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DEVELOPMENT OF THE OIL INDUSTRY IN THE USA IN THE 20th CENTURY (PART II)*

The article looks into the history of the oil and gas industry which has been dynamically developing today. Oil and natural gas as well as their processing products have a very long history of use by mankind though the history of the world oil industry counts as few as about 150 years and the gas industry is less than 100 years old. The authors intend to produce a series of articles covering the history of the world oil industry, aimed at understanding the "anatomy of success" which is much needed for the domestic industry. This series of articles begins the exploration of the USA oil industry development. The first part of the work deals with a period from the inception of the US oil industry to the late 19th century whereas the second part covers the 20th century.

Keywords: oil; natural gas; oil and gas industry; geologic exploration; history of technology; USA; 20th century.

Problem definition. Oil and natural gas as well as their processing products have a very long history of use by mankind though the history of the world oil industry counts as few as about 150 years and the gas industry is less than 100 years old. Despite such a relatively "young" age, oil and gas have become a determinant in the development of global economy, financial markets and political processes in numerous countries (sometimes in a latent form). The "information field" around the oil and gas industry is therefore invariably in the spotlight of the general public and demands of specialists thorough understanding of the historical development and prospects of oil and gas production. Historically, the oil industry development was related to a revolutionary invention of kerosene (Johan Zeg, Lviv, 1853) and world new demand for "big oil" for illumination of premises and city streets. Technically, industrial oil production was based on downhole technologies for oil discovery, use of steam engines for drilling wells, pumps for running oil and powerful oil refineries, but at the first stage it "coexisted" with traditional well oil production (except for the USA). Geographically, the world oil industry originated in the 1850s-1860s in three centers - the Carpathian region (Galicia and Romania), Pennsylvania (the USA) and Apsheron (Azerbaijan). However, it was in the USA where in a short period of time the most dynamic, innovative and world market oriented oil industry was developed, which maintained those trends throughout the 20th century. Modern US policy is aimed at global energy leadership through development of domestic fields, which has lately been a new feature of the industry. Based on the above, the historical experience of the US oil industry

development assumes particular importance and attracts wide public interest.

Level of problem research. The history of the world oil industry, in particular the development of the US oil industry, has not been covered by system studies of Ukrainian researchers and is only fragmentarily dealt with in some publications (Гайко, Білецький, 2013; Шнюков, 2008). Publications of the former USSR (Тьюгендхэт, Гамильтон, 1978; Фурсенко, 1985) were primarily focused on political aspects of the issue and were often committed to a "party vision". Translated American manuals and studies dealing with technological issues of oil production (Хайн, 2017; Грей, 2003) covered some aspects of the history of technology and its authors but did not aim to present the history of the oil industry. Problems of the global and American oil industries have been studied in reasonable depth by American researchers (Marius Vassiliou, 2018; Bringham Bruce, 1979; Chernow Ron, 1998) but the latter are almost unfamiliar to Ukrainian audience. Unlike Ukrainian publishing houses, those in Russia find some opportunities for translation of the most important works by American "oilmen" and Ukrainian readers familiarize themselves with such Russian translations (Ерзин, 2011; Ерзин, 2016; Экономидес, Олини, 2004). These fundamental publications are however still focused on geopolitical aspects of oil production. Some publications deal with leading personalities in the world oil industry, who deserve attention and learning (Меснянко, 2015). The review of the US oil industry development in the first part of our article covers a period from the inception of the US oil industry to the late 19th century (Gayko, Biletsky, 2018: 37-40).

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Object of the article. The authors intend to produce a series of articles covering the history of the world oil industry, aimed at understanding the "anatomy of success" which is much needed for the domestic industry. This article traces the oil industry development in the USA in the 20th century.

Presentation of the basic material. At the turn of the 20th century the US oil industry featured a steady dominance of the Standard Oil Company within the country and the beginning of international corporate competition, primarily with the British-Dutch "Royal Dutch Shell" Company, established in 1907. In 1911, to eliminate its monopolistic position, the Standard Oil Company was divided into 34 smaller entities under the decision of the Supreme Court of the United States, said entities however continuing their latent relations with John Rockefeller. Such "fragments" of Standard Oil as future Exxon, Socony, Mobil, Chevron etc. only confirmed a great potential of the Corporation, which met new challenges of the "automotive revolution" in the USA. Oilmen called Standard Oil "The old house".

In the 1910s the new automotive industry of the USA stated the need to significantly increase oil production volumes for gasoline production, the projected growth rates of car production indicating the critical limits of oil reserves at the explored deposits of the United States. The "automotive revolution" or "the era of motorization of the American people" began, which changed the life style of America and later of the whole world. The "human factor" of those changes was represented by the organizational talent and vision of Henry Ford who was not only the first to introduce a car assembly line and a full production cycle but also created a dream and new opportunities for millions of the Americans. As early as in the late 1920s there were 3.4 million registered cars in the USA (78% of the world quantity). During a decade (from 1919 to 1929) the volume of oil consumption in the country increased by 2.5 times, gasoline making 85% of the total oil consumption in 1929 (kerosene for lighting greatly yielded to the new fuel, its importance however eventually increased again, that time as aircraft fuel). The first gas station of the world appeared in 1907 in St. Louis (until then stores had sold gasoline in cans). In 1921 there were as many as 12 thousand gas filling stations in the USA and in 1929 the number reached 143 thousand. The scale and growth dynamics of the US automotive business demanded an adequate response from the oil production industry.

The Director of the United States Geological Survey in the 1910s, George Otis Smith, warned of potential "gasoline famine" and the need for large-scale geological surveys both domestically and outside the country. Certain hopes were pinned on large reserves of shale oil discovered in the mountains of Colorado, Utah and Nevada, but its cost at the time was recognized economically unacceptable. The US government provided assistance to oil companies and entrepreneurs who invested in the search for and development of new fields, including the support to an oil "campaign" in other countries. In 1912 an "emergency oil reserve" of the USA was created in case of a war or acute economic crisis.

The demand for oil encouraged geologists, oilmen and numerous, mostly small-scale, entrepreneurs to hunt new oil treasures. In the early 20th century near the "old" oil area (Pennsylvania, Ohio) there sprang up a new region in the south and west of the country: Oklahoma, California and Texas.

Geologists alluded to Oklahoma as a state with a very high oil potential. Exploration crews and individual prospectors started buying Indian reservation lands and boring numerous wells, sometimes on the off chance. Most of those people did not intend to set up oil companies and began to produce oil. Their dream was to discover "black gold" at the acquired plots and sell the latter to major companies for "big money". On 22 November 1905, Robert Galbreath and Frank Chesley, who carried out drilling operations on the lands of the Indian Ida Glenn near the town of Tulsa, succeeded in discovering a large oil field which was named "Glenn Pool" after the land owner. The discovery of rich oil caused another oil boom and the inrush of thousands of prospectors, workers and adventurers (during 1906 more than 3 thousand people arrived). Numerous flowing wells of the area blew out in aggregate more than 100 thousand barrels of oil per day, but for lack of an oil pipeline that raw material cost almost nothing. The clever businessman Harry Sinclair who was engaged in purchase and sale of small oil plots in Oklahoma took advantage of the situation. He bought up for a mere song all the oil which the drillers had diverted to dugout ponds (for there was no place to keep it), made a large number of steel tanks and stored the raw material there until the construction of an oil pipeline was completed, then sold the oil at a price which was 12 times higher than the purchase one. Before long, an oil company set up by Sinclair, following the above bargain, became one of the state's oil production leaders.

In 1907 Oklahoma produced the largest amount of oil among the US states, whereas the town of Tulsa, where they had begun to construct dozens of oil refineries, became the oil capital of America for some time. Glenn Pool made 340 million barrels of oil. The subsequent growth of oil production in Oklahoma was connected to the development of the Cimarron River banks where much oil was also stricken. One of the first Hollywood feature films from the provisional cycle "Oil rules the world" was naturally called "Oklahoma Oil" (directed by Stanley Kramer, 1973), which indicates the identification of that state with big oil in the public opinion of the Americans.

Southern California manifested itself as a real "Oil Eldorado". Ironically, the Spaniards who had been the first Europeans to discover and colonize those lands failed to find huge and diverse local mineral treasures. Back in 1776, the Spaniards founded a fort in the Golden Gate Bay, naming it after St. Francis of Assisi. The city of San Francisco turned into an important land development center of New Spain (California), although North America had long been considered by the Spaniards as an unpromising territory specifically in terms of lacking minerals (primarily, precious metals). It was designated as "Tierras de ningun provecho" on geographical maps i.e. "Lands that promise no profit". The fatal mistake of the Spaniards who first reached the richest gold and oil deposits of America but did not recognize their longed-for Eldorado is explained by the fact that they were searching with "fire and sword" rather than "pick and shovel".

The first oil in California was discovered as long ago as in 1876 by oil prospectors of the Star Oil Company (the Pico Canyon field to the north of Los Angeles). The flow of oil from the well however did not exceed 25 barrels per day, which only indicated the expediency of further searches (the latter involved the first oil geologists who appeared first actually in California). Such findings gave grounds for

the local entrepreneurs C. Felton, L. Tevis and J. Lumis to set up the Pacific Coast Oil Company in 1879. Standard Oil acquired the latter in 1900 and established the Standard Oil of California in 1906, which extended still more the domination of G. Rockefeller's Empire in the USA. Even earlier, some oil entrepreneurs of California, in particular L. Stewart, T. Bard and V. Hardison, had decided to counter the oil giant and united in an alternative alliance, forming the Union Oil Company in San Paulo. It managed to build its oil pipelines from Kern County fields to oil refineries on the Pacific coast and held out in a difficult competitive struggle. It is also worth mentioning Edward Doheny's company which drilled the first successful well near the city of Los Angeles (1892), starting the California oil boom.

The specifics of oil field development in California was that its territory was at a large distance from the main consumer market - the east of the USA, which restrained considerable capital investments. On the other hand, there were Pacific markets of Asia accessible and it was the west coast that eventually became a significant consumer. Rich oil fields discovered in the 1890s swept away all doubts - it was the beginning of the California oil era. The main oil and gas area of California is the San Joaquin River valley which includes such largest fields as Midway-Sunset (discovered in 1894), the Infantryman River oil deposit (1899) and South Belridge (1911) in Kern County. Large deposits were also discovered in the Los Angeles River basin - Wilmington (1932), Santa Fe Springs and Long Beach. In 1914 Ralph Lloyd's and Joseph Dabney's well in Ventura County produced a gush of oil of high destructive power at a depth of 780 m. Within a few years, Ventura County and the surrounding area were densely covered with oil derricks. The resort areas and famous beaches of California, which in the 1920s-1930s were completely filled with drilling rigs forming surreal landscapes, look strange in old photos. Oil was produced even in the center of star Beverly Hills.

Shortly, the baton of findings was passed from California to neighboring Texas. The discovery of Texas oil is to some extent associated with the name of the school teacher P. Higgins who often came with his students to the Spindletop Hill near the town of Beaumont in southeast Texas. Local water sources that evolved gas put the teacher onto an idea of a possible oil presence there. There had already been some unsuccessful well drilling attempts in the area, so oilmen were quite skeptical about the ideas of Higgins. Preliminary geological investigations carried out near Beaumont also yielded a negative forecast regarding the presence of oil fields. Having studied all the oil literature available, Higgins, however, proved the prospects of the Spindletop Hill to each and all in a confident and sometimes obtrusive way (he was therefore nicknamed by townspeople "lunatic", obsessed with "mythic Texas oil").

Higgins managed to raise some small funds and interest in his "oil region" the mining engineer Anthony Lucas (Antun Луиџ, a native of Austria-Hungary), a friend of the famed inventor Nikola Tesla, with whom they had studied together at the Polytechnic of Harz. Lucas worked in salt mines of Louisiana, was engaged in successful geological exploration of salt on the coast of the Gulf of Mexico and sometimes came across some oil shows. In 1899 he agreed to Higgins' offer to take a position of drilling engineer in their joint company. In 1900 Lucas staked the

foot of the Spindletop Hill, having rightly seen a salt dome in its form, which could cover oil. They drilled through quars and at a depth of 275 m the jetting drill failed. There was no money for renewal of the equipment and the partners turned to J. Rockefeller for help, but that time Standard Oil "misfired", having failed to recognize the Texas prospects. The partners were supported by the drilling company of J. Haley and J. Gaffey from Pittsburgh. On 10 January 1901, there was a gas outburst at a well depth of 370 m and an over 60 m high oil spring gushed.

"Lucas' fountain" was the beginning of a large-scale phenomenon known as the "Texas oil boom", which resulted in a rapid growth of the state economy. Over 50 thousand people came just to look at the gusher well which produced 75 thousand barrels per day. A whole oil lake with an area of 40 hectares was formed on the drilling site. The Beaumont population grew from 8 thousand to 60 thousand people within a year. At the beginning of 1902 there were 600 oil companies registered in the town, 285 wells operated (or drilled) in the neighborhood, which were eventually taken in by the newly created large company "Gulf Oil", owned by the financial group of the Mellons. There was also the rather aggressive company "Texaco" (owned by J. Cullinan) set up, which was over time taken by Standard Oil. The explorers Higgins, Lucas, Haley and Gaffey secured miserly profits (compared to Gulf Oil) from the Spindletop field but made their significant contribution to the discovery of Texan oil which according to many experts "helped the USA become a superpower". The American Oil and Gas Committee appointed Anthony Lucas its lifetime Honorary Chairman whereas the town of Beaumont installed a 15-meter granite pedestal to him in 1941. The Spindletop field has produced over 50 million barrels of oil, the production still under way up to the present day.

Texas managed to surprise the oil world once again in 1930, when the giant East Texas field was discovered in the east of the state (160 km to the east of Dallas). It occupies a huge area of 570 km² and has more than 30.3 thousand old and running wells (it is the second US field by reserves and the first one by the amount of oil produced since its discovery). The first attempts of borehole petroleum prospecting were made there as long ago as in 1911 but the drilling distance was only a few hundred meters (the then existing equipment was mostly "stuck" at great depths). Such wells formed only dry holes and resulted in bankruptcies of investing companies and drilling crews. The greatest persistence and perseverance were demonstrated by the driller Columbus Marion Joiner and the oil geologist A. D. Lloyd, who discovered oil on the former lands of the farmer Daisy Bradford (in whose honor they called their wells). On 3 October 1930 the Daisy Bradford No. 3 well produced an oil gusher at a depth of 1078 m.

Joiner's well fell almost within the southeastern boundary of the field. Before long, there was another successful well drilled 14 km northwest of the former, which daily produced over 22 thousand barrels of oil, and in the early 1931 yet another well, 40 km north of Daisy Bradford No. 3, produced rich oil, the three wells being of nearly similar depth (1070-1100 m). For some time those wells were considered fortunate discoveries of three different fields, the oilmen however had an almost fantastic idea of the three belonging to one and the same giant field. One of the first persons who "staked" on that bold idea

was Haroldson Hunt. He met with Joyner in the Baker Hotel in Dallas in November 1930 and bought his well and 5580 acre plot for a fabulous at the time sum of \$ 1.34 million. Hunt's active purchase of sites within the explored triangle and large-scale drilling of wells enabled him to set up his own Hunt Oil Company in 1934, which owing to large reserves of the East Texas field rather quickly took over the leadership in terms of crude oil output in the USA.

During World War II, Hunt Oil Company was a reliable supplier of oil and petroleum products to the US army and its allies. To transport oil to refineries in Philadelphia, the Company built the largest oil pipeline in the world at the time (which was constructed in 1942-44), the so-called "Big Inch", 2,300 km long and 24 inches (610 mm) in diameter. Tanker transportation was very risky as German submarines were continuously hunting tankers in the Gulf of Mexico. In the postwar years, Hunt's Company put in production over 300 new wells per year whereas the oil tycoon himself was recognized as the richest man of America in 1948. Management of numerous oil corporations was concentrated in Dallas and Houston, which became important oil centers of the United States.

In the second half of the 20th century there were many oil deposits of mean and high productivity discovered in the USA and only one giant oil "elephant" which exceeded the East Texas field - the Prudhoe Bay deposit in Alaska (1968). In the early 21st century about 24% of the total oil in the USA were produced in Texas, 23% in Alaska, 14% in Louisiana, 13% in California, 4% in Oklahoma, 3.5% in Wyoming, 3% in New Mexico, 2% in Kansas and 1.4% in North Dakota (other states account for less than 1%). In the 21st century Alaska and Texas, which significantly increased the oil potential of the country, are the leaders in discovery of new fields of high productivity.

Since 1939 there have been 3-5 thousand and since 1947 about 7 thousand exploratory wells drilled annually in the United States. Furthermore, one prospecting hole in the USA fell on 31 km² of a potential oil-bearing area whereas a respective average indicator of other oil-producing countries was 1259 km² (i.e. it was almost 40 times lower). Prospective oil was therefore not used in other countries to the extent it was in the USA for lack of sufficient background data. In 1930-1940 the number of wells (exploratory and producing) totaled 28-33 thousand per year and in 1948 there were 40 thousand wells (which means over 40 million running meters per year), 16% out of the number being "wild cats" i.e. not associated with any existing deposits. In the same 1948 oil was produced by 443 thousand wells. In the second half of the 20th century the above trends of involving small and medium-sized businesses in well drilling continued despite the increasing role of large companies.

Conclusion

The "automotive revolution" became a major factor in the development of the oil industry in the early 20th century in the USA which in some years produced up to 90% of the world output of cars. The above required new unprecedented volumes of oil and gasoline production, which gave rise to a large-scale search for new fields and various forms of their development. In the early 20th century old oil regions (Pennsylvania, Ohio) were supplemented with new areas - Oklahoma, California and Texas, and in the second

half of the century with Alaska. Major oil producing and refining companies in the United States were active in the formation of world markets as well as the search and development of new fields in South America and the Middle East. One of the main recipes for a great success of the USA in the development of oil and gas fields was and still is a large-scale well drilling, equal access to the sites resulting in "oil booms" with involvement of hundreds of drilling crews and individual prospectors at each rich deposit, who invested in the search for and production of oil. Concurrently, there were also large companies involved, which competed with each other and associations of small entrepreneurs, but the share of "prospectors" (small entrepreneurs) in the discovery of new deposits always ranged from 2/3 to 3/4. The same trends have held true for modern shale gas production.

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РОЗВИТОК НАФТОВОЇ ПРОМИСЛОВОСТІ В США У XX ст. (ЧАСТИНА II)

Стаття стосується історії нафтогазової галузі, яка сьогодні динамічно розвивається. Нафта і природний газ, а також продукти їх переробки мають дуже давню історію застосування людством, проте історія світової нафтової промисловості налічує всього лише близько 150 років, газової - менше 100 років. Завданням авторів є серія статей, присвячених історії світової нафтової промисловості задля розуміння "анатомії успіху", так потрібного вітчизняній економіці. Цей цикл статей розпочинаємо дослідженням становлення нафтової промисловості США. У першій частині роботи охоплено період від початків нафтової промисловості в США до кінця XIX ст., у другій частині - період XX ст. Показано, що основним фактором розвитку нафтової промисловості на початку XX ст. стала "автомобільна революція" у США, які продукували в окремі роки до 90% світового обсягу автомобілів. Це потребувало нових, раніше небачених обсягів видобутку нафти й виробництва бензину, що викликало масштабні пошуки нових родовищ і різноманітні форми їх освоєння. Старі нафтові райони (Пенсильванія, Огайо) на початку XX ст. поповнилися новими - Оклахома, Каліфорнія, Техас, а в другій половині сторіччя ще й Аляскою. Великі видобувні й переробні нафтові компанії США вели активну політику формування світових ринків, а також пошуків і освоєння нових родовищ у Південній Америці та на Середньому Сході. Одним з головних "секретів" великого успіху США в освоєнні нафтогазових родовищ було й залишається масове буріння свердловин, причому рівний доступ до ділянок призводив до "нафтових бумів" із залученням на кожному потужному родовищі сотень бурильних артілей і окремих старателів, що інвестували в пошуки й видобуток нафти. Одночасно діяли й великі компанії, які конкурували між собою та об'єднаннями дрібних підприємців, проте частка "старателів" (дрібних підприємців) у відкритті нових родовищ завжди складала від 2/3 до 3/4. Ті самі тенденції перейшли і на сучасний видобуток сланцевого газу.

Ключові слова: нафта; природний газ; нафтогазова галузь; геологорозвідка; історія техніки; США; XX сторіччя.

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