

International Requirements and Modern State in Sphere of Motor Fuels Quality Control: Basic Principles of Monitoring and Control



Olena Sibilieva , Sofia Dokshyna , and Petro Topilnytskyi 

1 The Origin and Supply Chain of Liquid Fuels to the Consumer Market, the Current State of Non-Food Product Quality and International Obligations for Ukraine

Implementation of technical solutions, regulations and directives of the European Union in Ukraine is an urgent task and a key component of ensuring the protection of consumer interests, environmental safety, and national security, including creating conditions for a free trade area for exports and imports of products. Given the challenges of today, on the path of recovery and sustainable development of Ukraine, with the aim of Ukraine's full membership in the EU and bringing the living standards of Ukrainians closer to the European level, the key issues of European integration, trade liberalization, and the removal of trade barriers are the main topical areas of the country. In particular, the Action Programme of the Cabinet of Ministers of Ukraine, approved by the Resolution of the Cabinet of Ministers of Ukraine № 471 dated 12.06.2020, has relevant goals that include the launch of new forms of cooperation with EU countries, updating the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand (hereinafter—the Association Agreement),

O. Sibilieva (✉)

State Environmental Inspectorate, Kyiv, Ukraine

S. Dokshyna

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine

e-mail: dokshyna.sofia@lil.kpi.ua

P. Topilnytskyi

National University "Lviv Polytechnic", Lviv, Ukraine

concluding an Agreement on Conformity Assessment and Acceptance of Industrial Products, and implementing international acts in Ukraine.

Pursuant to Article 56 of the Association Agreement, in order to guarantee the free movement of products to the EU countries, one of the steps for Ukraine is the obligation to harmonize EU legislation, including the requirements for the implementation of the Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20.06.2019 on market surveillance and compliance of products and amending Directive 2004/42/EC and Regulations (EC) No 765/2008 and (EU) № 305/2011 (hereinafter—Regulation № 1020), the provisions of which provide for a high level of protection of the public interest, increased consumer confidence, fair competition, public safety and environmental protection, which is achieved through enhanced state control, state market surveillance, elimination of risks of non-compliant and dangerous products, ensuring equal conditions for all business entities, with the mandatory introduction of clear, transparent and comprehensive rules, promotion of closer cross-border cooperation between law enforcement and customs authorities [1]. In particular, the provisions of Regulation № 1020 provide for the harmonization of 70 international acts of the EU, including Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC (hereinafter—Directive 98), Regulation (EC) № 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (hereinafter—Regulation № 715), etc.

Motor gasoline and diesel fuel (hereinafter—liquid fuels) are a mixture of liquid hydrocarbons obtained from the refining of crude oil and gas condensate (their mixtures). The transport industry accounts for the bulk of liquid fuels consumption (60%), and their quality is a key to the reliability, efficiency, and environmental friendliness of machines and mechanisms during operation, and an important component in the field of environmental protection, human life and health [2].

Quality control of liquid fuels in Ukraine is carried out in accordance with the Technical Regulations on the requirements for motor petrol, diesel, marine and boiler fuels (hereinafter—the Technical Regulations), including in accordance with the procedure provided for by the Law of Ukraine "On State Market Supervision and Control of Non-Food Products". The Technical Regulation is developed in line with Directive 98 and should include requirements to improve the quality of liquid fuels in terms of air pollution, including the introduction of environmental standards aimed at reducing emissions of gases and vapors from mobile and stationary sources, reducing the share of flavorings, olefins, sulphur, unburned hydrocarbons, carbon monoxide, as well as toxic emissions and secondary pollutants such as ozone, including the introduction of refining technologies for the sale of unleaded petrol, and the prohibition of the sale of leaded petrol due to the threat of air pollution caused by petrol combustion and lead ingress, which poses a threat to human health and the environment [3, 4].

According to the State Customs Service of Ukraine, in 2022, the total volume of imports of certain product subcategories of liquid fuels (Ukrainian Classification of Goods for Foreign Economic Activity codes 27,101,241, 27,101,245, 27,101,249,

2,710,194,300, 2,710,194,600, 2,710,194,710, 2,710,194,790, 2,710,194,800) amounted to 6,943,174.61 tons of products (worth 4,713,148.11 thousand USD) and was 10.6% less than in 2021 (total volume 7,768,738.14 tons, worth 8,302,999.05 thousand USD). In 2022, Ukraine imported liquid fuels from 42 producing countries (Hungary, Greece, the EU, Lithuania, Romania, Belgium, Bulgaria, Belarus, Israel, India, Spain, Italy, Malaysia, the Netherlands, Germany, Turkey, Turkmenistan, Israel, etc.), including the supply of products from 21 countries of origin whose imports were not registered in 2021 (Austria, Georgia, Denmark, Estonia, Egypt, Kazakhstan, China, Cyprus, Latvia, Republic of Moldova, and Ukraine, North Macedonia, Poland, Saudi Arabia, Serbia, Slovakia, Slovenia, Taiwan Province of China, Sweden, Finland, Tunisia, United Arab Emirates (total volume of 820,801.71 tons and worth 1,110,861.77 thousand USD). According to the State Tax Service of Ukraine, as of the beginning of 2022, 54,068 business entities were engaged in the business of liquid fuels in Ukraine, including the number of licenses issued (renewed) for the wholesale trade in fuels in the absence of wholesale trade outlets, was 3489 (328) for the wholesale trade in fuel, in the presence of wholesale trade outlets—711 (68), for fuel production—77 (9), for retail trade in fuel—11,768 (6091), for fuel storage—4010 (233), for fuel storage (exclusively for own consumption or industrial processing)—34,013 (8549) licenses, respectively. Given the origin and supply of liquid fuels to the Ukrainian consumer market, it can be determined that the products reach the consumer from both domestic and foreign producers. Oil products can be transported via main oil pipelines, rail, sea and road transport operators. Liquid fuels reach the consumer market based on the results of their production and on the results of "quality improvement", namely changes in physical and chemical properties by using (adding) additives, dopes and colorants to liquid fuels (Fig. 1). Taking into account the requirements of the Technical Regulations, the Law of Ukraine "On Technical Regulations and Conformity Assessment", Resolution of the Cabinet of Ministers of Ukraine dated 13.01.2016 № 95 "On Approval of Conformity Assessment Modules Used to Develop Conformity Assessment Procedures and Rules for Using Conformity Assessment Modules", for fuels produced or imported in batches, as well as for fuels produced in experimental batches, the manufacturer or an authorized representative must apply the conformity assessment procedure according to module F1, for fuels produced in series (domestic production)—module A1 [5, 6]. Based on the results of the conformity assessment, the manufacturer or an authorized representative must draw up a declaration of conformity, thus confirming by the first party that the liquid fuel meets the requirements of the Technical Regulations and that the specified requirements for the product and/or process have been met. Each batch of liquid fuel that is put into circulation or is in circulation must have a quality document (quality passport) for the fuel, on which the manufacturer or an authorized representative affixes the national conformity mark, which also confirms the fuel's compliance with the requirements of the Technical Regulations [7]. According to the Ministry of Energy of Ukraine, in 2022, based on the results of the conformity assessment to confirm the quality of motor fuels to the requirements of the Technical Regulations, conformity assessment bodies issued 80 certificates of conformity, which was 8.5 times less than in 2021 (682 certificates). A decrease in the number of

issued certificates of conformity may indicate the introduction of liquid fuels in the Ukrainian market in the absence of a conformity assessment and non-compliance by business entities with the requirements of the law, and as a result, the introduction and distribution of products of unknown origin with questionable quality. Thus, according to the Department of Strategic Investigations of the National Police of Ukraine, it was established that in 2022 the number of pre-trial investigations into criminal offences related to fuel trafficking amounted to 35 proceedings (including 27 under part one of Article 204; 5—under part two of Article 204 of the Criminal Code of Ukraine; 1—under part three of Article 204 of the Criminal Code of Ukraine; 2—under part one of Article 227 of the Criminal Code of Ukraine), which was 1.4 times higher compared to 2021 (25 pre-trial investigations). According to the State Tax Service of Ukraine, based on the results of the identified violations of tax legislation, in 2022, fines totaling 932.7 million UAH were imposed on business entities engaged in the sale of liquid fuels in Ukraine, which was 3.6 times less than in 2021 (3,367.8 million UAH). In particular, the results of the work of interagency regional working groups on combating illegal fuel trafficking showed that in 2022, 26.4% of fuel retail activities were carried out in the absence of quality documents (quality passports) and declarations of conformity, which is a violation of the Technical Regulations.

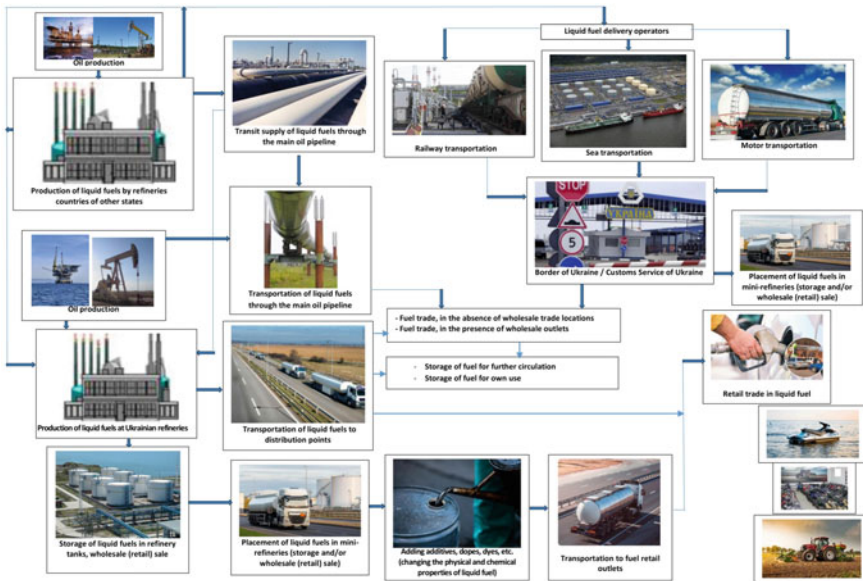


Fig. 1 Origin and supply of liquid fuels to the Ukrainian consumer market (photo from open sources)

2 Environmental Performance of Petrol and Diesel Fuels in Line with International Requirements

Comparing the requirements for environmental performance of petrol set out in Annexes 2 and 8 to the Technical Regulation, Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (hereinafter—Directive 2009/30/EC) and Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC (hereinafter—Directive 98), it can be determined that the quality control of petrol in the EU Community countries (hereinafter—the Community) is examined by 18 parameters, and in Ukraine—by 10 parameters (Table 1) [3, 4, 8].

In accordance with paragraph 1 of Appendix 1 to the Technical Regulations for automobile gasoline, designations are defined, which include such groups as: the first group—letter A, designation of gasoline for automobile engines with forced/spark ignition; the second group—digital designation of the octane number of automobile gasoline (80, 92, 95, 98) according to the experimental method; the third group—ecological class symbols: Euro3, Euro4, Euro5; the fourth group is a symbol for determining the content of bioethanol: E5, E7, E10.

Taking into account the above designations, in the Technical Regulations, the octane number according to the experimental and motor methods differs for gasoline brands A-80, A-92, A-95, A-98 (also taking into account the environmental class: Euro3, Euro4, Euro5), the saturated vapor pressure depends on the period of the year with a range from 45 to 90 kPa, the oxygen content depends on the bioethanol content and is no more than 2.7% for gasoline E0, E5, E7, and no more than 3.7% for gasoline E10.

In accordance with Directive 2009/30/EC, the environmental parameters for gasoline in the Community countries clearly define the content of ethanol as an oxidant and stabilizing component, which may not exceed 10%, and also define the content of such oxidants as methanol—up to a maximum of 3.0%, isopropyl alcohol—up to 12%, isobutyl alcohol—up to 15%, tertiary butyl alcohol—up to 15%, esters—up to 22%, and the indicator "other oxidants"—up to 15%.

According to Annex 2 to the Technical Regulation, the indicator ethanol is absent, however, there is an indicator of bioethanol content, which should be equal to 0% for E0 petrol, no more than 5% for E5, more than 5% and no more than 7% for E7, and more than 7% and no more than 10% for E10. In particular, the notes to Annex 2 to the Technical Regulation state that for E0, E5 and E7 petrols, the use of oxygen-containing additives other than bioethanol is additionally allowed, namely methanol up to 3% by volume, isopropyl alcohol up to 10% by volume, isobutyl alcohol—up to 10% by volume, tertiary butyl alcohol—up to 7% by volume, ethers—up to 15% by volume, other organic oxygen-containing compounds with a boiling point not

Table 1 Environmental performance of petrol

Parameters	Units of measurement	Limits ¹		Limits ²	
		Min	Max	Min	Max
Octane number by the research method		95	–	95	–
Octane number by motor method		85	–	85	–
Saturated vapour pressure	kPa	–	60.0	Summer: 45–80 Winter: 60–100 Transition period: 50–90	
Distillation:					
– Fraction of evaporation at 100 °C	% v/v	46.0	–	The indicator is absent	
– Fraction of evaporation at 150 °C	% v/v	75.0	–		
Hydrocarbons:					
– Olefins	% v/v	–	18.0	–	<18
– Aromatic (hydrocarbons)	% v/v	–	35.0	–	<35
– Benzene	% v/v	–	1.0	–	<1
Oxygen content	% m/m	–	3.7 ³	–	<2.7 (E0, E5, E7) <3.7 (E10)
Oxidants:					
– Methanol (stabilising agent)	% v/v	–	3.0	Indicators are specified in the notes to Annex 2 of the Technical Regulation, ethanol is equivalent to bioethanol, the content of oxygen-containing compounds depends on the content of bioethanol for E0, E5, E7, E10	
– Ethanol (stabilising agent)	% v/v	–	10.0 ³		
– Isopropyl alcohol	% v/v	–	12.0		
– Tert-butyl alcohol	% v/v	–	15.0		
– Iso-butyl alcohol	% v/v	–	10.0		
– Esters that contain more than 5 carbon atoms	% v/v	–	22.0		
Other oxidants	% v/v	–	15		
Sulphur content	mg/kg	–	10.0	–	<10

(continued)

Table 1 (continued)

Parameters	Units of measurement	Limits ¹		Limits ²	
		Min	Max	Min	Max
Lead content	g/l	–	0.005	–	<5 mg/dm ³
Volume fraction of bioethanol	%	Not specified		–	0 (E0) < 5 (E5) 5–7 (E7) 7–10 (E10)

Note

¹Annex 1 to Directive 2009/30/EC [4, 8];

²Annex 2 to the Technical Regulation (for A-95 Euro5) [3];

³For floating vessels and other special and recreational vehicles, in accordance with Directive 98 with a maximum oxygen content of 2.7%, the ethanol content (regardless of octane number by the motor method (95 or 98)) may not exceed 5%

exceeding 210°C—up to 10% by volume, provided that the mass fraction of oxygen does not exceed 2.7%.

For E10 petrols, the use of oxygen-containing additives other than bioethanol is additionally allowed: methanol—up to 3% by volume, isopropyl alcohol—up to 12% by volume, isobutyl alcohol—up to 15% by volume, tert-butyl alcohol - up to 15% by volume, ethers—up to 22% by volume, other organic oxygen-containing compounds with a boiling point not exceeding 210 °C—up to 15% by volume, provided that the mass fraction of oxygen does not exceed 3.7%.

Taking into account Annex 1 “Quality requirements for motor gasoline with a maximum oxygen content of up to 3.7% (m/m), used especially in vehicles and floating entertainment vehicles equipped with spark ignition engines” to the Regulation of the Ministry of Economy of the Republic of Poland dated 09.10.2015 (hereinafter—Regulation 1680) stipulates that in motor petrols with octane number 95, 98 (without tin), with a maximum oxygen content of up to 3.7% (m/m), used in vehicles and recreational floating craft equipped with spark ignition engines, the ethanol content (as a stabiliser) may not exceed 10% (v/v) [9].

In particular, in accordance with Annex 2 of Regulation 1680, motor gasoline with an octane rating of 95, 98 (tin-free), with a maximum oxygen content of up to 2.7% (m/m), used in vehicles and recreational boats equipped with spark ignition engines, the ethanol content (as a stabilizer) may not exceed 5% (v/v).

Also, in Annexes I-IV of Directive 98, in the Regulation 1680, the indicator bioethanol is absent in the parameters of quality requirements for motor gasoline; methanol, ethanol are indicated as stabilizers; isopropanol, -2-methylpropanol-2, -isobutanol, -esters, other oxygen-containing bonds are parameters of quality requirements for motor gasoline and are defined as the content of organic oxygen-containing bonds [4, 9].

In particular, Directive 98 and Regulation 1680 do not specify whether alcohols belong to biomethanol, bioethanol, biobutanol, their synthetic products, including

their use as biocomponents, and taking into account the test reports, that accompanied the fuel for putting into circulation on the territory of Ukraine in 2022 under № PBZ-007071EN of 21-DEC-2022, Gasoline Standard 95/EN228-10 ppm (petrol with octane number 95) contained a limit on ethanol content $\leq 5\%$ (v/v), while in fact it was 0.13% (v/v), the limit on oxygen content $\leq 2.7\%$ (m/m), in fact—2.19% (m/m); № PBZ-0070759EN of 25-DEC-2022 Gasoline Standard 95/EN228-10 ppm, petrol with octane number 95, oxygen content limit $\leq 2.7\%$ (m/m), actually—1.92% (m/m), ethanol content limit $\leq 5\%$ (v/v), actually—0.11% (v/v); in the test report under № 4489/BP09/2022 data 2022–08-01 Benzyna Bezolowiowa 95 (petrol with octane number 95), the oxygen content limit was $\leq 2.7\%$ (m/m), in fact—2.10% (m/m), the ethanol content limit was $\leq 5\%$ (V/V), in fact—4.6% (v/v); № 158746_4591871 data 2022–07-23 UNLEADED PETROL “Premium” grade 95 with oxygen of 2.7% (m/m) (petrol with octane number 95, with a maximum oxygen content of up to 2.7%) the ethanol content limit is $\leq 5\%$ (v/v), in fact—0% (v/v).

Thus, the ethanol content in the Community countries is controlled and cannot exceed the established requirements, and international directives and regulations do not specify different designations (names) of petrol based on the share of bioethanol.

Article 1 of Directive 2009/28/EC defines a common framework for encouraging the production of energy from renewable sources, provides mandatory national targets for the share of energy produced from renewable sources in the total final energy consumption, as well as the share of energy produced from renewable sources for energy consumption in the transport sector; rules are introduced on statistical transfers between Member States, joint projects between the latter and with third countries, guarantees of origin, administrative procedures, information, training and access to the grid for energy produced from renewable sources; stability criteria for biofuel and biofuel liquids are determined [8].

Article 2 of Directive 2009/28/EC defines that “energy produced from renewable sources” means energy produced from non-fossil renewable sources (wind, solar, geothermal, hydrothermal, marine and hydroelectric, biomass energy, landfill gas, gas from sewage and biogas treatment plants); “biomass” —part of products subject to biological decomposition, waste and residues of biological origin obtained from agriculture (including substances of plant and animal origin), forestry and related industries, including fishing and aquaculture, as well as part of industrial and municipal waste, which is biodegradable, “biofuel liquid” means a liquid fuel produced from biomass and intended for energy use other than transport, including electricity generation, heating or cooling, “biofuel” means a liquid or gaseous fuel produced from biomass that is used for transport.

In particular, in accordance with Annex 3 of Directive 2009/28/EC, it is defined that bioethanol is ethanol produced from biomass, bio-ETBE is ethyl tert-butyl ether produced from bioethanol, biomethanol is methanol produced from biomass and is used as biofuel.

Thus, in the Technical Regulation, the indicator “bioethanol” needs to be clarified regarding its use, including taking into account the way of its extraction and use in liquid fuel in the territory of Ukraine.

Comparing the requirements for environmental performance of diesel fuel set out in Annexes 3 and 9 to the Technical Regulation, Directive 2009/30/EC and Directive 98, it can be determined that diesel fuel quality control in the Community countries is mainly based on 6 parameters, while in Ukraine—on 8 parameters, in particular, Directive 98 and Directive 2009/30/EC do not define the indicators “flash point in a closed cup”, “maximum filterability temperature”, “lubricity” (diameter of wear spot at 600 °C), which are given in the Technical Regulation, and vice versa, Annexes 3, 9 to the Technical Regulation do not contain such a quality indicator as diesel density at 15 °C, which are specified in international documents (Table 2).

Table 2 Environmental parameters of diesel fuels

Parameters	Units of measurement	Limits ¹		Limits ²	
		Min	Max	Min	Max
Cetane number		51.0	–	Summer: 51 winter: 49 arctic: 48	–
Density at 15 °C	kg/m ³	–	845.0	The indicator is absent	
Distillation or fractional composition 95% by volume distilled at	°C	–	360.0	–	< 360
–Polycyclic aromatic hydrocarbons	% m/m	–	8.0	–	< 8
Sulphur content	mg/kg	–	10.0	–	< 10
–Flash point in a closed crucible	°C	The indicator is absent		–	> 55
Filtration limit temperature	°C	The indicator is absent		–	Summer minus 5 Winter minus 20 Arctic minus 30
Lubricity (wear scar diameter at 60 °C)	micrometres	The indicator is absent		460	–
Volume fraction of methyl/ethyl esters of fatty acids	% v/v	–	7,0	–	For DP [in Ukrainian] B0—0; for DP [in Ukrainian] B5—no more than 5; for DP [in Ukrainian] B7—more than 5 and not more than 7

Note

¹ Annex 2 to Directive 2009/30/EC [8];

² Annex 3 to the Technical Regulation (for Euro 5) [3]

Paragraph 2 of Annex 1 to the Technical Regulation contains the following groups of diesel fuel designations: the first group includes the letters DP [in Ukrainian], the designation of diesel fuel for automotive diesel engines; the second group includes the letter designation of the climatic period: L [in Ukrainian] (summer), Z [in Ukrainian] (winter), Ark [in Ukrainian] (arctic); the third group includes environmental class symbols: Euro3, Euro4, Euro5; the fourth group is a symbol for determining the content of methyl/ethyl esters of fatty acids: B0 (in their absence), B5, B7.

Thus, in Ukraine, the parameters of diesel fuel in terms of cetane number, maximum filterability temperature, and volume fraction of methyl/ethyl esters of fatty acids differ both by climate period (summer, winter), environmental class symbol (Euro3, Euro4, Euro5), and the content of methyl/ethyl esters of fatty acids, the value of which is not reflected in international directives.

In accordance with the requirements for the characteristics of motor gasoline and diesel fuel set out in Annexes 2, 3, 8, 9 to the Technical Regulations, in 2022, amendments to paragraph 26 of the Technical Regulations (Resolution of the Cabinet of Ministers of Ukraine № 292 dated 16.03.2022) removed paragraphs two and three of paragraph 26 of the Technical Regulations, namely, the deadline for the introduction into circulation of automobile gasoline and diesel fuel of the environmental class Euro 3 by December 31, 2015 and Euro 4 by December 31, 2017 has been canceled.

In particular, taking into account the requirements of Annexes 1, 2, 3, 8, 9 of the Technical Regulation, from March 16, 2022, the introduction of automobile gasoline and diesel fuel of the environmental class Euro 3 and Euro 4 with the appropriate designation of the environmental class into circulation on the market of Ukraine is again allowed: for gasoline according to the content bioethanol (E0, E5, E7, E10) and octane number (80, 92, 95, 98); for diesel fuel—according to the content of methyl/ethyl esters of fatty acids (B0, B5, B7) [3].

Thus, the above-mentioned requirements of the Technical Regulation allow the introduction into circulation in Ukraine of liquid fuels according to the environmental class Euro 3 and Euro 4, with a sulfur content for gasoline from 50 to 150 mg/kg, diesel fuel from 50 to 350 mg/kg, which does not correspond international requirements, which create conditions for exceeding the standard emissions of maximum permissible concentrations of toxic substances, heavy metals into the atmospheric air (nitrogen dioxide, carbon oxides, others) and, as a result, pollution of the atmospheric air and the environment as a whole.

3 Implementation of a Fuel Quality Monitoring and Control System as a Key to Reducing Hazardous Substances Emissions and Ensuring Environmental and Human Health Safety

Commission Regulation (EC) № 692/2008 of 18 July 2008 implementing and amending Regulation (EC) № 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (hereinafter—Regulation № 715) is a legal document of the Community countries, which aims and regulates the determination of specific technical requirements for the control of emissions from vehicles, including the approval of the type of mechanical vehicles taking into account emissions into atmospheric air from light passenger and cargo vehicles, approval of the type of mechanical vehicles taking into account the specification of fuel according to the environmental class Euro 5 and Euro 6 [10].

Thus, in accordance with paragraph 3 of Article 1 of Regulation № 715, gaseous pollutants are emissions of carbon monoxide and nitrogen oxide expressed in terms of nitrogen dioxide (NO₂) equivalent and have the following ratios: C₁H_{1.89}O_{0.016} for petrol (E5), C₁H_{1.86}O_{0.005} for diesel fuel (B5), C₁H_{2.525} for liquefied petroleum gas (LPG), C₁H₄ for natural gas (NG) and biomethane, and (E85) C₁H_{2.74}O_{0.385} for ethanol.

In accordance with the requirements of Regulation № 715, in order to determine the suitability of a vehicle for operation, the manufacturer shall conduct exhaust gas toxicity tests, measure fuel consumption and CO₂ emissions, and other measures, based on the results of which the manufacturer receives official approval of the vehicle type from the competent authority in terms of emissions into the atmosphere.

In particular, the provisions of Regulation № 715 introduce mass and quantity limits for exhaust particle emissions, requirements for the conformity of production and goods during the operation of vehicles, requirements for the approval of the type of pollution control devices, as well as requirements for easily accessible information on on-board diagnostics, repair and maintenance.

Directive 2009/30 amended Directive 98 on petrol and diesel fuel specifications, introducing a mechanism for monitoring and reducing greenhouse gas emissions with regard to the protection of the environment and human health, and reducing greenhouse gas emissions, emitted during the entire life cycle of road vehicles and off-road mobile machinery (including inland navigation vessels when not at sea), agricultural and forestry tractors and recreational vessels, and appropriate changes in the environmental parameters of petrol and diesel fuel [8].

The requirements of such technical specifications are the introduction of petrol with a maximum sulphur content of 10 mg/kg, oxygen 2.7%, ethanol 5% (oxygen 3.7%, ethanol 10% for floating vessels and other special and recreational vehicles). For the Community countries with low summer ambient temperatures (Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Sweden, the United Kingdom), it is

allowed to sell ethanol-containing petrol with a maximum vapour pressure of 70 kPa during the summer period, and 60 kPa for other countries. It also stipulates that Community countries may continue to allow the sale of small quantities of leaded petrol with a lead content not exceeding 0.15 g/l, up to a maximum of 0.03% of total sales, for use in older vehicles.

As of 1 January 2011, the maximum permissible sulphur content of gas oils shall be 10 mg/kg and Community Member States shall ensure that liquid fuels other than gas oils may be used in inland navigation and pleasure craft, agricultural, forestry tractors and recreational vessels only if the sulphur content of such liquid fuels does not exceed the maximum permissible content of such gas oils. In particular, for the Community Member States with severe winter weather, the maximum distillation point for 65% should be at 250 °C, for diesel fuel and gas oil—10% at 180 °C [8, 10–13].

According to the 2021 Annual Summary Report by Poland to the European Commission on the sulphur content of light fuel oil, heavy fuel oil, inland navigation fuel oil and marine fuel used in ships, it was determined that two exceedances of the permissible value for sulphur content (0.14% (m/m) and 0.12% (m/m)) were detected on ships out of 249 samples taken. The lowest sulphur content by weight was 0.00062% (m/m), and the highest was 2.42% (m/m). And the highest sulphur content value of 2.42% (m/m) was recognized as meeting the quality requirements, given the use of equipment with an exhaust gas cleaning system on the ship [14].

Taking into account the photo materials shown in Fig. 2, it can be determined that the type of fuel in the retail network of car and gas filling stations of some countries of the Community and in the city of Kyiv differs significantly, namely, in the countries of the EU Communities, mainly gasoline is introduced into the circulation of products with an octane number according to the motor method 95, 98, diesel fuel, liquefied gas. In the city of Kyiv, the sale of liquid fuels, the difference between gasoline with an octane number of 92, 95, 100, diesel fuel and liquefied gas, including the sale of various types of gasoline and diesel fuel with an octane number of 92, 95, 100 branded as “Shebel”, “Shell V –Power”, “Premium”, “Energy”, “Mustang”, “Euro Plus”, “Brand oil” others, which are put into circulation taking into account the change in their physical and chemical properties by adding additives, dopes, dyes to liquid fuels (fuel dopes) and the sale of liquid fuel products under its own brand.

According to some open sources, fuel dopes should be added to improve the quality of liquid fuels, improve performance, environmental and ergonomic characteristics, improve the combustion process, increase the octane or cetane number, as well as to increase their compression and reduce corrosion or oxidation in the working mechanisms of vehicles [15, 16].

According to data from some open sources, fuel dopes should be added in order to improve the quality of liquid fuels, to improve operational, environmental and ergonomic characteristics, to improve the combustion process, to increase the octane or cetane number, as well as to increase their compression and reduce corrosion or oxidation in working mechanisms of vehicles [15, 16].

According to some authors, there are currently more than 40 fuel additives that differ in purpose and brand (anti-detonation, cetane-enhancing antioxidant, anti-smoke, anti-carbon, antistatic, biocidal, depressants, detergents, anti-corrosion, etc.) [15, 17].

In addition to liquid fuel producers, fuel dopes are widely used in Ukraine by fuel distributors for marketing purposes and to create their own brand on the consumer liquid fuel market. In particular, given the absence of officially defined requirements and procedures for the use of such additives, dopes, colourants, as well as the identification of less harmful ones for use, their uncontrolled use in the country creates conditions for the introduction of liquid fuels of dubious and dangerous quality for vehicles, human health and the environment in general.

The requirements of the World Fuel Charter and Directive 98 define strict requirements for the use of fuel additives for various functional purposes by manufacturers, which are added to the mixture of liquid fuels during the production process, with compliance of fuel parameters with the requirements of technical standards, in particular, they clearly define the specification of liquid fuels according to the Euro 5 and Euro 6 environmental class [4, 10].

In particular, in some Community countries, in order to reduce toxic emissions and comply with the Euro 6 environmental standard, AdBlue is used as an additional operating fluid for diesel engines, which is placed in a separate tank (fuel dispenser) and used at the request of the consumer during refuelling. For cars and trucks, AdBlue is used in an average of 1.5–2.5 L per 1000 km (Fig. 3).

All European Union countries are required to check the quality of liquid fuels sold at petrol and gas stations. The obligation was established in view of the differences in legislation and administrative regulations adopted by the Member States on fuel specifications, in particular, it was recognized that differences in requirements create obstacles to trade within the Community, and therefore directly affect the functioning of the internal market, the international competitiveness of both the European automotive industry and the oil refining industry.

According to paragraph 8 of Regulation 2009/30, the combustion of road fuels is responsible for around 20% of greenhouse gas emissions in the Community. One approach to reducing these emissions is to reduce greenhouse gas emissions throughout the life cycle. Reducing such emissions involves a gradual reduction of greenhouse gas emissions by up to 10% per unit of energy through the use of biofuels, alternative fuels and reduced combustion at production sites, including through the use of environmentally friendly carbon capture and storage technologies and the use of electric vehicles.

In addition, the protection of human health and the environment was taken into account, as air pollutants, nitrogen and sulphur oxides, unburned hydrocarbons, particulate matter, carbon monoxide, benzene and other toxic substances emitted in vehicle exhaust gases pose a direct and indirect threat. Therefore, in 2003, the European Parliament adopted Directive 2003/17/EC amending Directive 98, setting new, more stringent environmental requirements for fuels on the market.

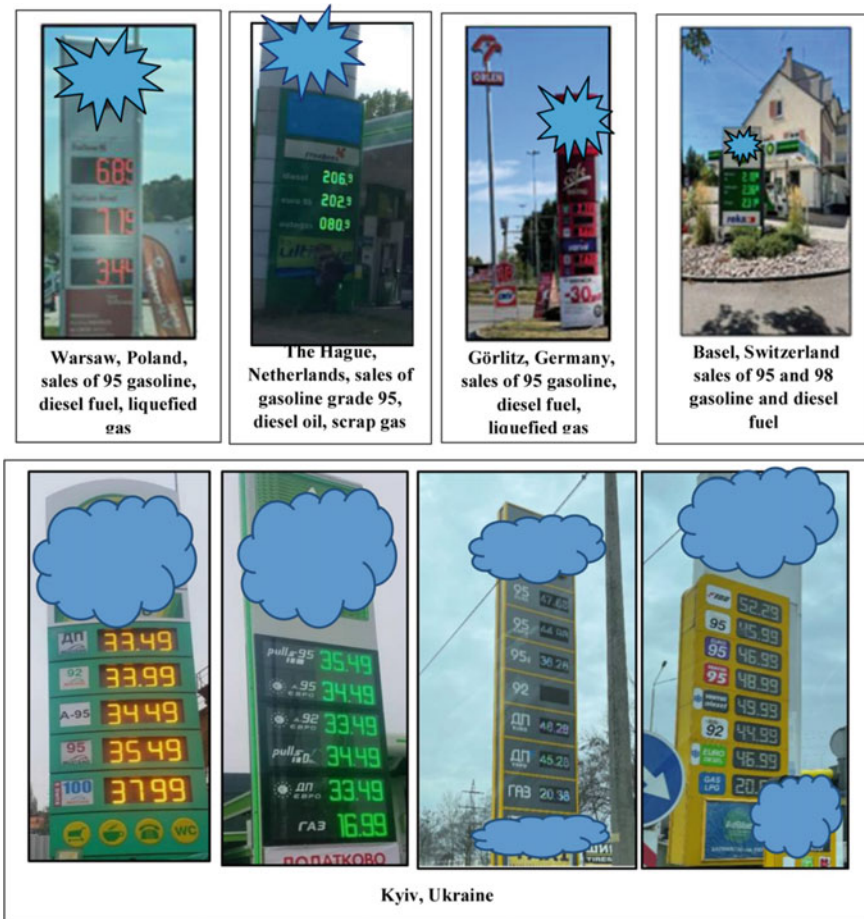


Fig. 2 Photo materials of the type of fuel in the retail network of fuel stations (car gas filling stations) in some Community countries and Kyiv (photo August–September 2022)

According to the requirements of Regulation 2009/30, suppliers or suppliers responsible for the monitoring and reporting of greenhouse gas emissions designated by the Member States of the Community report on the greenhouse gas emissions during the life cycle of the fuel they supply and on the extent of their reduction from 2011, which are formed during the life cycle per unit of supplied fuel energy [8].

The fuel quality control system in the Community countries is based on European standards, including EN 14,274:2003 “Automotive fuels—Assessment of petrol and diesel quality—Fuel quality monitoring system” and EN 14,275:2003 “Automotive fuels—Assessment of petrol and diesel fuel quality—Sampling from retail site pumps and commercial site fuel dispensers”. This standard defines in detail the rules for



Fig. 3 Distribution complex at a gas station for the sale of diesel fuel and AdBlue reagent in Germany (photo August 2022)

sampling and the minimum number of samples, the method of sampling at petrol stations, the rules for their transportation, storage, examination, requirements for accredited laboratories, etc.

Each Community country has its own specifics and elements that distinguish it from other EU countries (legal framework, institutions involved in the organization of the system), however, each state is obliged to comply with the requirements of Directive 98, Directive 2009/30/EC, EN 14,274: 2003 standard, including the obligation to report annually to the Council of Ministers (by 31 July) on the quality of liquid fuels, the quality of liquid biofuels, liquefied petroleum gas (LPG) and compressed natural gas (CNG), and to the European Commission (by 31 August) on the quality of fuels sold on its territory, to organize a fuel quality control system based on EU principles and to carry out relevant analysis.

In particular, since 2012, the European Commission has been reporting every two years to the European Parliament and the Council on third countries and Community Member States that are sources of biofuels or feedstocks for biofuels consumed within the Community and on national measures taken to meet sustainability criteria, and to protect soil, water and air.

Given the practice of fuel quality control in Poland, since January 1, 2007, the main regulatory document governing the functioning of the fuel quality monitoring and control system is the Act of 25 August 2006 “On the Fuel Quality Monitoring and Control System” [19, 20].

The Head of the Competition and Consumer Protection Authority is responsible for the functioning of the control system, which is supported by the Trade Inspectorate responsible for fuel control. The control and monitoring of the quality of fuels is divided into summer and winter periods, with samples taken for examination every

month, as well as systematic statistical observations of the quality of fuels placed on the market.

Samples are collected at petrol and gas filling stations by oblasts. Sampling locations are selected randomly for each type of fuel and are proportional to the share of liquid fuel sales in that region and the total liquid fuel sales in the country.

Within the national part, the control system is aimed not only at detecting cases of fuel trade that does not meet quality standards, but also provides for the inspection of liquid fuels to which changes in physical and chemical parameters (quality improvement) are applied where violations have been identified, including as a result of previous inspections of drivers' complaints, information received from the police.

Systematic monitoring is carried out for all types of fuel (unleaded gasoline of the 95 and 98 grades, diesel fuel, liquid biofuel (diesel fuel with a 20% content of complex esters (B20) and methyl ester of fatty acids as an independent fuel (B100)) and covers the entire chain of circulation operators fuel, namely:

- entrepreneurs who store fuel;
- entrepreneurs who carry out activities in the field of fuel transportation (control at the request of the police);
- owners and operators of fuel stations (car gas filling stations) of car parks;
- state and corporate gas stations where control of liquid biofuel, liquefied petroleum gas (LPG) and compressed natural gas (CNG) is carried out;
- farmers who produce liquid biofuel for their own use;
- entrepreneurs who sell light petroleum products, light and heavy fuel oils [20, 21].

Control over the quality of fuels also includes control over compliance by business entities with the obligations to sell motor petrol with a bioethanol content of up to 5% (10%) at petrol stations (filling stations) with the appropriate labelling of fuel dispensers offering such petrol in order to identify for the consumer the percentage of such biocomponents in this fuel, as well as to inform that the proposed fuel can be used in an engine that allows its use. In addition, the labelling of fuel dispensers used at petrol stations or factories for the sale of liquid fuels containing metal dopes must be marked with the inscription "Contains metal dopes".

The Office for Competition and Consumer Protection in Poland is responsible for preparing reports for the European Commission and the Council of Ministers. The report contains information on: the quality of liquid fuels and the quality of liquid biofuels, liquefied petroleum gas (LPG), compressed natural gas (CNG); sulphur content in light fuel oil, heavy fuel oil. The reports are generated on the basis of data from the Chief Environmental Inspector or Directors of Maritime Offices if the data relate to motor fuel oil for inland navigation and/or fuel used on marine vessels.

The relevant reports are available at the following links in the public domain [14, 22]. The fuel quality monitoring and control system in Germany is different from others, it does not belong to any model that operates according to EN 14,274:2003 - and is considered a national system. The control system mainly provides requirements for the labeling and quality of automobile gasoline, motor oils and liquid gaseous fuel in accordance with the Law of the Federation "On Protection from Emissions" and other standards [23].

Monitoring of fuel quality does not involve checking all the parameters contained in the European standards, but only indicators of particular importance for the environment, consumer protection, or indicators of product non-compliance that have been established as a result of previous inspections.

The Ministry of the Environment is responsible for submitting an annual report to the European Commission. The report is based on data provided by the Federal Environment Agency and on information provided by the German federal states, as well as statistics from the Federal Office for Economic Affairs and Export Control.

The fuel quality monitoring and control system in Austria is implemented throughout the country and covers the quality of motor petrol and diesel fuel sold at petrol stations. All parameters of liquid fuels are measured in accordance with EN 14,274:2003. The examination (testing) of the parameters is carried out in accredited laboratories of the Federal Office for Consumer Protection and the Federal Environment Agency. And since Austria has only one refinery (Schwechat), whose products cover a significant part of the national demand, the entire territory of Austria is considered as one region for control [18, 23].

In Ireland, the control over the quality of gasoline and diesel fuel in circulation is checked by the Revenue Service. The selected samples are tested by the National Laboratory. Information on the annual volume of fuel sales is collected and provided by the Department of Transport, and the Department of Environment, Heritage and Local Government is responsible for the preparation and submission of the annual fuel quality monitoring report to the European Commission.

There is one refinery operating in Ireland, all products are inspected by the refinery operator before shipment and transported by road and sea to customers. Samples of fuel products are taken by the tax service once every three months at fuel terminals and after each refueling at the National Bank of Fuel Reserves. Also, samples are taken from gas stations, tankers, trucks and minibuses. The monitoring and quality system includes inspections by the Irish Petroleum Industry Association, which takes its own samples for testing at car parks and at the refinery in July–August and December each year.

In Ukraine, according to the List of types of products for which state market surveillance bodies carry out state market surveillance, the State Ecological Inspection of Ukraine is a state market surveillance body for compliance with the requirements of the Technical Regulation.

Control of fuels is carried out on time and in the prescribed manner in accordance with the Law of Ukraine "On State Market Supervision and Control of Non-Food Products" (hereinafter—the Law). In particular, checking the characteristics of liquid fuel products is carried out on a scheduled basis exclusively at distributors of such products (fuel stations (car gas filling stations)) within 4 days, and unscheduled at distributors of liquid fuels in the presence of substantiated appeals-complaints from consumers regarding the non-compliance of products, at manufacturers (within 5 days)—in case of establishment of non-conformity of the products based on the results of the examination, which was taken from the distributors. Control of importers, authorized persons who introduce liquid fuels into the territory of Ukraine is carried out based on the results of the customs suspension of products

and the corresponding notification of the state market surveillance authority by the customs authority [24].

Thus, in Ukraine, control over the quality of liquid fuels does not cover business entities that store fuel, store and/or use liquid fuels for their own needs, transport, fleet operators, state and municipal enterprises, as well as business entities engaged in wholesale trade in fuel, importers, authorized persons, and manufacturers on a routine basis.

In particular, according to Article 27 of the Law, sampling of liquid fuels and their examination (testing) are carried out on the basis of a reasoned written decision of the head of the market surveillance authority or his/her deputy (chairman and members or an authorized person of the state collegial body). Thus, the procedure for taking samples of liquid fuels requires, first of all, formal processing (analysis) of documents provided by the business entity that must accompany the fuel batch, secondly, signing the decision on sampling, and thirdly, organizing and conducting the sampling procedure.

Under such conditions, it takes time to take a sample of products and conduct their examination. In practice, sampling takes place in one to three days, which leads to conditions where products may be generally absent according to the documents provided on the first day of the inspection by the market surveillance authority, or to the creation of conditions that lead to certain actions on the part of business entities, namely the replacement of the full volume of such products at the fuel station (car gas filling station), and as a result, inappropriate sampling measures, spending unnecessary budgetary costs during further examination (testing).

The standard EN 14,274:2003 defines a system for monitoring the quality of fuels to assess their quality, which is sold in any country of the Community. According to the internal regulations of CEN/CENELEC, national standardization organizations of such countries as Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, Great Britain are required to implement the EN 14,274:2003 standard [18].

The EN 14,274:2003 standard contains statistical justifications and describes a fuel quality monitoring system in accordance with European Directive 98/70/EC and cannot be adjusted in a specific region, however, it can be extended to achieve additional goals.

Due to the specific parameters of the European fuel specifications, EN 228 and EN 590 standards state that each country should select limit values from a certain set of values and take into account such limit values for a specific country, taking into account geographical and climatic factors. Such values may differ, therefore the specific parameters in the monitoring and quality system of the Community countries are different.

According to EN 14,274:2003, a country should be treated as a single region for sampling purposes. The number of samples for the purpose of checking their quality depends on the size of the country, taking into account the total amount of fuel sold in this country (a small country—15 million tons or less are sold per year, a large country—a total of more than 15 million tons are sold per year), places of

sale (dispensing) of fuel (object of retail or wholesale trade). The calculation of the necessary number of such samples is determined by each country of the Community separately, at the same time, their minimum number should be such that the data are effective and representative for the overall assessment of the monitoring system for that country. In particular, it is noted that the country may, at its own discretion, use more than the minimum number of samples, but not less.

According to the requirements of the EN 14,274:2003 standard, taking into account the specification of liquid fuels, the minimum number of samples for each type varies from 50 to 200 samples. Fuel quality is tested twice a year: once in winter and once in summer.

In accordance with the requirements of EN 14,274:2003, the Community countries shall establish a list of sampling sites, which shall be updated annually. Such a list should contain information on the region in which the facility is located and be divided into facilities based on their turnover.

In order to determine the amount of each type of liquid fuel to be assessed, information on the total amount of fuel sold in the country, sources of supply and the supply chain with distribution in the network, and, if available, data on the population and number of vehicles with their respective regional distribution are taken into account.

Accredited laboratories performing tests for fuel quality monitoring are determined by the competent authority in each Community and take into account the eligibility criteria, which include the qualifications and competence of the staff to take and examine fuel samples and prepare an analytical report.

In Ukraine, the selection of samples of liquid fuels is carried out by officials of the market surveillance body in accordance with the requirements of DSTU [in Ukrainian] 4488:2005 "Oil and petroleum products. Sampling methods", the Procedure for selecting product samples to determine their quality indicators and the form of the act of selecting product samples, approved by Resolution № 1280 of the Cabinet of Ministers of Ukraine dated 30.10.2007. Examination (testing) is carried out in accredited laboratories based on the results of tender procurement and conclusion of contracts with business entities for the lowest value proposition [25, 26].

Thus, an official who takes samples of liquid fuels must be qualified to conduct such sampling at high-risk facilities, including being provided with the necessary equipment, facilities, personal protective equipment, with mandatory specialized training on occupational health and safety, and admission to such work, etc.

Liquid fuels in EU countries are checked mainly for all quality indicators provided for by Directive № 98. According to the report in Poland for 2021, non-compliance with the parameters is noted by the indicators of oxygen content, organic oxygen-containing compounds, ethanol (A-95) and saturated vapor pressure (A-98). The highest excess of sulfur content was registered in Poland in 2005 and was more than fifty times the established norm (more than 2734 mg/kg) [19].

Taking into account data from open sources, it is noted that the lowest non-compliance with quality standards in the studied fuel samples is noted in Germany, Ireland, Latvia and Austria (below 1%), a little more—in the Czech Republic and Poland (1–5%), and the effective effect is emphasized of the implemented system

of monitoring and control of fuel quality from year to year, which was launched in 2004 [16, 23].

In Ukraine, non-compliance with the requirements of the Technical Regulation in products of the type "diesel fuel" is noted by indicators of sulfur content, flash point in a closed crucible, in products of the type automobile gasoline—by sulfur content, volume fraction of benzene, mass fraction of oxygen, detonation resistance according to experimental and by the motor method, as well as by the volume fraction of "bioethanol".

In particular, in products of the diesel fuel type, the sulfur content exceeded the established requirements by 3–3.5 times (49.4 ± 62.4 mg/kg), the flash point in a closed crucible was 1.3 times lower (42.43 ± 9.85 °C). In gasoline samples, the indicator of detonation resistance according to the experimental method was 1–2 times lower (90.8 ± 0.43 units), the sulfur content exceeded the established requirements by 4–10 times (49.4 ± 62.4 mg/kg), the volume fraction of benzene and the mass fraction of oxygen are 2–2.5 times ($2.7 \pm 3.43\%$) and 2.5 times ($6.71 \pm 3.1\%$), respectively.

Non-compliance with the requirements of the Technical Regulations was noted both in products of the type: A–92–Euro5–E5, A–95–Euro5–E5, DP–Z–Euro5–B0 [in Ukrainian], DP–L–Euro5–B0 [in Ukrainian], and in products of the 95–Euro5 brand –E5 "Premium", 95–Euro5–E5 "Shebel", DP–Z–Euro5–B0 [in Ukrainian] "Shell V–Power", DP–Z–Euro5–B0 [in Ukrainian] "Premium", DP–Z–Euro5–B0 [in Ukrainian] "Energy", in imported fuel and fuel of domestic production. In general, the ratio of non-conformity to fuel compliance was 1:4 in gasoline samples, 1:5 in diesel fuel [27].

A significant part of the vehicles used in the world are equipped with spark ignition engines (gasoline engines), the rest are compression ignition engines (diesel engines), which are the most economical and environmentally friendly today [28, 29].

Gasoline, which is a product of crude oil processing, is usually used to power spark-ignition engines. The fuel used in compression ignition engines is diesel, and like gasoline it is a mixture of hydrocarbons separated from crude oil by distillation, but unlike gasoline, diesel distillates have a higher boiling point. Differences in the design and principles of operation of gasoline and diesel engines are different, therefore the requirements for their physical and chemical properties are also different [2, 17].

During storage, transportation and distribution in the fuel supply system, liquid fuels are exposed to physical and chemical influences that change their quality. Therefore, the fuel that is in the tank of the vehicle may have different properties than when it was produced at the refinery.

The potential for fuel to become contaminated with water during storage, transportation or distribution is just one of many factors that cause fuel quality to vary from production to consumer market. And on the way to determine the main factors that can cause changes in the physical and chemical properties of liquid fuels, one can include improper decantation, storage of fuels in containers that exclude their

tightness, interaction of fuel with oxygen in the air, and ingress of dust during distribution in the network, evaporation of light fractions, ingress of solid impurities of corrosion products from tanks, pipelines during their oxidation and polymerization.

Thus, the system of control and monitoring of the quality of liquid fuels should be organized at all stages of production, storage, transportation and their distribution, as well as apply to each market operator, economic entity that carries out appropriate measures in the way of introduction into circulation, application and /or storage.

Pursuant to the Regulation 1680, fines in Poland for the production, transportation, storage or sale of liquid fuels, liquid biofuels, liquefied petroleum gas (LPG), compressed natural gas (CNG) or light fuel oil that do not meet the quality requirements are:

- from 50,000 to 500,000 PLN (425,000-4,250,000 UAH) (or imprisonment for up to 3 years);
- from 100,000 to 1 million PLN (850,000-8,500,000 UAH) or imprisonment for a term of 3 months to 5 years if the fuel is property of significant value;
- from 10,000 to 25,000 PLN (85,000-212,500 UAH) in case of lesser severity;
- from 25,000 to 250,000 PLN (212,500-2,125,000 UAH) for unintentional actions that led to product non-compliance.

In addition, fines of 5,000 PLN (42,500 UAH) are provided for farmers who produce liquid biofuels that do not meet quality requirements, including those used for their own needs; owners or users of a vehicle fleet that use liquid biofuels that do not meet quality requirements.

Business entities are also liable for the production, storage or sale of liquid biofuels in tanks that are not labelled in accordance with the established procedure, including for failure to post information on fuel stations (car gas filling stations) about the content of biocomponents in liquid fuels sold at fuel stations (car gas filling stations). In particular, the fine is imposed on the day of the inspection based on an administrative decision made by an inspector of the Trade Inspection.

Pursuant to Article 44 of the Law, fines for business entities that have put products on the market (importers, authorized persons, manufacturers) are imposed in the event of non-fulfilment or incomplete fulfilment of a decision to take restrictive (corrective) measures with respect to products that do not meet the established requirements and/or pose a risk of 102,000 to 170,000 UAH, and for distributors—from 68,000 to 119,000 UAH. The penalty is imposed upon failure to comply with such decisions, drawing up a protocol or resolution, and may be applied within 30 days.

Thus, taking into account the legislation of Ukraine, liability for business entities in the Community countries is more economically severe and demanding, and applies to the range of all entrepreneurs involved in the circulation of fuels from production, management, distribution to storage and use, and is generally aimed at bringing to justice for non-compliance with emission reduction requirements, failure to implement measures to use alternative fuels, and misleading consumers.

Taking into account the above, on the way to complying with the requirements of the Association Agreement, with the aim of Ukraine's accession to the countries of the European Community, as well as the creation of conditions for the acceptance of

liquid fuels for the creation of a free trade zone, a number of problematic and urgent issues arise in Ukraine that need to be resolved, and which are inevitable in today's.

The solutions to such issues will be directed and connected primarily with the implementation of the requirements of Directive 98, Directive 2009/30/EC, standard EN 14,274:2003, internal regulations of CEN/CENELEC, European specifications EN 228 and EN 590, including a comprehensive restructuring in the organization, the creation of an appropriate system of control and monitoring of the quality of liquid fuels on the territory of Ukraine, secondly, the introduction of effective levers for the implementation of special legislation, strategies, complex programs and the determination at each stage of competent executive authorities responsible for their implementation.

The control and monitoring system should provide for both internal and external control for business entities, regulatory authorities and take into account the origin and chain of introduction and distribution of liquid fuels, and should be aimed at reducing emissions into the atmosphere, ensuring the protection of consumer interests, safety environment, and national security of the state.

References

1. Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019 on market surveillance and compliance of products and amending Directive 2004/42/EC and Regulations (EC) No 765/2008 and (EU) No 305/2011 (20 June, 2019). Verkhovna Rada Ukraine [in Ukrainian]. https://zakon.rada.gov.ua/laws/show/984_012-19#Text
2. Boichenko, S.V., Leida, K., Yakovleva, A.V., et al.: Influence of rapeseed oil ester additives on fuel quality index for air jet engines. *Chem. Technol. Fuels Oils* **53**, 308–317 (2017). <https://doi.org/10.1007/s10553-017-0807-5>
3. On the approval of the Technical Regulations on motor gasoline, diesel, marine and boiler fuels: Resolution of the Cabinet of Ministers of Ukraine № 927. (2013, August 1). Verkhovna Rada Ukraine [in Ukrainian]. <https://zakon.rada.gov.ua/laws/show/927-2013-п#Text>
4. Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Directive 93/12/EEC. (1998, October 13). EUR-Lex. https://eur-lex.europa.eu/resource.html?uri=cellar:9cdbfc9b-d814-4e9e-b05d-49dbb7c97ba1.0008.02/DOC_1&format=PDF
5. About technical regulations and conformity assessment № 124-VIII. (2015, January 15). Verkhovna Rada Ukraine [in Ukrainian]. <https://zakon.rada.gov.ua/laws/show/124-19#Text>
6. On the approval of conformity assessment modules, which are used to develop conformity assessment procedures, and rules for the use of conformity assessment modules: Resolution of the Cabinet of Ministers of Ukraine № 95. (2016, January 13). Verkhovna Rada Ukraine [in Ukrainian]. <https://zakon.rada.gov.ua/laws/show/95-2016-п#Text>
7. On approval of the form, description of the mark of compliance with technical regulations, rules and conditions of its application: Resolution of the Cabinet of Ministers of Ukraine № 1184. (2015, December 30). Verkhovna Rada Ukraine [in Ukrainian]. <https://zakon.rada.gov.ua/laws/show/1184-2015-п#Text>
8. Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing

- Directive 93/12/EEC. (2009, April 23). EUR-Lex. <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1520077936157&uri=CELEX:02009L0030-20160610>
9. Act of 23 October 2015 on quality requirements for liquid fuels: Regulation of the Minister of Economy. (2015, October 23). Minister Gospodarki [in Polish]. <https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20150001680/O/D20151680.pdf>
 10. Commission Regulation (EC) No 692/2008 of 18 July 2008 implementing and amending Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information. (2008, July 18). Ligazakon [in Ukrainian]. <https://ips.ligazakon.net/document/view/EU080011>
 11. Regulation (EC) № 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles. (2009, April 23). EUR-Lex. <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009R0443>
 12. Directive 2010/75/EU of the European Parliament and of the Council of November 24, 2010 on industrial emissions (integrated approach to pollution prevention and control). (2010, November 24). Verkhovna Rada Ukrainy [in Ukrainian]. https://zakon.rada.gov.ua/laws/show/984_004-10#Text
 13. Commission decision of 15 December 2010 amending Decision 2006/944/EC determining the respective emission levels allocated to the Community and each of its Member States under the Kyoto Protocol pursuant to Council Decision 2002/358/EC. (2010, December 15). EUR-Lex. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0778&from=FR>
 14. Reports for the Council of Ministers on fuel quality. Urząd Ochrony Konkurencji i Konsumentów [in Polish]. https://uokik.gov.pl/szukaj.php?szukaj=raporty_+jakosc_paliw
 15. Liakh, M.A., Demianiuk O.S., Barylko, O.S.: Regarding the issue of using fuel additives abroad and in Ukraine. Zbiryk naukovykh prats Viiskovoho instytutu Kyivskoho natsionalnoho universytetu imeni Tarasa Shevchenka, 17 [in Ukrainian] (2009)
 16. World-wide fuel charter. International Organization of Motor Vehicle Manufacturers. <https://www.oica.net/worldwide-fuels-charter/>
 17. Yakovlieva, A., Boichenko, S.: Energy efficient renewable feedstock for alternative motor fuels production: solutions for Ukraine. In: Babak, V., Isaienko, V., Zaporozhets, A. (eds.), Systems, Decision and Control in Energy I. Studies in Systems, Decision and Control, vol. 298. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-48583-2_16.
 18. EN 14274:2013 – Automotive fuels – Assessment of petrol and diesel quality – Fuel quality monitoring system (FQMS). ITEH. <https://standards.iteh.ai/catalog/standards/cen/6bcedd74-c5e0-48c4-bbb0-0a0783dc9a04/en-14274-2013>
 19. Reports for the European Commission on fuel quality. Urząd Ochrony Konkurencji i Konsumentów [in Polish]. https://uokik.gov.pl/raporty_jakosc_paliw.php#faq1499
 20. Act of 25 August 2006 on the fuel quality monitoring and control system. (2006, August 25). ISAP. Internetowy System Aktów Prawnych. <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20061691200>
 21. Zmijewski, K., Sokołowski, M.: The development of power grids in Poland in the context of regulatory acts of the climate and energy package. Acta Energetica, 86–94 (2010)
 22. Raport z kontroli paliw ciekłych w 2021 roku. (2022). Urząd Ochrony Konkurencji i Konsumentów [in Polish]. <https://uokik.gov.pl/search.php?szukaj=raport+dla+Komisji+Eur+opejskiej>
 23. Description of the fuel quality monitoring and control system. Urząd Ochrony Konkurencji i Konsumentów [in Polish]. https://uokik.gov.pl/opis_systemu_monitorowania_i_kontrolowania_jakosci_paliw.php#faq3757
 24. On state market supervision and control of non-food products № 2735-VI. (2010, December 2). Verkhovna Rada Ukrainy [in Ukrainian]. <https://zakon.rada.gov.ua/laws/show/2735-17#Text>
 25. Yakovlieva, A., Boichenko, S., Boshkov, V., Korba, L., Hocko, M.: Experimental study of physical-chemical properties of advanced alcohol-to-jet fuels. Aviation 27(1), 1–13 (2023). <https://doi.org/10.3846/aviation.2023.18564>

26. On the approval of the Procedure for the selection of product samples to determine their quality indicators and the form of the product sample selection act: Resolution of the Cabinet of Ministers of Ukraine № 1280. (2007, October 30). Verkhovna Rada Ukrainy [in Ukrainian]. http://online.budstandart.com/ua/catalog/doc-page?id_doc=59378
27. DSTU 4488:2005 [in Ukrainian]. Oil and oil products. Sampling methods. (2006, October 1). K.: Upravlinnia Derzhspozhyvstandartu, 34 p. [in Ukrainian].
28. Sibilieva, O.V.: The quality of automobile gasoline and diesel fuel on the market of Ukraine. *Ekolohichni nauky*, No 4(43), 100–106 (2022). [in Ukrainian]
29. Topilnytskyi, P., Romanchuk, V., Boichenko, S., Golych, Y.: Physico-chemical properties and efficiency of demulsifiers based on block copolymers of ethylene and propylene oxides. *Ch&ChT* 8(2), 211–218 (2014)