SYSTEM OF MONITORING AND QUALITY CONTROL OF LIQUID FUELS IN POLAND - CONCEPTUAL MODEL

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Abstract

The conviction of good fuel quality determines whether the user is satisfied and loyal. The most important criterion in this case is trust in the quality offered. Achieving a compromise between quality and price is the main goal of the aspirations of most users of modern automotive technology. For some, it is the expectation of the highest quality, for others a satisfactory quality at the lowest possible price, but a minimum level of confidence is always a necessary condition that the fuel used will not harm the automotive technique used. The perception of fuel quality is much more often based on a skillfully created brand image than on the observations, experience and knowledge of customers, because the quality of fuel can only be objectively assessed by a professional laboratory, conducting sample tests in accordance with established standards and procedures. Therefore, we are dealing with a kind of asymmetry of knowledge between the fuel buyer and its supplier, which in turn requires a huge credit trust of customers, on the one hand, and on the other is a temptation to various types of abuse. That is why there are systems that play the role of an impartial, objective expert whose one of the tasks is to eliminate the mentioned asymmetry. Functioning systems often do not fully meet the requirements set out in them, which is why the presented concept of modification of the national system for monitoring and controlling the quality of liquid fuels in Poland, according to the author, can contribute to improving the effectiveness of eliminating inadequate quality fuels from the market.

The article discusses the legal foundations and main assumptions of the liquid fuel quality monitoring and control system in force in Poland, with particular emphasis on the risk of quality deterioration occurring in the distribution process. The biggest shortcomings of the functioning system were identified. The next part presents the author's proposition to modify the existing system of monitoring and quality control in Poland, developed on the basis of experience and conclusions gathered during the research on the correct functioning of the system in the years 2009 - 2018.

Keywords: Liquid fuels, supply chain, system of monitoring and quality control 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. 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 Community, 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 Community 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. 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 [7,8].

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 [1,2].

Deterioration of quality is caused by [3,5,6]:

- 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 condition.

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 [4]. 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* [13], 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.

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"* [9] and *EN 14275:2013 "Automotive fuels - Assessment of gasoline and diesel fuels quality - Sampling from retail and factory distributors"* [10]. 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.

The main assumptions of the system set out in the above standards are based on the following principles [14]:

- 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.

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* [11] and a dozen or so issued on the basis of its implementing regulations.

The basic structure, subject and principles of operation of the fuel quality monitoring and control system in Poland are as follows [11]:

- 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 [12];

- 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 (two parts):
  - European (compliant with EU requirements);
  - national.

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 [own study]

System element	European (part) subsystem	National (part) 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. CONCEPT OF MODIFICATION OF THE SYSTEM OF MONITORING AND QUALITY CONTROL LIQUID FUELS IN POLAND

To get to the presentation of the concept of system modification, you must first formulate general, universal substantive assumptions of the system:

1) The liquid fuel quality control system should be focused on obtaining reliable data on the quality of motor gasolines, diesel fuels and other fuels in specified locations of the logistics process.

2) The main goal of the system should be to prevent the distribution of liquid fuels not meeting the quality requirements specified in applicable regulations.

3) The system should cover all components of the fuel logistics process liquid.

4) The system should not be "repressive" by definition, since it is currently in force such a system has failed. Education on changing consciousness is necessary all system participants. The main philosophy of the system should be preventive actions, i.e. counteracting mechanisms leading to deterioration of fuel quality. It is proposed that the penalty imposed on dishonest sellers was an order to suspend the sale of fuel of poor quality, until it is replaced in the tank (at the owner's expense).

5) In addition to controlling the current state of fuel quality, the system should seek to determine causes of poor quality and their elimination or minimization. It is necessary introduction of feedback, i.e. implementation of conclusions resulting from the analysis results of qualitative research in improving the functioning of the system.

6) The results of tests and qualitative analyzes of liquid fuel samples taken should serve as databases to develop appropriate procedures to eliminate fuels of poor quality liquid from commercial trading - the system should be open.

7) The system should be as close as possible to the relevant EU legislation regarding fuel quality control.

8) The system should have an internal (own) control subsystem, so-called Quality Inspectorate, e.g. checking if the sample taken actually comes from the place provided in the label; should control the repeatability and reproducibility of test results qualitative samples of liquid fuels.

9) It is necessary for the system manager to draw conclusions and take corrective actions, leading to the improvement of the quality of liquid fuels on the basis of mandatory end of each year of reporting documents (Trade Inspection reports) - existence of a "coupling back".

10) The system cannot be too expensive during implementation.

11) The system should have a clearly defined boundary purpose from the very beginning - one can speak of full correctness of its functioning in the case of participation in sales (turnover) of poor quality samples at a level not exceeding 3 %.

Taking into account these assumptions, it is proposed to modify the national monitoring system and quality control of liquid fuels in the following areas:

1) Responsibility for individual areas of the system should be divided into two parts:

- Trade Inspection - would only be responsible for collecting samples for analysis and immediately forward them to the laboratory;

- Office of Competition and Consumer Protection - would be responsible for functioning all other elements of the system, exercising substantive supervision over its proper functioning (System Manager).

2) Introduction of mobile quality control laboratories subordinate to the Trade Inspection, used at the request of the System Manager when receiving a notification suspected inadequate fuel quality. Such laboratory should be equipped in research equipment necessary to quickly determine the values of basic parameters qualitative liquid fuels. In case of a positive result of an on-the-spot check at the controlled entity, samples are not taken for analysis and sent to laboratory to determine all specified quality parameters in relevant regulations. This will reduce the operating costs of the whole system.

3) Establishment of the Quality Inspectorate, an independent unit reporting directly to the Managing Authority a system that would act as a quality police. It should be composed of experts whom the task will be to check the correct functioning of all system components, including the area of responsibility of the Trade Inspection. Inspectors should have competence to independently collect and submit samples for qualitative analyses anywhere in the system. Their actions would be aimed at eliminating fraud at collecting samples and determining the reproducibility and repeatability of tests in mode continuously.

4) Indication of one central laboratory performing qualitative analyses of samples collected samples and three laboratories conducting counter-sample analyses. Choosing a laboratory for follow-up analysis should be done by lot. Counter sample forwarded to control (repeat) analysis should be marked in an anonymous way, preventing it the ability to identify where it was downloaded and view the result of the quality control carried out in the central laboratory. The result of the check-up (regardless of whether or not positive or negative) should be sent directly to the cell dealing with results analysis (reporting to the System Manager), bypassing central laboratory. This will ensure full objectivity of research.

5) It is proposed to modify the existing sampling method for analysis qualitative - the change should concern the number and purpose of individual samples. Three (instead of two as usual) should be taken for analysis:

- sample A - intended for basic qualitative analysis - collected directly by the inspector and transferred to the executing laboratory analysis, no later than within 12 hours of collection;

- sample B - counter-sample - intended for control analysis in the event of disclosure deviations from the norm in sample A - taken by the inspector and transferred with sample A to the laboratory performing the analysis, not later than within 12 hours of collection; in case of deviations from quality standards (in sample A) it is sent to the selected laboratory by lot;

- sample C - secured by the inspector and left in place at the controlled person; can be used by the controlled entity to conducting qualitative analysis at your own expense (only in the laboratory accredited), and the results obtained in this way should be treated by the courts in criminal cases on an equal footing with those obtained in laboratories participating in the system - this is to ensure possibility of defence.

The samples taken should be marked so that the location cannot be determined their collection by unauthorized persons or persons conducting qualitative analyses, and such identification would be possible only through a special cell reporting directly to the Manager the system after passing data from the Trade Inspection.

6) To improve the reliability of the "national" subsystem, due to the high costs functioning, low efficiency and systematic reduction of financial resources allocated to its implementation, the scope of control should be limited to testing parameters qualitative as in the 'European' subsystem with the proviso that they have been downloaded all parameters that are given must be inspected in quality standards (eliminating the possibility of influencing the selection of parameters up to testing by the System Manager).

7) It is necessary to perform the full implementation of the standard in the scope of appropriate selection "country model" for statistical assessment of the quality of fuels placed on the market liquid - transition from model B to model A - increase in the number of analysed samples up to about 200 per year for each fuel tested. This will allow for fuller image reproduction of liquid fuel quality in Poland.

8) It seems advisable to divide all normative parameters of fuels liquid into two groups:

- group I - parameters important from the point of view of operational safety, constituting 20 % of the causes causing 80 % of all effects of liquid fuels inadequate quality (using the assumptions of the Pareto-Lorenz diagram concept); all quality parameters indicated in this way should be mandatory controlled by mobile laboratories upon receipt notifications of suspected inadequate fuel quality;

- group II - all other quality parameters specified in the relevant ones regulations (less important from the point of view of operational safety), whose change is not directly related to the intentional action of third parties (e.g., natural storage processes, inadvertent cause accidental quality change).

9) During the development of the results of the analysis and handling of the entity found poor quality fuel should only focus on those system participants logistic in which evident and intentional adulteration of a fuel batch was found - this would result in greater transparency of the analyses presented and would increase efficiency in eliminating dishonest sellers from the market.

10) In the event of receiving a signal about the trade of poor quality fuel (obligatory confirmed from several sources), guaranteeing IH representatives the possibility of publishing immediate decisions suspending the authorization of trading in liquid fuels until the moment of receiving the results of the qualitative analysis of "suspicious" fuel. After taking a sample of the product immediately, it should be sent immediately to analyses and treated by the system laboratory as a priority in research study "instant control" (the test result should be known within 72 hours). Because of the possibility pursuing claims by the controlled entity due to incurred losses termination such must be implemented at the statutory level.

11) Introduction, the so-called deviations allowed for quality parameters from group II. This would allow a more reliable representation of the quality picture and avoid e.g. a problem stigmatizing distributors for violating vapor pressure during transitional periods.

12) Inclusion in the "European part" of the system liquefied petroleum gas (LPG), exceptionally fuel important in our country.

13) Enabling the System Manager to modify its functioning on based on the conclusions and proposals presented by the team analysing the results research, so-called "open system" - such a provision should be included in the [11].

The implementation of the proposed system changes has been presented in the form of an algorithm in **Figure 1**.
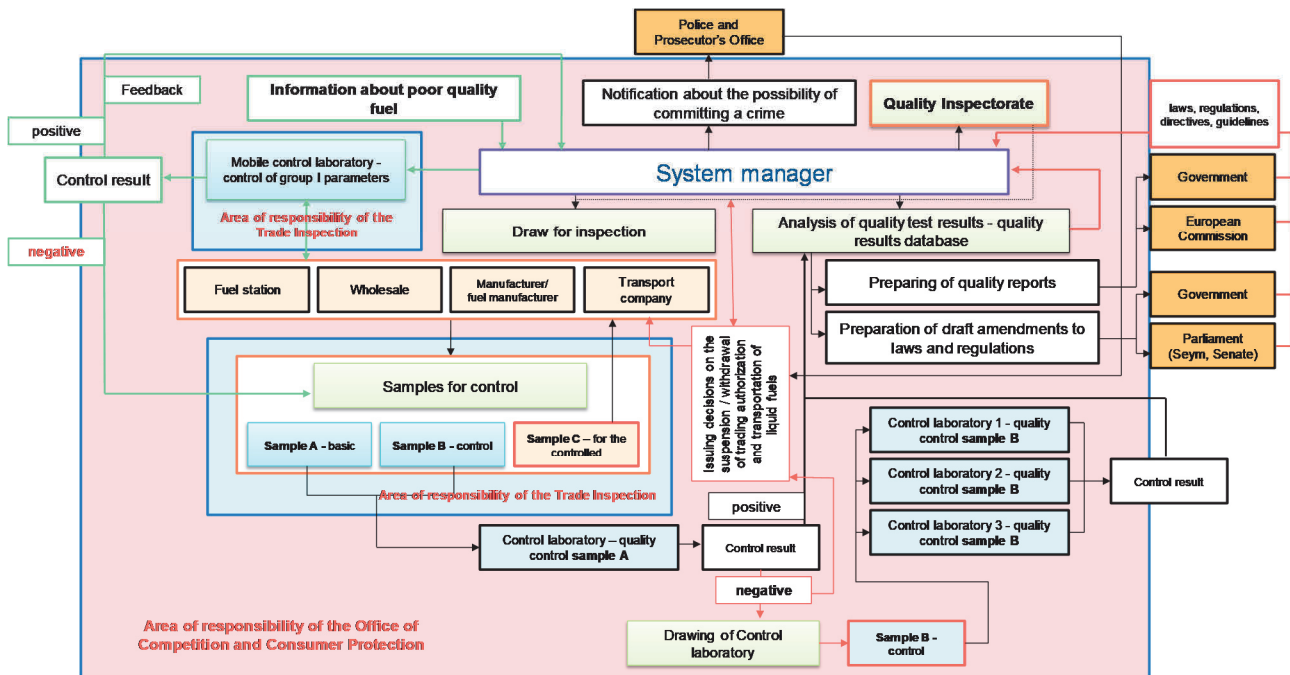

Figure 1 The concept of the modification of system of monitoring and quality control of liquid fuel in Poland [own study]

5. CONCLUSION

The conviction of good fuel quality determines whether the user is satisfied and loyal. The most important criterion in this case is trust in the quality offered. A compromise between quality and price is the main goal of the majority's aspirations users of modern automotive technology. For some, this is the highest expectation quality, for others satisfactory quality at the lowest price, but always a condition a minimum level of confidence is needed that the fuel used will not hurt used automotive technology. Fuel quality perception is more often based on skillfully created brand image than on the observations, experiences and knowledge of customers, because the quality of fuel can be objectively assessed only by a professional laboratory, conducting research samples in accordance with established standards and procedures. So we are dealing with a certain type knowledge asymmetry between the fuel buyer and his supplier, which in turn requires one huge credit trust of customers, on the other hand it is a temptation to various types of abuse. That is why there are systems that play the role of an impartial, objective expert, of which one of the tasks is to eliminate this asymmetry. Functioning systems often not quite meet their requirements, which is why the concept of national modification is presented monitoring and quality control system of liquid fuels in Poland, the task of the author may be contribute to improving the effectiveness of eliminating inadequate quality fuels from the market.

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