Periodica Polytechnica
Transportation Engineering

Road Transport Liquid Fuel Today and Tomorrow: Literature Overview

43(4), pp. 172-176, 2015
DOI: 10.3311/PPtr.8095

Máté Zöldy[1], Ádám Török[2*]

RESEARCH ARTICLE

Received 18 February 2015; accepted 09 May 2015

Abstract
This article aims to investigate the development path of fuel development. From fossil fuel to alternative fuel technologies and drivetrains. Various technologies have been emerged in the recent years in the transport sector in order to facilitate the decrease of environmental pollution of the road vehicle.

Keywords
fossil fuel, alternative fuel technologies, alternative drivetrains

1 Introduction – Historical Background

John D. Rockefeller, founder of the Standard Oil Company (Fig. 1.):

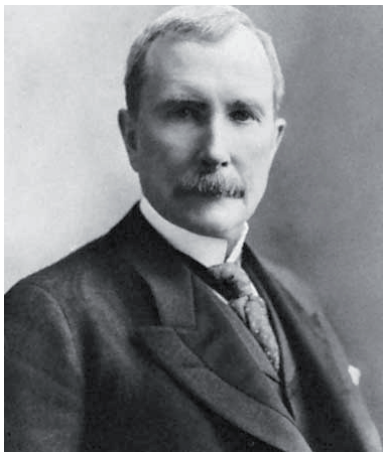

Fig. 1 John D. Rockefeller 1884 (1839-1937)
(Source: Britannica Encyclopaedia)

Born into modest circumstances in upstate New York, he entered the then-fledgling oil business in 1863 by investing in a Cleveland, Ohio, refinery (Encyclopaedia Britannica). In USA private companies could have the opportunity to harvest and to mine the treasures of earth (Fig. 2):

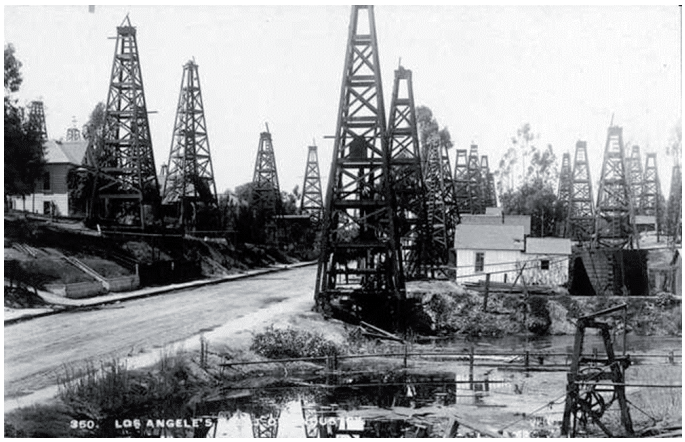

Fig. 2 Landscape of Los Angeles (1850)
(Source: W. W: Norton & Company)

[1] MOL PLC., Division of Research and Development,
1117 Budapest, Október huszonharmadika 18., Hungary

[2] Department of Transport Technology and Economics,
Faculty of Transport Engineering and Vehicle Engineering,
Budapest University of Technology and Economics,
H-1111 Budapest, Muegyetem rkp 3., Hungary

* Corresponding author, e-mail: atorok@kgazd.bme.hu

In 1870, he established Standard Oil, which by the early 1880s controlled some 90 percent of U.S. refineries and pipelines. Critics accused Rockefeller of engaging in unethical practices, such as predatory pricing and colluding with railroads to eliminate his competitors, in order to gain a monopoly in the industry. In 1911, the U.S. Supreme Court found Standard Oil in violation of anti-trust laws and ordered it to dissolve (Boyd, 2001).

The Sherman Act passed in 1890 was in response to the monopoly that John D. Rockefeller and his company Standard Oil had on the oil industry. Rockefeller did not take over the task of drilling for oil. Instead, he concentrated buying the oil that other men drilled--refining it and selling it. By 1869, he had the largest refinery in the country and a year later Standard Oil of Ohio was born. When competition squeezed profit margins, Rockefeller squeezed the competition. Willing competitors were bought. Unwilling competitors found themselves cut-off from railroads, pipelines, and credit. The Sherman Act made it illegal for any firm to obtain a monopoly — that is to get complete control over the production of all the goods in one market. Secondly, the Sherman Act made it illegal for firms to get together and agree on the way in which they would compete, for example, by setting prices or dividing markets or determining which customers they would deal with Despite the Sherman act it took a while for the courts to finally break up Standard Oil. By 1911, competitors like Western Oil, like Gulf and Texaco had entered the refining business and had broken the Standard monopoly. That and the Sherman Anti-trust Act had ended the era of the big trusts (W. W: Norton & Company).

Fig. 3 Marcus Samuel (1853–1927)
(Source: Shell Globa Inc.)

The market of oil remained to lighting and lubricants until 1886, when the internal combustion engine and demand for gasoline arrived. By that time Marcus Samuel junior (Fig. 1) and his brother Sam exported British machinery, textiles and tools to newly industrialising Japan and the Far East and on return imported rice and silk from china and copperware to the Middle East and Europe. In London, they traded with commodities such as sugar, flour and wheat worldwide. It was during a trip to Japan that Marcus became interested in the oil exporting business based in Baku, Azerbaijan. Shipping still posed a problem as the oil was carried in barrels, which could leak and took up much space in the ship's hold. Marcus and Sam commissioned a fleet of steamers to carry oil in bulk, using for the first time the Suez Canal. They also set up bulk oil storage at ports in the Far East. In 1892, the Samuels had achieved a revolution in oil transportation. Bulk transport substantially cut the cost of oil by enormously increasing the volume that could be carried. The Samuel brothers initially called their company The Tank Syndicate but in 1897 renamed it to Shell Transport and Trading Company. Petroleum was also being produced in the East Indies, in a Dutch colony, and in 1890 a company had been formed to develop an oilfield in Sumatra. This was the origins of what was to become the Royal Dutch Petroleum Company. Faced with the competition from the Samuels' low bulk transport costs, Royal Dutch began the construction of tankers and bulk storage installations and set up its own sales organisation. The full merger of the two companies into the Royal Dutch Shell Group came in 1907. The Group rapidly expanded across the world (Shell Global Inc.).

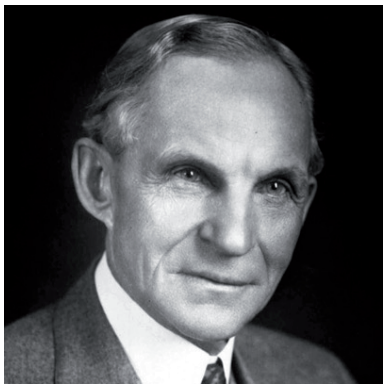

Fig. 4 Henry Ford (1863-1947)
(Ford Company)

At the beginning of the 20th century, the automobile was a toy for the rich. Most models were complicated machines that required a chauffeur with the extended mechanical knowledge to drive it. Henry Ford decided to build a simple, reliable and affordable car. Therefore, he invited the assembly line and mass production of automobiles. Henry Ford did not invent the car; he produced an automobile that was within the economic reach of the society. Ford developed a design and a method of manufacture that steadily reduced the cost of the vehicle. Instead of pocketing the profits; Ford lowered the price of his car. As a result, Ford Motors sold more cars and steadily increased its earnings - transforming the automobile from a luxury toy to an every-day-use equipment (Borkowski et al., 2013). Central to Ford's ability to produce an affordable car was the development of the assembly line that increased the efficiency of manufacture and decreased its cost. Ford did not conceive the concept, he perfected it. Prior to the introduction of the assembly line, cars were individually crafted by teams of skilled workmen - a

slow and expensive procedure. The assembly line reversed the process of automobile manufacture. Instead of workers going to the car, the car came to the worker who performed the same task of assembly over and over again. With the introduction and perfection of the process, Ford was able to reduce the assembly time (Alizon, Shooter and Simpson 2009).

2 Fuels today and tomorrow

A barrel is a hollow cylindrical container, traditionally made of wood staves and bound with iron hoops. Its top and bottom are circular and flat, and usually equal in diameter. The standard barrel of crude oil or another petroleum product (abbreviated bbl) is 42 U.S. gallons (34.972 Imperial gallons or 158.987 litres). This measurement originated in the early Pennsylvania oil fields and permitted both British and American merchants to refer to the same unit, based on the old English wine measure, the tierce. Oil has not actually been shipped in barrels since the introduction of oil tankers, but the 4.2 US-gallon size is still used as a unit for measurement, pricing, and in tax and regulatory codes (Pasqualini and Bassi, 2014).

Crude oil is a mixture of different length hydrocarbon chains (Fig. 5):

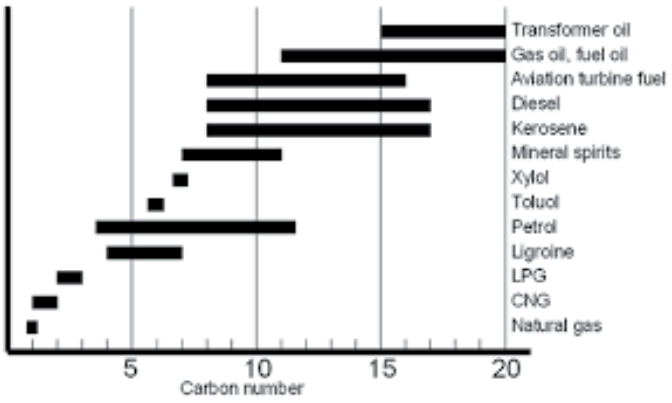

Fig. 5 Carbon chain length for typical hydrocarbons (Díaz et al., 2014)

As previously mentioned the usage of crude oil - as the demand changed – changed. The gasoline or diesel oil were vaporised. Formerly the top, profitable product was the tar and the petroleum.

Nowadays more than 900 products are derived from crude oil such as CNG, LPG, gasoline and diesel oil for road transport and navigation, kerosene for aviation, lubricants, heating oil, bitumen. Nowadays the diesel oil is the top, profitable product. But it is not possible to produce diesel or positive margin products from diesel, thus an overall margin of the total yield from sulphur and coke up to diesel and LPG have to be handled together.

These different products can be obtained from different source of crude oils. Some source can be easily and cheaply reachable and some can be hardly reached (Mercure and Salas 2013; Aguilera, 2014).

Chart 4.

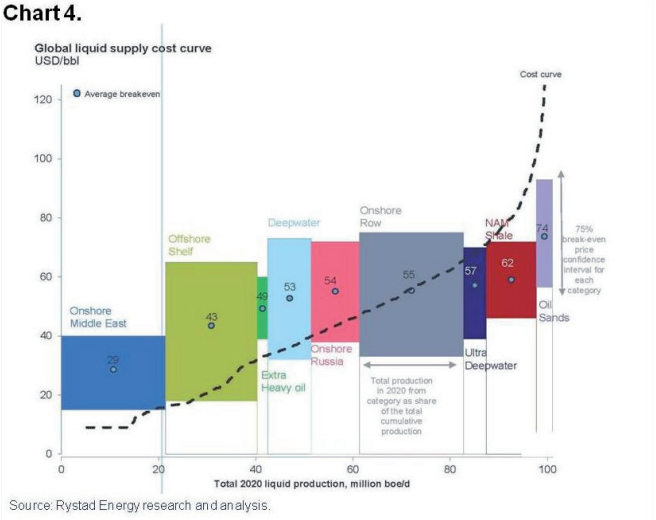

Fig. 6 Marginal Abatement Cost Curve of UK. (Brecha, 2012)

A Marginal Abatement Cost Curve (MAC curves) is a set of options available to an economy to reduce pollution. They are valuable tools in understanding emissions trading, driving forecasts of carbon allowance prices, prioritizing investment opportunities, and shaping policy discussions. Economists have used MAC curves to explain the economics of interregional carbon trading, and policy-makers turn to MAC curves to show how much abatement an economy can afford and where policy should be directed to achieve the emission reductions. Various economists, research organizations, and consultancies have produced MAC curves. Bloomberg New Energy Finance and McKinsey & Company have produced economy wide analyses on greenhouse gas emissions reductions for the United States. The Wuppertal Institute for Climate, Environment and Energy produced several Marginal Abatement Cost curves for Germany (also called Cost Potential Curves), depending on the perspective (end-user, utilities, society). The US Environmental Protection Agency has done work on a MAC curve for non-carbon dioxide emissions such as methane, N_2O, and HFCs. Enerdata and LEPII-CNRS (France) produce MAC curves with the POLES model for the 6 Kyoto Protocol gases, these curves have been used for various public and private actors either to assess carbon policies or through the use of a carbon market analysis tool. Typically, MAC curves cover emissions reduction opportunities across a number of sectors in an economy including power, industry, waste, buildings, transport, agriculture, and forestry. MAC curves are beginning to gain traction as financial tools to compare the merits of competing carbon reduction projects and technologies.

There are technological approaches that are decreasing the fuel consumption and/or environmental emission. These technological approaches have costs on individuals and on the society as well. There is a rational contradiction between transport and environmental protection. There are more affordable sectors where societies can gain cheaper results on environmental protection than transport.

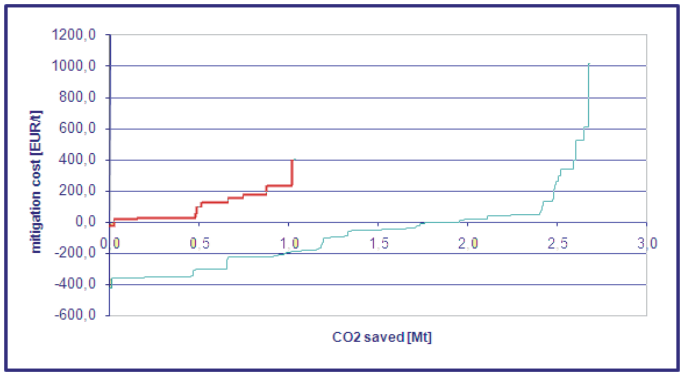

Fig. 7 Difference in abatement cost curves in Transport sector (red) and Residual sector (blue)
(Source: own calculation based on MAC curves for Hungary by Ecofys Netherlands BV, ERTI, Golder Associates, MAKK, SIU)

3 Alternative drivetrains

Lot effort has already been done by the transport sector. The industry made efforts on fuel and drivetrain development. Alternative drivetrains and solutions are required because the demand for oil and the source of oil is spatially different.

Fig. 8 Oil trade in the world 2010
(source: www.plate-energies.com/tankers.html)

Currently, there are two ways of improving the environmental performance of internal combustion engines in the passenger car vehicles. One way could be the modification of fuel with additives and blending. In that case the internal combustion engine structure and basic idea would not change. This type of solutions could be the blending of bioethanol with gasoline (Park, Yoon and Lee, 2014), bioethanol with diesel oil (Tutak et al., 2015), CNG with biomethane (Szwaja et al., 2013), butanol with biodiesel (Siwale et al., 2013), diesel fuel with butyl ester (Makarevičienėa et al., 2013) diesel fuel with brown's gas (Rimkusa et al., 2013) or partially sunflower based kerosene (Eller et al., 2012) or pure usage of woody biomass (Glavonjić and Oblak, 2012). Furthermore, these blends can be combined and biodiesel–diesel–bioethanol can be investigated (Barabás, 2013).

Another way could be the changing of drivetrains. This could be the modification of engines or new alternative propulsions. Such modification was described with gas engines (Domanovszky, 2014; Arroyo et al., 2015), or hydrogen fuel cell (López Cascales et al., 2015) or battery electric vehicles (López-Arquillos et al., 2015). Electric road vehicles can be serial (where internal combustion and electric engines are serial placed) (Chen et al., 2015) or parallel (where internal combustion and electric engines are parallel placed) (Finesso, Spessa and Venditti, 2014). Both arrangements can be found on the market with compression or spark ignition engines.

4 Conclusion

Although there is a strong political commitment on EU level to reduce the emission of road transport sector and lot has been done, but the path of development is still questionable. There is a lot of possible solution on the market some of are in the research phase and some of them are already available on the market.

References

Aguilera, R. F. (2014) Production Costs of Global Conventional and Unconventional Petroleum. *Energy Policy*. 64 (1). pp. 134-140. DOI: 10.1016/j.enpol.2013.07.118

Arroyo, J., Moreno, F., Muñoz, M., Monné, C. (2015) Experimental Study of Ignition Timing and Supercharging Effects on a Gasoline Engine Fueled with Synthetic Gases Extracted from Biogas. *Energy Conversion and Management*. 97 (6). pp. 196-211. DOI: 10.1016/j.enconman.2015.03.061

Barabás, I. (2013) Predicting the Temperature Dependent Density of Biodiesel–diesel–bioethanol Blends. *Fuel*. 109 (7). pp. 563-574. DOI:10.1016/j.fuel.2013.03.001

Borkowski, S., Stasiak-Betlejewska, R., Torok, A. (2013) Theoretical Investigation of Supply Chain Service Level in Hungary and Poland. *Transport and Telecommunication*. 14 (2). pp. 93-101. DOI: 10.2478/ttj-2013-0008

Boyd, J. (2001) The Rhetoric of Arrogance: The Public Relations Response of the Standard Oil Trust. *Public Relations Review*. 27 (2). pp. 163-178. DOI: 10.1016/S0363-8111(01)00078-9

Brecha, R. J. (2012) Logistic Curves, Extraction Costs and Effective Peak Oil. *Energy Policy*. 51 (12). pp. 586–597. DOI: 10.1016/j.enpol.2012.09.016

Chen, Z. Xia B., You C., Mi, C. C. (2015) A Novel Energy Management Method for Series Plug-in Hybrid Electric Vehicles. *Applied Energy*. 145 (5). pp. 172-179. DOI: 10.1016/j.apenergy.2015.02.004

Díaz, J. A., de la Osa, A. R., Sánchez, P., Romero, A., Valverde, J. L. (2014) Influence of CO_2 Co-Feeding on Fischer–Tropsch Fuels Production over Carbon Nanofibers Supported Cobalt Catalyst. *Catalysis Communications*. 44 (1). pp. 57-61. DOI: 10.1016/j.catcom.2013.07.033

Domanovszky, H. (2014) Gas propulsion or e-mobility is the solution on the way of clean and carbon free road transportation? *Periodica Polytechnica Transportation Engineering*. 42 (1). pp. 63-72. DOI: 10.3311/PPtr.7254

Eller, Z., Holló, A., Hancsók, J. (2012) Production of Reduced Aromatic Jet Fuel From Sunflower oil- Kerosene Mixture. In: *20th Biomass Conference and Exhibition*. Milano, Italy, 18.06.2012-22.06.2012. pp. 1786-1791.

Fabrice, A., Shooter, S. B., Simpson, T. W. (2009) Henry Ford and the Model T: Lessons for Product Platforming and Mass Customization. *Design Studies*. 30 (5). pp. 588-605. DOI: 10.1016/j.destud.2009.03.003

Finesso, R., Spessa, E., Venditti, M. (2014) Layout Design and Energetic Analysis of a Complex Diesel Parallel Hybrid Electric Vehicle. *Applied Energy*. 134 (12). pp. 573-588. DOI: 10.1016/j.apenergy.2014.08.007

Glavonjić, B., Oblak, L. (2012) Consumption of woody biomass in industry, commercial and public facilities in Serbia: present state and possible contribution to the share of renewable sources in final energy consumption. *Thermal science*. 16 (1). pp. 7-19.

López-Arquillos, A., Rubio-Romero, J. C., Súarez-Cebador, M., del Carmen Pardo-Ferreira, M. (2015) Comparative Risk Assessment of Vehicle Maintenance Activities: Hybrid, Battery Electric, and Hydrogen Fuel Cell Cars. *International Journal of Industrial Ergonomics*. 47 (5). pp. 53-60. DOI: 10.1016/j.ergon.2015.02.005

López Cascales, J. J., Juan-Segovia, M. C., Ibáñez Molina, J., Sánchez Vera, J., Vivo Vivo, P. M. (2015) Environmental Impact Associated with the Substitution of Internal Combustion Vehicles by Fuel Cell Vehicles Refueled with Hydrogen Generated by Electrolysis Using the Power Grid. An Estimation Focused on the Autonomous Region of Murcia (Spain). *Renewable Energy.* 77 (5). pp. 79-85. DOI: 10.1016/j.renene.2014.11.082

Makarevičienė, V., Matijošius, J., Pukalskas, S., Vėgneris, R., Kazanceva, I., Kazancev, K. (2013) The exploitation and environmental characteristics of diesel fuel containing rapeseed butyl esters. *Transport*. 28 (2). pp. 158-165. DOI: 10.3846/16484142.2013.801364

Mercure, J. F., Salas, P. (2013) On the Global Economic Potentials and Marginal Costs of Non-Renewable Resources and the Price of Energy Commodities. *Energy Policy*. 63 (12). pp. 469-483. DOI: 10.1016/j.enpol.2013.08.040

Park, S. H., Yoon, S. H., Lee, C. S. (2014) Bioethanol and Gasoline Premixing Effect on Combustion and Emission Characteristics in Biodiesel Dual-Fuel Combustion Engine. *Applied Energy.* 135 (12). pp. 286-298. DOI: 10.1016/j.apenergy.2014.08.056

Pasqualini, D., Bassi, A. M. (2014) Oil Shale and Climate Policy in the Shift to a Low Carbon and More Resilient Economy. *Technological Forecasting and Social Change*. 86 (7). pp. 168-176. DOI: 10.1016/j.techfore.2013.08.018

Rimkus, A., Pukalskas, S., Matijošius, J., Sokolovskij, E. (2013) Betterment of ecological parameters of a diesel engine using Brown's gas. *Journal of Environmental Engineering and Landscape Management*. 21 (2). pp. 133-140. DOI: 10.3846/16486897.2012.679661

Rockefeller, J. D. (2015) *Encyclopaedia Britannica*. [Online] Available from: http://www.britannica.com/EBchecked/topic/506239/John-D-Rockefeller [Accessed: 3rd April 2015]

Shell (2015) Introdoction of early history. [Online] Available from: http://www.shell.com/global/aboutshell/who-we-are/our-history/the-beginnings.html [Accessed: 3rd April 2015]

Siwale, L., Lukács, K., Torok, A., Bereczky, A., Mbarawa, M., Penninger, A., Kolesnikov, A. (2013) Combustion and Emission Characteristics of N-Butanol/diesel Fuel Blend in a Turbo-Charged Compression Ignition Engine. *Fuel.* 107 (5). pp. 409-418. DOI:10.1016/j.fuel.2012.11.083

Szwaja, S. Kovacs, V. B., Bereczky, A, Penninger, A. (2013) Sewage Sludge Producer Gas Enriched with Methane as a Fuel to a Spark Ignited Engine. *Fuel Processing Technology*. 110 (6). pp. 160–166. DOI: 10.1016/j.fuproc.2012.12.008

Wojciech, T., Lukács, K., Szwaja S., Bereczky, A. (2015) Alcohol–diesel Fuel Combustion in the Compression Ignition Engine. *Fuel*. 154. pp. 196-206. DOI: 10.1016/j.fuel.2015.03.071