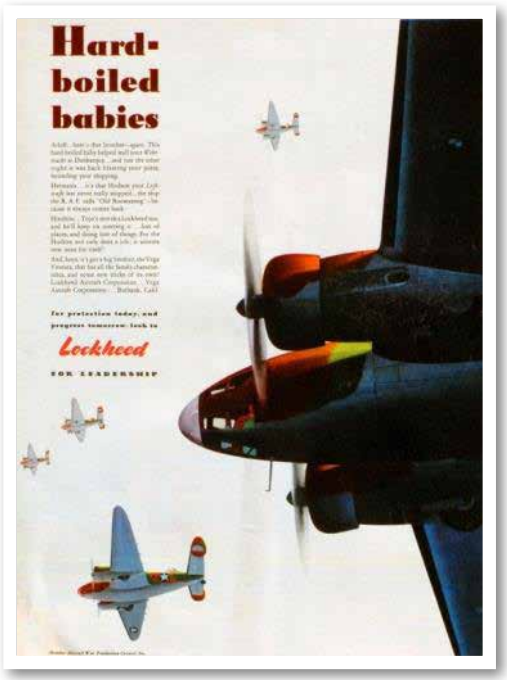


Tetraethyllead

- Synergistic with advanced products like alkylate to boost octane
- Not sufficient by itself
- 4 cc/gal concentration typically in 100/130 octane avgas
- 6-8 cc/gal in 115/145 octane avgas late in WWII
- 44:1 experimental mix. Maximum horsepower, but caused mechanical issues

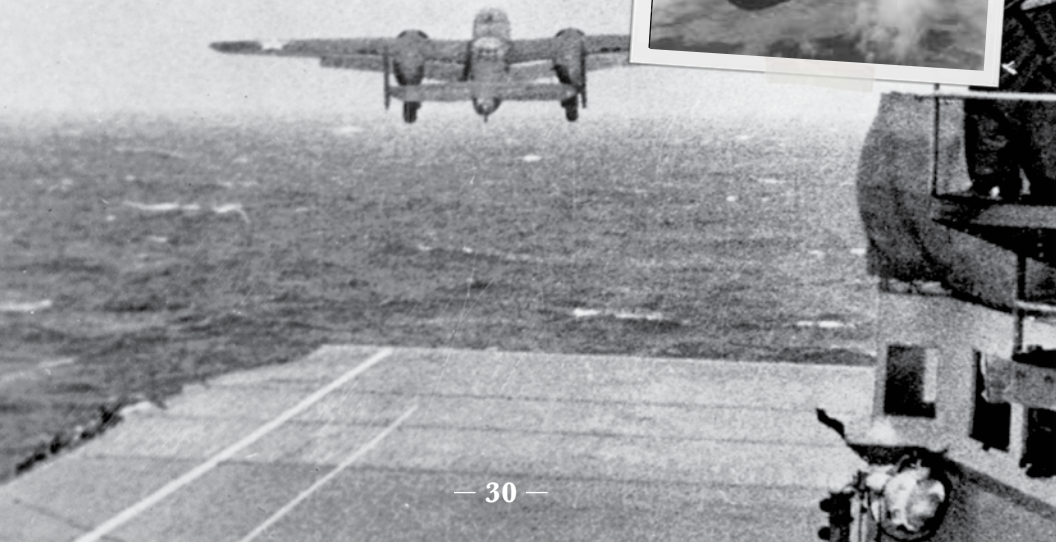
Texaco and WWII Aviation

- Historical relationship between Texaco Aviation and Lockheed Aircraft Company in Burbank
- Lockheed Skunk Works built planes for the war
- High heat/high compression of aircraft engines necessitated integration of design with petroleum producers
- Allison engines used in P-38s produce 2500 HP
- Texaco lubricants and fuels preferred



WWII Aviation Gas Critical to Allied Victory

- 1942: B-25 Doolittle raid on Tokyo. First ever bomber lift from a carrier deck, only possible with 100/130 avgas
- Axis powers limited to 92 octane
- Green 100/130 and Purple 115/145 (aka "Grape Juice") allowed higher, faster, farther flights carrying more payload
- America sourced all allied high octane fuel for US, Britain, Russia, and China
- Fillmore supported the Pacific Theater – the largest geographical conflict in human history – using copious amounts of fuel

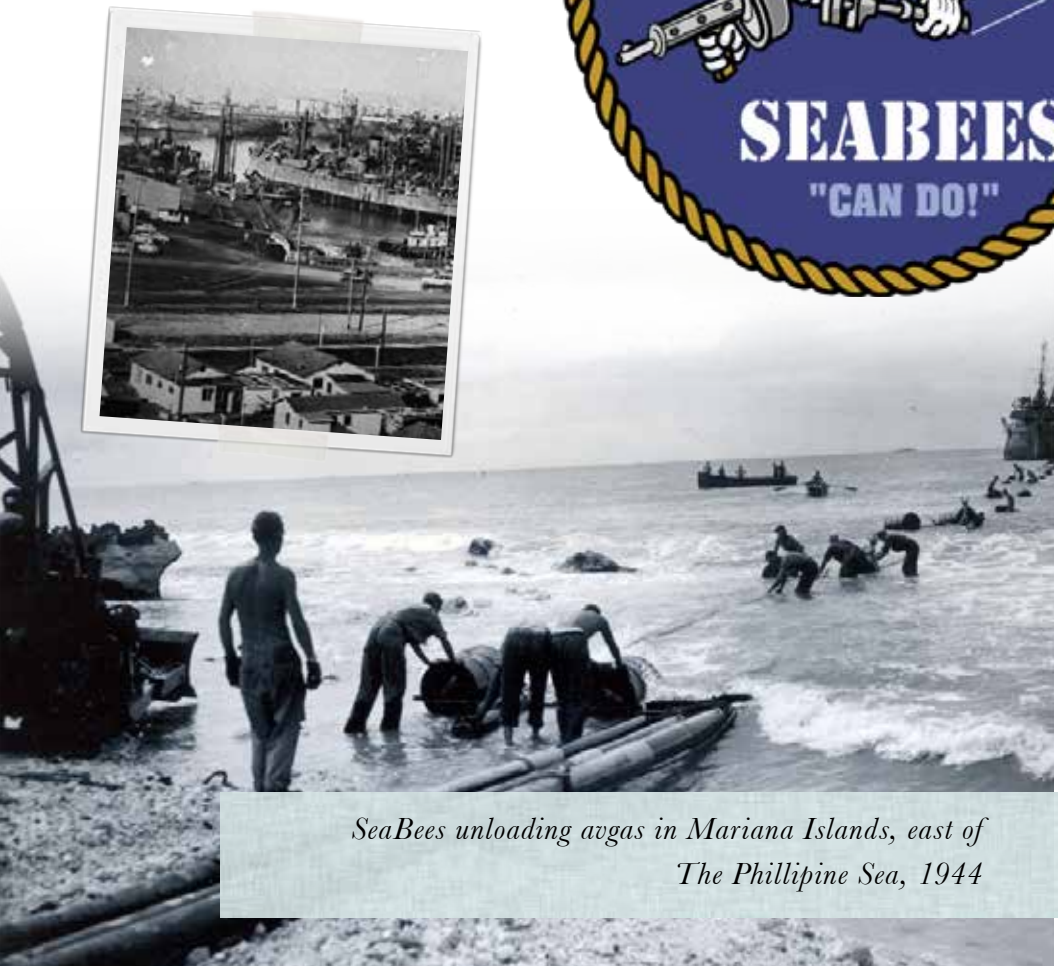


Higher, Faster, Farther (and more payload, too)

- High quality avgas was the deciding factor in air supremacy in both theaters
- Many Axis planes bested by Allied planes tested comparable after the war when run on US avgas
- Speeds capable of chasing the German V-2 rockets
- Extremely long range high payload bombing runs in the Pacific impossible without high octane avgas
- Avgas permitted bombers to fly above altitude of many Axis fighters
- Kamikaze: inferior pilot skill, air force becomes flying bombs

Fillmore Works, Port Hueneme, and the SeaBees

- Fillmore avgas directed to the US Navy at Port Hueneme (CA)
- Home of the SeaBees and "Can do!" spirit
- Tankers called oilers replenish carriers at sea or at makeshift avgas lines on island beaches

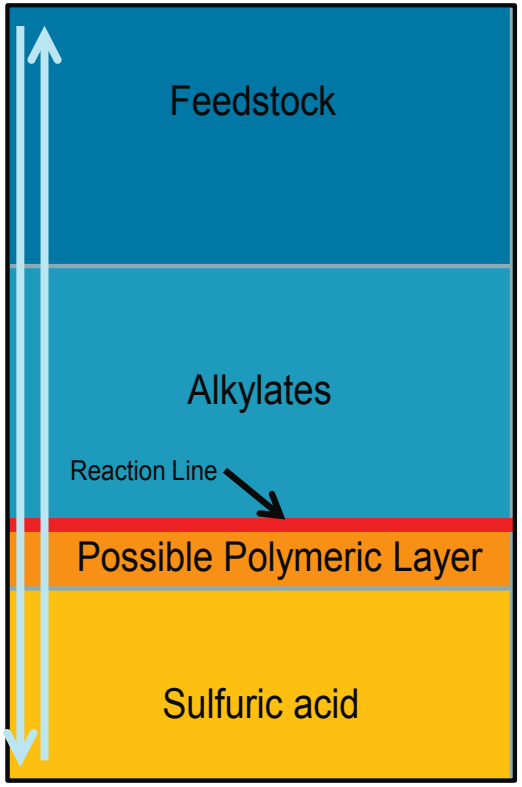


SeaBees unloading avgas in Mariana Islands, east of The Phillipine Sea, 1944

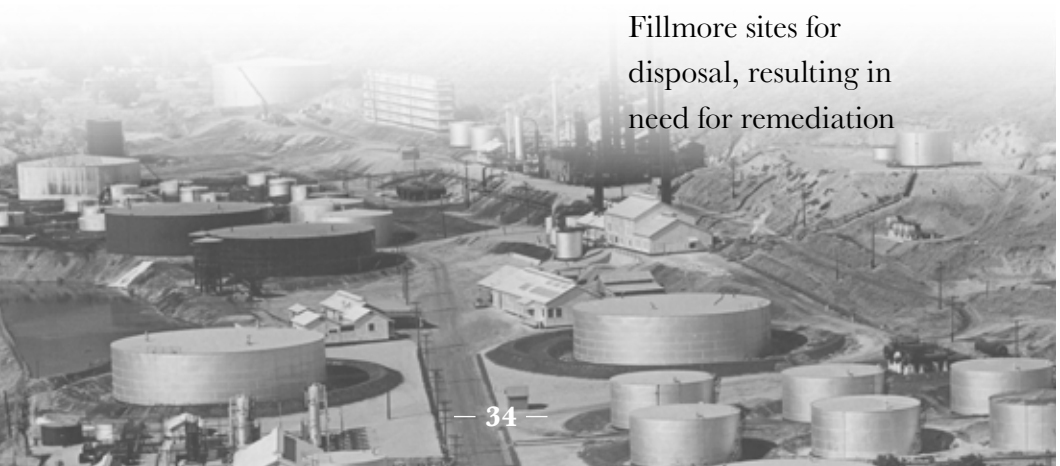
Critical Texaco WWII Innovations, Isobutane, and Safety

- Texaco fuel, lube, and rubber supported multiple critical industries
- Texaco advanced in petroleum-steel interactions promoted refining/shipping safety
- Texaco advanced increased availability of isobutane, critically needed for avgas alkylate

Alkylation



- Alkylation at Wilmington combined light feedstocks to create high octane fuel from otherwise wasted gas
- Used sulfuric acid catalysts
- WWII alkylation processes subject to "runaway" reactions causing emulsions
- High waste creation
- Gaining experience on new operations
- Exigency of war did not permit proper waste management
- Waste from Wilmington transported to McColl Fullerton and Texaco Fillmore sites for disposal, resulting in need for remediation



Winding Down and Land Revitalization

Winding Down

- First jets from Lockheed Aviation Company used avgas (P2V Neptune from carrier USS Roosevelt)
- Switched to jet fuel and WWII ending drastically reduced need for avgas
- Market switches to consumer fuel for commercial aircraft
- Following WWII, Texaco Fillmore Works hired war veterans returning to Fillmore to work at the refinery
- More sophisticated refineries in Los Angeles with better access to oil and markets made refining impracticable at Fillmore
- Fillmore refining ceased in 1950
- Refinery dismantled by 1951
- Converted to crude oil storage and transfer station - Pacific Coast Pipeline
- Operated through 2002; last tank removed in 2004

Land Revitalization

- WWII and refinery operations waste removed from on-site pits and soil remediated
- Tetraethyllead became inorganic lead in soil and was remediated
- Fuel releases to groundwater undergoing remediation
- Land revitalization for future beneficial uses

Rendering of future Fillmore Works site

Glossary

Alkanes – Also known as paraffins, are saturated hydrocarbons composed only of carbon and hydrogen in single bonds, with no cyclical molecular structures.

Alkenes – Hydrocarbons with at least one set of double-bonded carbon atoms.

Alkylates – Products of the alkylation process in which a short alkene is combined with a short-branched alkane, generally producing high octane compounds in the carbon (C) range, C5 to C12.

Alkylation – A refining process in which light alkenes (primarily propylene and butane) are combined with primarily isobutene, a C4 branched alkane, to produce alkylate.

Catalytic or "cat" cracker – a vessel in which long-chain, heavy hydrocarbons are split into shorter-chain, lighter hydrocarbons in the presence of a catalyst typically for the purpose of increasing the gasoline range composition of refinery feed stock. This process has become the heart of modern refining.

Emulsion – A liquid resulting from the coupling of water and oil fractions by compounds that contain functional groups that bond to both water and oil. Emulsions are observed during hand washing of a greasy pan with dish soap.

Fractionation – In refining, the process of separating mixed fluids, such as light hydrocarbons from heavy ones, or alkanes from alkenes.

Isomerization – A process used to produce gasoline blending stock by combining light alkane gases, such as propane (C3) and butane (C4) to produce branched, higher octane paraffins.

Isobutene – A C4 hydrocarbon (otherwise known as 2-methyl propene) composed of a CH2 group double-bonded to and replacing hydrogens of the central carbon of a propane (C3) molecule. Isobutene is a critical feed stock for alkylation.

Iso-octane – A C8 highly-branched hydrocarbon (otherwise known as 2,2,4-trimethyl pentane). Iso-octane is the defined standard chemical for 100 octane anti-knock performance and is the typically desired product of alkylation.

Light feeds – Typically C2 to C5 hydrocarbons.

Polymeric layer – A fluid layer in a catalytic reactor in which light feed stocks are combining to become heavier (typically gasoline range) hydrocarbons.

Polymerization – In petroleum refining, the process by which the double bond of an alkene is cleaved and linked to the carbon of another alkene. Two of the same alkenes are linked to form a "dimer," three form a "trimer," and four produce a "tetramer." This process increased higher octane fuel production from feed stocks that would have been waste prior to WWII.

Pressure stills – A still used for distillation of hydrocarbons under pressure.

Propylene – A C3 hydrocarbon with one double-bonded set of carbons.

Tetraethyllead – A lead (Pb) atom bonded to four ethyl molecules originally manufactured by the Ethyl Corporation used to promote anti-knock characteristics of gasoline.

Thermal cracking – A simple, heat-based cracking method dominant in the early 20th Century before the advent of catalytic cracking.

Straight run – The products of simple distillation of crude without cracking.

BCA BARNETT COX & ASSOCIATES