Baytown Humble Refinery's Contribution to World War II:

The Development and Production of 100-Octane Aviation Fuel and Toluene and Its Impact on Allied Victory

Donna Brewer
Lee College

Baytown, located on the Texas Gulf Coast 19 miles southeast of Houston, is the site of one of the largest petrochemical complexes on earth, most of which is now owned by Exxon, formerly Humble Oil and Refining Company. Humble's contribution to twentieth century refining technologies and to Allied victory in World War II are broad and far reaching. Many of its contributions were given freely to the entire petrochemical industry with no compensation for their invention and development, due to the fact that they were created during World War II, under the direction of the United States Petroleum Administration for War.[1]

Humble's Baytown refinery's most outstanding achievements lay in its unparalleled production of both toluene (TNT's main ingredient) and 100-octane aviation fuel. According to the *History of Humble Oil & Refining Company*, the Baytown refinery "produced half of the nation's toluene used in making trinitrotoluene (TNT), the chief explosive used during the war."[2] Both products were absolutely vital for Allied victory in World War II. Humble researcher and inventor Herbert H. (Herb) Meier, indispensable in the development and production of both toluene and 100-octane fuel, wrote in an unpublished document that "[t]he TNT in approximately two-

thirds of the bombs dropped, shells fired and torpedoes launched by the U.S. Military in World War II was manufactured from Baytown Ordnance Works toluene."[3]

However, Baytown's history had more than one "Humble" beginning. Prior to the discovery of the Goose Creek oil field in 1908,[4] the vicinity of Baytown was sparsely populated. In the early 1800s, immigrants from the United States began settling in Mexico's Coahuila-Texas coastal territory between the San Jacinto River and Cedar Bayou. The Anglos lived there in happy obscurity, with free reign to develop the land on which they settled, although grants were slow in coming since Mexico had a law prohibiting dispensing land to immigrants within 26 miles of the coast.[5] There were few exceptions to this rule.

The anonymity and autonomy of the Anglo settlers was relatively short lived, since events soon turned to Mexico's independence from Spain and Texas' subsequent independence from Mexico. The Battle of San Jacinto was fought not five miles from Baytown's current location and the monument to that battle looms large on the city's horizon.

Settled in the latter half of the 19th century by such notables as David Burnet and Sam Houston, the area surrounding current Baytown was well suited for rice growing.[6] Farms, as well as bay homes for Houston residents, began to spring up along the many bays and inlets all along Baytown's coastline. Its most marketable natural resource was the thick clay that lay just inches under the sandy soil. This was ideal for brick-making which was indeed the first true industry in the vicinity.[7]

However, it was the discovery of the Goose Creek oil geyser in 1908 that defined Baytown's *raison d'etre.* The small farming community's existence came to an abrupt end as Goose Creek in ten short years was catapulted to the forefront of the Petroleum Age.[8]

Soon after the Goose Creek oil field was proven, Robert Lee Blaffer and William Stamps Farish acquired portions of it. These two men were "founders, original directors, and future presidents of Humble Oil and Refining Company."[9]

By 1919, Humble began plans for a refinery to be constructed at the Goose Creek oil field site. Two years later in 1921, the company commemorated the refinery's opening on San Jacinto Day, April 21, honoring both their achievement and those of the men who helped win Texas' independence at the Battle of San Jacinto in 1836. Humble's top management shunned the "meaningless" name Goose Creek and came up with the less colorful name of Baytown for the refinery.[10] Years later, when the city

Humble's Baytown refinery's most outstanding achievements lay in its unparalleled production of both toluene (TNT's main ingredient) and 100-octane aviation fuel.... the Baytown refinery "produced half of the nation's toluene used in making trinitrotoluene (TNT), the chief explosive used during the war."

incorporated in 1948, the newly formed city council chose the name Baytown from among those of the bitterly merged communities of Goose Creek, Baytown, and Pelly.[11]

By the 1930s, the Baytown refinery developed into one of the largest on earth, replete with the latest catalytic cracking technologies for distillation and separation of crudes—truly on the cutting edge of the oil industry.[12]

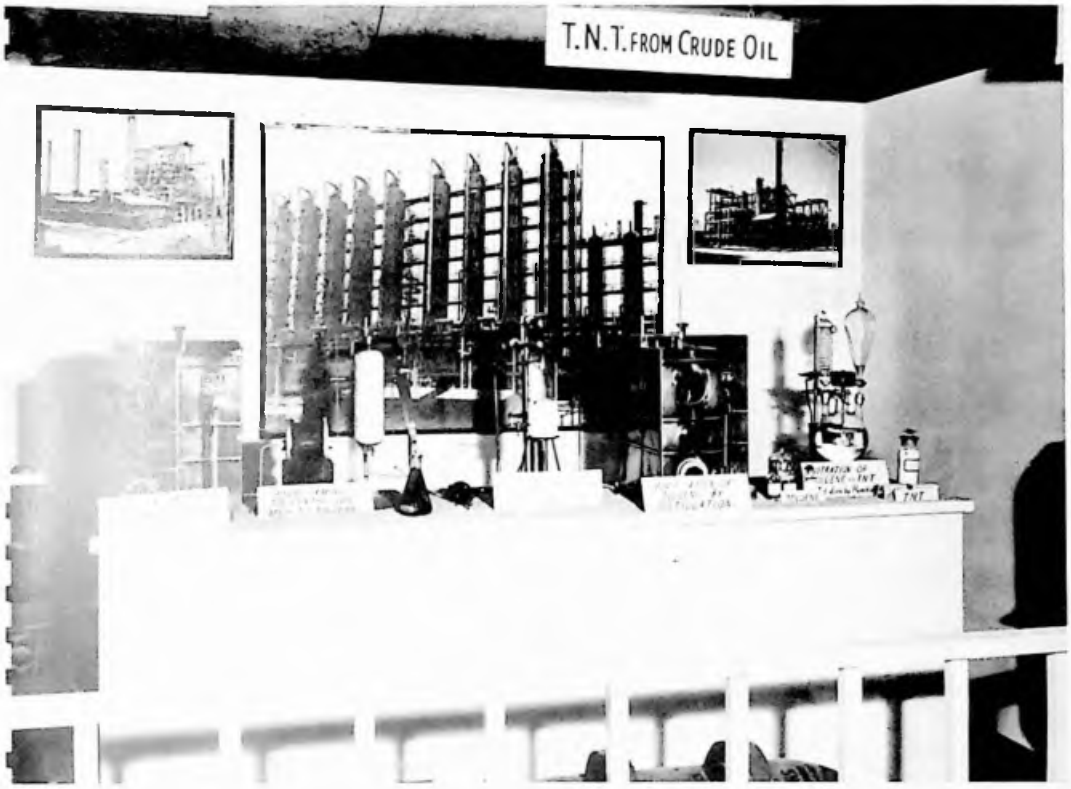
The needs of the auto industry largely dictated the petroleum industry's entire focus on improving refinement of crude oils. Research in both sectors targeted development of fuels to enhance the technology of high compression automobile engines which required slower burning gasolines to operate efficiently and to avoid engine "knock."[13]

Among the foremost researchers in this area were Charles F. Kettering and his research assistant, Thomas Midgley, Jr., both of whom worked in the research laboratories of General Motors in the 1920s. It was Midgley who initially noted the relationship of slow burning fuel to reduced engine knock. His intensive research brought about the development of tetraethyl lead as an antiknocking additive to gasoline, as well as the currently used octane rating of 0 to 100.[14] In the 1920s, Midgley discovered that there was a vast difference in hydrocarbons—the base ingredient of gasoline—and how efficiently they burned in the engine cylinders. The hydrocarbon that burned the fastest was "normal heptane," and was the worst for engine knock. On a scale of 0 to 100, normal heptane was thus assigned an octane rating of 0. The hydrocarbon that burned the slowest and smoothest was isooctane, or what is known as 100 octane fuel. It enhanced an engine's functioning dramatically, adding up to 50% more mileage to the gallon and adding greater maneuverability and speed to the vehicle using it. A small portion of tetraethyl lead added to an already high octane gasoline could raise its octane number to 100.[15]

This discovery spawned a joint venture between General Motors and Standard Oil of New Jersey who together in a 50/50 partnership formed the Ethyl Corporation in August of 1924. The Ethyl Corporation did much toward researching various ways to produce isooctane, or 100 octane gasoline. The most widely used method—although expensive—was through a complex process of refining crude oils to obtain isobutylene, merging these molecules to form diisolbutylene and hydrogenating them to create isooctane. It was this crucial development of 100 octane fuel that played a major part in Allied victory during World War II.[16]

The bulk of moneys spent during the war to upgrade refineries and their processes ($867,000,000 out of $917,000,000) "went for facilities needed for the production of 100-octane aviation gasoline."[17]

Soon after the bombing of Pearl Harbor on December 7, 1941, the United States government established the Petroleum Administration for War (P.A.W.), under whose direction the petrochemical industry pooled resources, research, and technology for the greater benefit of ultimate Allied victory in World War II. One of the major thrusts of the P.A.W. was their 100-octane program. According to the United States government publication *A History of the Petroleum Administration for War*, "The spectacular section of the wartime refining program was 100-octane aviation gasoline, the superfuel that meant more speed, more



A model, intended to demonstrate the importance of Baytown's Humble Refinery to the war effort, shows how T.N.T. is produced from crude oil.

PHOTO COURTESY BAYTOWN HISTORICAL MUSEUM

power, quicker take-off, longer range, greater maneuverability—all of the things that meant the victory margin in combat.[18]

It was to this program that Baytown contributed most significantly and dramatically, through their unsurpassed development and production of toluene and 100-octane aviation gasoline.

Baytown's achievements are cited in *History of Humble Oil & Refining Company*, "The Baytown refinery, as already noted, produced and delivered more 100-octane aviation gasoline than any other refinery in the world . . . On December 14, 1944, the refinery celebrated the production of its billionth gallon of 100-octane gasoline; it was the first refinery in the world to make this record and one of three to do so during the war."[19]

Baytown also produced 50% of the toluene (TNT's main ingredient) used by all of the Allied nations during World War II, and at one point early in the war's onset, it was producing 75% of all Allied toluene needs.[20]

How Humble's Baytown refinery accomplished this is perhaps best told by those who worked there at the time. Among them was Hampton G. Corneil, a graduate of the University of Oklahoma with a B.S. in Chemical Engineering. He worked in Humble's Research and Development Department starting from 1936 to 1948, and during the greater part of World War II, worked with the

Petroleum Administration for War on the Aviation Gasoline Advisory Committee.[21]

According to Corneil, the initial breakthrough for commercial production of 100-octane aviation fuel came through a little known meeting that took place in the autumn of 1938 between Sam Adey of the Anglo-Iranian Oil Company's London laboratories and several of the Baytown refinery's top personnel—among them Herb Meier, Head of the New Projects Group, Refinery Manager Gordon Farned, and Arthur Draeger, Head of Research and Development. Adey had been the refinery manager for Anglo-Iranian Company's plant in Abadan, Iran, and at the time of the meeting was working in Research and Development in the company's London laboratories.[22]

Adey knew that the method of cold acid dimerization, used by a few refineries on the cutting edge of the industry, could with a very minimal modification, be used to produce isooctane much more simply through the Anglo Iranian Company's newly discovered method of refining called alkylation. The London laboratories had measured success using this process to produce isooctane and published their results in a British trade journal May of 1938,[23] hoping to spark the interest of Shell or Standard Oil of New Jersey, who also had cold acid dimerization facilities.

These companies paid little heed to the Anglo-Iranian Company's discovery. So in a desperate bid to find some company who would try to manufacture alkylation isoocatine on a commercial level, Adey came to the Baytown refinery unannounced, with all of the equipment necessary to produce a batch of isooctane using the method of aklylation, hoping to convince a refinery with the necessary facilities to give it a try. The Anglo-Iranian refinery in Abadan did not have a cold acid dimerization plant, and England was in dire need of 100-octane gasoline quickly. There was not enough time to construct a refinery in Abadan before Britain might fall under Germany's dominion. Time was of the essence.[24]

In the autumn of 1938, Adey garnered a meeting with the aforementioned top staff at Humble's Baytown refinery, with impressive results. Adey, described by Corneil as "a very deliberate, calm, and collected man," brought all the data to the Baytown refinery in order to show that this formula would do what he said it would do. The Anglo-Iranian Company could make isooctane in their laboratories in London—but they did not have any facilities that could readily be converted into an alkylation plant to produce isooctane in commercial amounts. Once he showed Humble's research and management staff what could be done through the newly discovered aklylation process, things began to move very quickly. Within 48 hours, Humble's Research and Development Laboratories on San Jacinto Drive repeated the process with excellent findings. The staff could hardly contain their excitement. The Anglo-Iranian Company's process clearly unclogged the bottleneck of expensive isooctane production. The Baytown Refinery held in its hands the means to rapid commercial production of a vitally needed wartime commodity. Within three months, the Baytown technical crews and laborers, guided by the research staff, converted the cold acid dimerization facility to the Anglo-Iranian Company's method of aklylation. Unaware that he was a part of history in the making, a young technical

assistant named Ovide Webber oiled the compressors on the earliest operable aklylation plant on earth and thus produced the first gallon of 100-octane aviation fuel ever made by this process. Baytown was the first refinery worldwide to commercially implement alkylation, now an industy standard.[25]

Ironically, Humble's parent company, Standard Oil of New Jersey, initially insisted the Anglo-Iranian alkylation process was not viable, even after the Baytown refinery reported to them news of the success. Finally, after two consecutive weeks of consistent results, Standard Oil consented to examine Baytown's breakthrough and concurred that in fact, their research labs had been wrong and the process was indeed a triumph.[26]

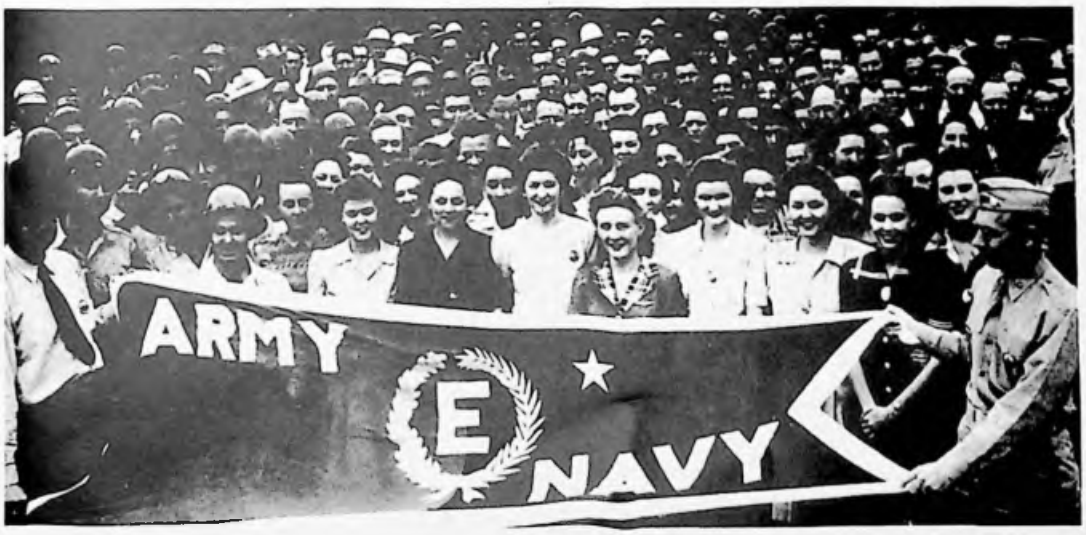
Herb Meier, a brilliant researcher and one of Humble's most innovative men in terms of improving refining processes, pondered on the puzzling reasons two major corporations failed to realize the value and feasibility of the Anglo-Iranian Company's alkylation process. Meier came to the following conclusion:

> With respect to Standard Oil Development and Shell, I believe that psychology enters into the picture; I strongly suspect that subconsciously, neither one of them really wanted the Anglo-Persian process to work. In pursuing this point, I will talk only about Standard Oil Development's course of action, because being "related" to them, we knew a good deal more about how they operated than we did about Shell. Why,

For continued excellence in operations, Baytown Ordnance Works employees were awarded a star for their Army-Navy "E" flag in the Spring of 1943.

PHOTO COURTESY BAYTOWN HISTORICAL MUSEUM

Ordnance Employees Given Star Award for "E" Flag



deep down in the subconscious, would Standard Oil Development not want the process to work? I think it was because of their tremendous urge, along with that of most of petroleum research organizations, to develop a direct isobutane-olefin process of their own, and their prior extensive work on this, involving the use of a large variety of exotic catalysts, that they just couldn't bring themselves to the point of accepting that a plain old garden-variety catalyst such as sulfuric acid could do the job. They were like the ostrich who is said to bury his head in the sand on the assumption that if he couldn't see his enemy, his enemy couldn't see him; if they maintained a firm belief that the Anglo-Persian process didn't work, it wouldn't and they would be afforded time to develop a process of their own.[27]

While this assessment may seem rather cynical, other persons besides Herb Meier held this view through their personal experiences in dealing with the Research and Development of Standard Oil. In the early fifties, Humble employee Bob Love of the Baytown Refinery's Research and Development department, shared a new angle on the refining process known as hydroforming at a joint meeting with parent company Standard Oil. Standard Oil ignored Love's more efficient and economical process in favor of their own more expensive but patentable fluid hydroforming process. With full knowledge of the effectiveness and economy of the Humble process, Standard Oil disregarded it and constructed a costly fluid hydroforming facility in Whiting, Indiana. It was only after the fluid hydroforming plant exploded that Standard Oil ceased construction of an identical plant in Baton Rouge, and acquiesced to using the Humble Baytown Refinery's less volatile and more economical process. Humble received no monetary remuneration for this process—called fixed bed platinum hydroforming—but it, also, is industry standard worldwide today.[28]

On December 14, 1944, the Humble Baytown Refinery celebrated Billion Gallon Day commemorating its production of 1,000,000,000 gallons of 100-octane aviation fuel. It was the first refinery in the world to achieve this.

Humble Baytown Refinery's improvements and discoveries in setting the standard for refining processes were remarkable, considering the size of the corporation in relation to its giant competitors. Head of New Projects Herb Meier proved his genius time and again, finding remarkable yet simple methods of slightly altering some process to get phenomenal results. He substantially improved the alkylation process first offered by the Anglo-Iranian Company by changing their recommended 2:1

In 1945, representatives of the armed services explain to refinery workers the importance of Humble's continuing contribution to the campaign to defeat the Axis.

PHOTO COURTESY BAYTOWN HISTORICAL MUSEUM

ratio of isobutane to butylene to 11:1. He reasoned that "by so doing, one greatly magnifies the opportunity for a butylene molecule to react with an isobutane molecule and vastly diminishes its opportunity to meet up with another butylene molecule before the desired combination with the isobutane molecule has taken place."[29]

As a result of this and other improvements, refineries all over the nation and world emulated the Baytown refinery's alkylation plant. In the early forties, the United States Petroleum Administration for War directed Humble researcher Hampton G. Corneil to travel to refineries throughout America and work with them in modifying whatever processes they had available to that of alkylation plants similar to the converted cold acid dimer plant in Baytown.[30] The Baytown refinery had already constructed second and third plants, specifically designed for alkylation in 1938 and 1939.[31]

During the war, Corneil also traveled to Abadan, Iran to help build an alkylation facility there. Russia received the 100-octane fuel produced in Iran and used it in American planes to bomb Germany. Corneil asserts that this was a major reason Germany succumbed to Russia on the Eastern front.[32]

Another major breakthrough in Baytown's refining technology greatly aided the Allied effort: Herb Meier and his research staff developed a means of distilling toluene from petroleum. Prior to Meier's discovery, toluene could only be derived from coal tar through a rather lengthy and costly process. This radically limited the supply of toluene available. Toluene, the key ingredient in trinitrotoluene (TNT), was the main explosive used in World War II. Through Meier's method, the Baytown refinery was ultimately able to produce half of the toluene used by the Allied forces during

the war.

Co-researcher Bob Love told in detail how Meier achieved this:

> Through a hydroforming process, the Humble research laboratory made toluene, but at only 20 or 30 percent. Meier figured out how to get toluene out of the hydroformate in 99 to 100 percent purity. It was a logical process. Humble had purchased a liquid SO_2 plant from Germany back in the mid thirties. It was used for making kerosene. In order for kerosene to burn smokelessly, the aromatics—such as toluene and xylene—had to be removed. Meier deduced that if liquid SO_2 could extract these things out of kerosene, it could also extract them out of hydroformate, hence the process called hydroforming: you take naphtha fractions containing some toluene and through a dehydrogenation process purify it. When methyl cyclohexane has the hydrogen removed from it, it forms toluene.[33]

As a result of Meier's laboratory research, the United States Army Ordnance Department awarded Humble Oil and Refining Company a contract to build an ordnance works for the production of toluene. On October 12 of 1940, Humble's Baytown refinery signed the contract with the U.S. Ordnance Department. One year and one week later, the Baytown refinery completed the Ordnance Works and delivered its first shipment of toluene by October 23 of 1941, two months before the bombing of Pearl Harbor. Herb Meier and Art Draeger, both brilliant researchers, made innovative contributions toward the more efficient operation of the toluene manufacturing facility. They removed manufacturing bottlenecks and made such vast improvements that ultimately the Baytown Ordnance Works produced at 200% more than its originally designed capacity. By the end of the war, about two-thirds of all the explosives used by the Allied Forces came from toluene manufactured at the Baytown Ordnance Works. Because of its strategic importance to the war, the United States Army built three barracks around the facility to house troops and had anti-aircraft guns mounted around its perimeters.[34]

Herb Meier's consistent track record in such crucial areas as the Ordnance works and aviation fuel production garnered him the epithet from one of his coworkers as "the man singly most responsible for the winning of World War II." Considering how instrumental he was in facilitating and improving production—both in quality and volume—of such critical items, there may be more truth to the statement than many realize.[35]

From 1939 to 1940, all of the high performance military aircraft tested flew on 100-octane fuel made at the Baytown refinery. Baytown's successful implementation of the Anglo-Iranian Company's alkylation process factored greatly in determining whether or not the United States and Royal Airforces would manufacture as a main strategic item high performance aircraft requiring 100-octane fuel. While these aircraft would possess far greater maneuverability, speed, and distance range, if there were no 100-octane gas to fuel them, they

would be useless.[36]

The United States armed forces decided to manufacture planes with high performance engines requiring 100-octane aviation fuel based in part on the advice of famed aviator James Doolittle (who later led the daring air raid on Tokyo in April, 1942). The Royal Air Force of Great Britain also decided to manufacture Spitfire aircraft with high performance engines due to the availability of 100-octane fuel initially made possible through the Baytown refinery. Herb Meier wrote in a letter to associate Dr. Robert Jordan, "Because of the Baytown development mentioned, our principals were in a position to assure the British Air Ministry that ample quantities of 100-octane fuel would be available from the company's Aruba, Baytown, and Baton Route refineries within a year's time. The Air Ministry then set its course on the basis of that projected availability."[37]

After 1941, once the United States entered the European theater of the war, the air supremacy that Hitler previously enjoyed was abruptly shattered. Based out of England, American and Royal Air Force high performance planes, with engines burning the 100-octane "superfuel," flew bombing expeditions 50% farther than the Luftwaffe, penetrating deep into German airspace and destroying strategic manufacturing targets.[38] Hitler's Luftwaffe ran on 70-octane fuel and, hence, simply could not compete in terms of aerial exploits.[39]

Toward the war's end, Germany began flying prototype jet planes in a desperate bid to regain some semblance of air dominion. While these jet fighters flew 150 to 200 mph faster than anything the Allies had, their range was limited to brief 35 to 40 minute flights, and the engines had to be replaced after only three or four missions. Not quite ready to be taken off the drawing board, these jets were manufactured anyway to enable Germany to continue its fight against the Allies, but it was too late. Too much had already been lost to the Allied forces.[40]

On December 14, 1944, the Humble Baytown Refinery celebrated Billion Gallon Day commemorating its production of 1,000,000,000 gallons of 100-octane aviation fuel. It was the first refinery in the world to achieve this. Two other Humble refineries, one located in San Antonio and the other at Ingleside, Texas, produced a billion gallons of 91-octane fuel.[41]

Humble bequeathed a medal commemorating the event to every employee. At three o'clock on that fine autumn day, over 6,000 people gathered in a huge celebration outside the refinery's main building. During the next three days, over 50,000 people visited the exhibits in pavilions set up on the refinery grounds. The War Production Board in Washington, D.C., sent a representative to the event, offering a flag flown from the nation's capitol the day before as a gift to Humble Oil and Refining Company. Major General Hubert R. Harmon addressed the employees in a "stirring" speech, and part of the event was broadcast via radio statewide.[42]

On October 31, 1944, Humble President Harry C. Wiess received the following letter from Commanding General of the United States Army Air Forces H. H. Arnold:

> Dear Mr. Weiss:
>
> The Occasion of your delivery of the billionth gallon of 100-octane gasoline provides the Army Air Forces a splen-

did opportunity to extend to you and all the employees of the Humble Oil and Refining Company our deepest commendation. This outstanding contribution to our global war effort has been a major factor in our struggle toward achieving the supremacy which our airmen now maintain in every theater of combat operations.

The commemorative medallions which you are distributing to those who shared in this superb productive effort will, in the days to come, be a source of justifiable pride to all recipients.

Without the continuing, all-out backing of the petroleum industry, the tremendous war machine which the citizens of this nation have created would have been impotent.

The Army Air Force salutes the Humble Oil & Refining Company for its efforts to "Keep 'em flying."[43]

Prior to the writing of this paper, no single document or documentation existed chronicling in detail the story of Baytown's contribution to the Allied efforts during World War II, with the possible exception of a single lengthy letter written by Herb Meier to Dr. Robert C. Jordan.[44] Statements in passing alluding to the Baytown refinery were made in such books as Larson and Porter's *History of Humble Oil & Refining Company* and in the United States government document *A History of the Petroleum Administration for War.* In the latter, vague commemorations were made to anonymous refineries for certain unspecified achievements.

"Some companies had proceeded (with the development of specialized refinery equipment) on faith, and were already building expansions to existing facilities, contracts or no contracts."[45] This quote, in fact, likely refers to the Humble Oil and Refining Company in relation to the Baytown Ordnance Works, as can be seen by the quote below from *History of Humble Oil & Refining Company*:

> So anxious was Humble to get this vital defense material into production that its subcontractors were ordered to start work early in October of 1940, before all details had been settled and the contract finally signed.[46]

This paper is an effort to dispel the anonymity of the accomplishments of this refinery and some of the individuals who contributed significantly toward its achievements. Certainly these deeds are historically noteworthy. Many of the individuals who contributed to these exploits are now dead. After twenty years, all of them will be. The interviews recorded herein are all that remain of the historic accomplishment of a small southern refining town. Baytown Exxon archives currently are in disarray; little effort has been given to preserving the works of its predecessor, the Humble Company. It is equally unlikely that any other oil company will step forward to publicize how they benefited from the sharing of Humble's technologies under the Petroleum Administration for War. Yet in all likelihood, the contributions made by Humble in Baytown factored heavily toward ultimate Allied victory

in World War II. While it is entirely possible these events and facts will never be recorded in any history book, at least they are written here.

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[5]Margaret Swett Henson, *The History of Baytown* (Baytown: Bay Heritage Society, 1986), 10.

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[7]Ibid., 62.

[8]Ibid., 79.

[9]Larson and Porter, *History of Humble Oil and Refining*, 23.

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[13]Hampton G. Corneil, Engineer at Humble Oil and Refining's Research and Development Laboratory from 1936 to 1948. Advisory Board member to the Petroleum Administration for War 100-Octane Aviation Fuel Committee. Telephone interviews by author Dec. 3 and 6, 1993. (913) 381-9090. (Typed notes of interviews in possession of author.) [corroboration in Alfred P. Sloan, *My Years with General Motors*, eds. McDonald and Stevens, (Garden City, New York: Doubleday and Co.) 222]

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[15]Corneil, 2nd telephone interview by author, Dec. 6, 1993.

[16]Ibid. [corroboration Sloan, *My Years with General Motors*]

[17]United States Government, *A History of the Petroleum Administration for War*, eds. John W. Frey and H. Chandler Ide (Washington: United States Government Printing Office, 1946), 193.

[18]Ibid., 193.

[19]Larson and Porter, *History of Humble Oil and Refining*, 595.

[20]Bob Love, B.S. in Chemical Engineering, Rice University, research chemical engineer. Began work in Humble's Research and Development in 1941. Head of Baytown Chemical laboratory 1968-71. Environmental Coordinator, Baytown Chemical Plant 1971-77. Telephone interview by author Dec. 13, 1993. 404 Burnet, Baytown, Texas (713) 424-4810. (Typed notes of interview in possession of author) [corroboration: Larson and Porter, *History of Humble Oil and Refining*, 597]

[21]Corneil, telephone interview by author, Dec. 3, 1993.

[22]Ibid.

[23]*Journal of the Institution of Petroleum Technology*, May 1938, Vol. 24 (London), 303-320.

[24]Corneil, telephone interview by author, Dec. 3, 1993.

[25]Ibid.

[26]Meier to Jordan, Oct. 10, 1977, 11

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[28]Love, telephone interview by author, Dec. 13, 1993.

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[30]Corenil, telephone interview by author, Dec. 6, 1993. [corroboration: *History of Petroleum Administration for War*, 200]

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[32]Corneil, telephone interview by author, Dec. 3, 1993.

[33]Love, telephone interview by author, Dec. 13, 1993.

[34]John Henderson, Humble Oil and Refining employee, Administration and Accounting, telephone interview by author, Dec. 14, 1993. (Typed notes of interview in possession of author) [corroboration: Henson, *History of Baytown*, 124]

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