

QUALITY CONTROL IN THE SUPPLY CHAIN - CASE STUDY

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Abstract

Among all operational fluids, the most important is attributed to the appropriate quality of liquid fuels. This is due to the fact that fuels constitute the largest group of operating fluids introduced to trade and the fact that their inadequate quality parameters cause many adverse effects, including min. deterioration of the functional characteristics of the engine, increase in the costs of vehicle operation, deterioration of reliability and durability of the machine or emission of harmful components of the exhaust gases emitted to the environment. Therefore, many different technical, organizational and legal projects are planned so that the quality of fuels in the supply chain will not deteriorate. One of such undertakings is a properly designed system for maintaining the quality of liquid fuels in the supply chain: from the source of supply to the end user. Systems operating in relation to liquid fuels are not perfect and have some functional and organizational defects. Therefore, it seems advisable to carry out a thorough identification of existing solutions and to identify the possibility of their improvement. The article presents the results of research on the fuel quality monitoring and control system in Poland carried out by the author in 2009-2018.

Keywords: Liquid fuels, supply chain, quality monitoring and control system of fuels

1. INTRODUCTION

Product quality can be defined as the degree of product compliance with the pattern or specified requirements. This definition applies in particular to fuels in the context of inspections carried out at petrol stations. Its aim is to provide the right quality, that is, a set of features important from the point of view of functionality, environmental protection and durability and service life of internal combustion engines [1,2]. These elements affect on one hand the ability to meet the needs and ensure the satisfaction of the buyer, on the other hand, they are an important element of the common policy of the European Union, aimed at reducing the emission of harmful substances into the atmosphere, including greenhouse gases. International regulations on fuel quality are undoubtedly a necessary element. The European Union is first and foremost a common economic area, a common market. Its participants are both individual clients, as well as companies or institutions.

The area of interest for monitoring and quality control systems is the issue of environmental protection and health care as well as protection of consumers against unfair practices of fuel producers and distributors. The fuel quality control system is therefore needed and useful, both at the level of a given country and internationally [3]. Hence the need to create and implement such systems at the level of government ministries or central offices with broad control powers, systems that act as a motivator towards producers and distributors, through the mere fact that their fuel can be controlled and errors can be show public's. The aim of the article is to presents the results of research on the fuel quality monitoring and control system in Poland carried out by the author in 2009-2018.

2. CHANGES OF THE QUALITY OF LIQUID FUELS IN THE SUPPLY CHAIN

Before the fuel goes from the source of supply to the user, it undergoes repeated operations of storing, transporting the pumping, during which it is exposed to physical and chemical stimuli, causing a change

(deterioration) of its quality.

Deterioration of quality is caused by [1-6]:

- natural aging processes of fuels, the intensity of which depends on the properties of fuel and the time and conditions of storage,
- penetration of external pollutants into the fuel through leaking or contaminated warehousing and distribution facilities,
- penetration into the batch of fresh fuel of contaminated fuel or other fuels that have been transported, stored or transported beforehand and no appropriate technological procedures have been applied,
- lack of periodic cleaning or drainage of storage tanks (e.g. at petrol stations),
- contamination of fuel or distribution installations with microorganisms,
- intentional or accidental addition to the fuel of another species or other type of fuel, e.g. heavy fuel oil for light diesel,
- evaporation of light fuel fractions during transfer, distribution or refueling processes, when these processes are not conducted in airtight conditions.

In order to prevent the deterioration of the quality of fuels in the supply chain, strictly defined procedures are implemented: acceptance, storage, issuance, quantitative and qualitative pick-up of the entire supply chain from the producer to the user. Currently, these are generally the procedures developed for the needs of fuel bases and petrol stations. The quality of the fuel is given to the control, consisting in checking selected or all normative quality parameters, covered by the applicable standards or regulations, on individual levels of the logistics system from the manufacturer to the user.

3. SYSTEM OF MONITORING AND QUALITY CONTROL OF LIQUID FUELS IN POLAND AND THE EUROPEAN COMMUNITY - DIFFERENCES AND SIMILARITIES

All European Community member states, according to the requirements of *Directive 98/70/EC*, referring to the quality of gasoline and diesel, have been obliged to check the quality of fuels sold at petrol stations. This obligation was established due to differences in the statutory or administrative provisions adopted by member states regarding fuel specifications for vehicles equipped with gasoline engines and diesel engines [11].

In view of the above, in 2003 the European Parliament adopted *Directive 2003/17/EC* amending *Directive 98/70/EC*, establishing new, stricter environmental specifications for fuels on the market. The quality control system is based on European standards *EN 14274:2013*: “*Automotive fuels - Assessment of petrol and diesel fuels quality - Fuel quality monitoring system*” and *EN 14275:2013* “*Automotive fuels - Assessment of gasoline and diesel fuels quality - Sampling from retail and factory distributors*”. These standards define in detail the rules for the selection and minimum number of samples, the method of sampling at service stations, the principles of their transport, storage and testing [7,8,11,12].

The main assumptions of the system set out in the above standards are based on the following principles [11,12]:

- the member state should be divided into regions where samples will be taken in a quantity proportional to the amount of fuel sold - if there is no full information on the amount of fuel sold, the division into regions can be based on the number of petrol stations in the region or other criteria, subjectively selected by the member state (e.g. number of vehicles, population). It is also possible to divide compliant with geographical or administrative division of the state. In the case of small countries, the division into regions is not applicable,
- for the purposes of quality monitoring, the year has been divided into two periods - winter and summer. This is determined by the different value of the vapor pressure parameter in these periods, contained in the quality standard for motor gasolines,

- the minimum number of samples to be taken for testing in each region in particular monitoring periods is 100 for each type of fuel in countries classified as small (sales up to 15 million tons per year). In countries where the annual sales of fuels exceed 15 million tones, the minimum number of samples is 200,
- fuel distribution points intended for inspection are drawn and samples are taken at petrol stations (public and company),
- use unused metal containers for sampling with a capacity of approximately 4 liters. These containers should have an external fastening enabling their sealing. The container is filled with a maximum of 3 liters of fuel; each container must have the following marking elements: place, date and time of sampling, product name and type, sample identification code.

The division of the country into regions determines the choice of one of the three possible models of the monitoring system in accordance with *EN 14274:2013* - A, B or C [11].

Model A is based on the division of the country into macroregions in geographical terms in such a way that in each region the total amount of fuel sold and the number of distribution places are similar. This is a general rule of conduct recommended for all countries, because it enables the effective recognition of fuel differentiation and, consequently, a lower number of samples taken. If the grouping of regions in geographical, administrative or other terms does not allow all criteria to be met to design this recommended model, then the use of Model B, based on the criteria of geographical and administrative division of the country, is considered. Model C is chosen when the country is small and it is not possible to divide its territory into macroregions or regions. The minimum number of distribution places in a given member state, from which samples should be taken, determines: the form of division into regions, the size of the country determined on the basis of annual sales and the share of a given fuel in the sale.

The monitoring and quality control system in Poland is consistent with the system in force in the European Community. It is based on the *Act of 26 August 2006 on monitoring and quality control of liquid fuels* and a dozen or so issued on the basis of its implementing regulations [9,10].

The basic structure, subject and principles of operation of the fuel quality monitoring and control system in Poland are as follows:

- the system is managed by the President of the Office for Competition and Consumer Protection ("the manager" of the system) and the controls are carried out by the Trade Inspection [10];
- all types of fuels available on the Polish market are controlled;
- control is carried out at all levels and in all elements of the supply chain - producer, fuel bases, fuel transporting agents (including car tankers) and petrol stations;
- the quality requirements are set by the Minister of Economy, taking into account the values of the quality parameters specified in the relevant standards (this is due to the fact that the application of standards is voluntary);
- it is forbidden to sold fuels that do not meet the quality requirements;
- the lower and upper ranges of penalties for introducing fuels with parameters that do not meet the requirements are established;
- the system for collecting, testing and publishing the results of fuel samples testing is standardized;
- fuel control is carried out in two subsystems: European (compliant with EU requirements) and National level.

The scope of control in both systems is convergent (**Table 1**).

Table 1 System of monitoring and quality control of liquid fuels in Poland - differences in the national and European subsystem - based on [9,10]

System element	European subsystem	National subsystem
Fuel type	Motor gasoline, unleaded gasoline, diesel and liquid biofuels	Unleaded gasoline, diesel, propane - butane mixture (LPG), compressed natural gas (CNG), light fuel oil
Checked parameters	Only the selected parameters affecting the environment (including the toxicity of exhaust gases)	All normative parameters of tested fuels
Sampling points (controls)	Only petrol stations (factory and public)	All elements of the fuel supply chain, i.e. producers, wholesalers, cisterns, petrol stations. Control in randomly selected companies based on information on inadequate fuel quality (driver complaints, police reports, negative results of previous inspections).
Annual reports on inspections	For the European Commission	For the Council of Ministers

4. RESULT OF TESTS OF FUNCTIONING SYSTEM OF MONITORING AND QUALITY CONTROL IN POLAND IN 2009-2018

In 2009 - 2018, the quality control of fuels carried out by the Trade Inspectorate in the area concerned the following areas:

- petrol stations, in which the quality of gasoline, diesel oil, diesel oil with 20 % ester content (B20) and an ester as separate fuel (B100) were controlled (for monitoring and drawing up a Report for the European Commission on the quality of liquid fuels and liquid biofuels),
- entrepreneurs running a business in the field of fuel production and storage,
- fuel wholesalers,
- fuel stations where quality control of liquefied gas (LPG) has been performed.

In the case of obtaining information indicating the possibility of wrong fuel quality, the fuel stations that were suspected were inspected. Information about improper fuel quality should be understood as complaints from drivers who, when buying fuel at the station, could notice its negative impact on the vehicle's operation. Other sources could include police information and negative results of previous inspections. **Figure 1** presents data on the results of quality control of liquid fuels in 2009-2018.

When assessing the presented results, it should be remembered that control activities carried out by the Trade Inspection are conducted on two separate levels, i.e. within the so-called European subsystem and other controls (National subsystem), whose goals differ from each other. Therefore, it is not possible to make a real comparison of the results from both parts due to the fact that the selection of entities to be audited is carried out in a different way (European part - lottery, other checks - complaints, negative results of previous inspections, information from law enforcement agencies). It seems, that the results of inspections carried out at the randomly selected stations (the European subsystem), precisely because of the way of selecting for control, present a real picture of the quality of fuels in Poland.

When comparing the results of fuel quality control over the years 2009 - 2018, it should be stated, that the share of samples that do not meet quality requirements in each year is shaped at other levels, which may be influenced by various factors, e.g.:

- number of entities checked, and samples taken,



- the range in which the samples are tested (European subsystem part or other controls - National subsystem),
- changing quality requirements (three different quality regulations during the observation period);
- number of parameters that are subject to testing.

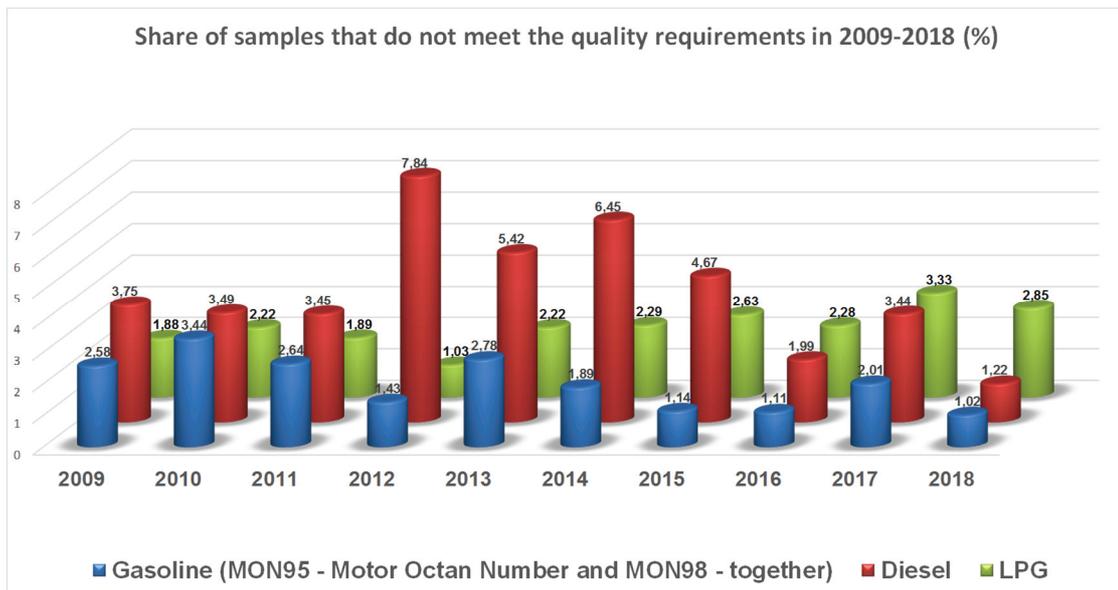


Figure 1 Results of quality control of liquid fuels in Poland in 2009-2018 (together-European and National Subsystem) [own study]

Taking into account the presented results, the following conclusions can be formulated:

- In the entire analyzed period, among all tested samples the worst results we can observe for diesel fuel.
- Definitely the best quality fuel is sold at the fuel stations of large producers (ORLEN, BP, STATOIL, etc.) and supermarket's fuel station (AUCHAN, CARREFOUR).
- In the entire analyzed period, there was no case of exceeding the quality parameters in both diesel and gasoline. The "leaders" of poor-quality fuel trade are small private petrol stations.
- A positive aspect of the operation of the liquid fuel quality control system is the fact that "quality supervision" covers all entities involved in trading on the liquid fuel market.

5. CONCLUSION

The system of monitoring and quality control of liquid fuels in the supply chain in Poland requires refinement and modification. An example is the fact that the following issues are unresolved:

- if the Trade Inspection receives information on poor quality of fuel, this fuel is not automatically withdrawn from trade and is subject to further distribution, and after examining the sample and receiving a negative result of the qualitative test, it turns out that the subject does not have the questioned fuel in its resources, because it has been entirely sold - as a result, the questioned fuel found its way to the end user,
- the system operates on the basis of computer zero-fault applications - the fuel tested either meets or does not meet the quality requirements, without completely differentiating the size of the exceeded parameter and its impact on the user's health or operational safety.

In addition, there is a high probability that at least some of the identified irregularities are the result of conscious and deliberate or unconscious actions of the human factor, such as:

- mixing effects resulting from diversified component compositions of liquid fuels (especially motor gasolines) occurring during the storage of fuels from various deliveries in fuel stations or wholesalers,
- contamination of motor gas with diesel oil and diesel oil pollution with gasoline, occurring during transport and storage of liquid fuels in tanks, to a negligible extent, the likely activities of an illegal production of liquid fuels.

It should be emphasized that the activities of the Trade Inspection conducted since 2004 as part of the system of monitoring and quality control, they have contributed significantly to improving the quality of fuels in Poland. In spite of the presence of poor quality fuels on the market, it should be remembered that during the first inspection carried out in 2003 (before the system started operation), the percentage of liquid fuels failing to meet the quality requirements was 30 %. Currently, the percentage of fuels of inadequate quality is at a much lower level, which is confirmed by the presented analyzes.

Poland is a good example of the fact, that a properly functioning system and consistent implementation of the fuel quality control program, are an effective tool for eliminating from the market fuel that does not meet quality standards, and thus an effective way to protect consumers.

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