Ukraine. The specific number of farms where appropriate to use grain seeders type SZ-3,6 is defined. These include farms with cultivated area from 250 to 1000 hectares. The specific number of these farms IS 15.5%.

Grain drill, cultivated area, grain and leguminous crops.

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STAGE AND ENVIRONMENTAL STANDARDS FOR DIESEL ENGINES TIER SILSKO-
And forestry tractors and self-propelled machines

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The modern environmental standards for diesel silsko- and forestry tractors and self-propelled machines and Stage Tier, which operating in countries EU and US respectively, and are technologies to fulfill emission regulations and smoke exhaust gas of standards.

Tractor, engine, the standard toxicity, opacity, ecology, economy, rule, Stage, Euro, Tier.

Problem. Saving energy and reducing impact on the environment is by far the most difficult problems in the world. Obviously, the urgency to tackling these problems will only be strengthened over time. No exception in this respect is the industry silsko- and Forestry, which involves a large number of vehicles equipped typically diesel engines. The latter is known to be one of the biggest polluters of the environment and, in practice, not exhausted its potential improvement.

Two factors have recently stimulate dvyhunobudivni leading corporations and firms drastically improve engines including and diesel using advanced new technologies enter in law strict regulations toxicity and smoke SH (exhaust gas) railroads and stiff competition. This is promoted as the rapid development of microprocessor technology, digital technology, sensors and actuators, which are integral components of modern engines and systems.

Analysis of recent research. In the European Union (EU) to reduce the intensity of air pollution emission regulations imposed VG and Euro Stage, and in the US - the rules EPA Emission Standards and EPA Tier. To the main (road) technology standards are Euro and EPA

Emission Standards, to off-road vehicles and machinery - Stage and Tier. Environmental standards harmonized EU and the US together.

Environmental standards for levels of toxic substances in the VG engine tractors, self-propelled machines, vehicles and special vehicles consistently amplified around the world, including in Ukraine. Therefore, emission regulations are becoming increasingly important for manufacturers of machinery and for operatives.

An analysis of the literature found that today in Ukraine is practically not covered this issue. In Russia, published several articles on this topic [1-3]. Ago ***purpose Research*** is a review of current and future environmental standards for diesel forestry and agricultural machines Mobile Stage and Tier, operating in the European Union and the United States respectively, and analysis technologies that fulfill emission regulations and exhaust smoke emissions in accordance with these standards.

Results. Standards of Stage I, II, III and IV set maximum permitted levels of toxicity and smoke SH diesel engines Special (off) vehicles not intended for use on public roads. These rules are current or over time crucial for Ukraine and CIS countries as putting them on the EU.

The first European emission regulations SH mobile off-road vehicles (Directive 97/68 / EC) introduced in two stages: Stage I came into effect in 1999. And Stage II - gradually, from 2001 to 2004, depending on the engine. Under these standards fall, industrial drills; compressors; Building wheel loaders; bulldozers; terrain vehicles; excavators that can move on public roads; trucks; machinery for road construction, snowblowers; Machine airport ground handling; lifts, aerial platforms and mobile cranes.

Toxicity silsko- and forestry tractors governed by the same standards, but the timing of the introduction of the different (Directive 2000/25 / EC). Engines for ships, rail, aviation and industrial generator sets are not subject to regulations Stage I / II.

December 9, 2002 the European Parliament adopted Directive 2002/88 / EC supplementing Directive 97/68 / EC of the relative toxicity and smoke of the SH-road vehicles. The latest additions standards toxicity VG gasoline engines of small volume for utility vehicles with a capacity of less than 19 kW. The Directive also expands the scope of the rules on Stage II engines operating in steady state. Engine emission regulations utility vehicles largely harmonized with US similar rules.

Standards of Stage III and IV toxicity VG engine off machines approved by the European Parliament April 21, 2004 (Directive 2004/26 / EC), and agricultural and forestry tractors - February 21, 2005 (Directive 2005/13 / EC).

Stage III norms vvodyatsya effect in stages from 2006 to 2013., Stage IV will take effect in 2014 Performance standards Stage III and IV, except engines categories that fall under Stage I / II, covers rail and marine engines operated on inland waterways. Standards of Stage III and IV apply only new machinery and equipment, as well as new engines installed on the machine instead of standard (except engines rail railcars, locomotives and ships are operated on internal waterways).

It should be noted that each standard toxicity VG established EU usually has two relevant dates: the date of type approval, after which all new models that have been approved type shall comply with this standard and date-to-market (or first registration), after which all new engines produced in the market, must meet this standard. All dates listed in the following tables are dates to market. Approval Date type is set in the year before the relevant date to market. To set two years duration sale, which is expected for engines produced to date relevant to market. As a specific duration sale - from zero to two years - each EU country defines itself, the exact timing of the legislation in different countries may vary.

Manufacturers of engines and other equipment by all means affect the legislative bodies of the EU, the US and Japan, seeking harmonization toxicity SH worldwide. Unification of laws eliminate obstacles of improving engines and certification (type approval) engines for different markets. Standards Stage I / II were partially harmonized standards the United States. The rules are Stage III and IV standards harmonized with US Tier 3 and 4 (Table. 1).

1. Comparison of European and US legislation on environmental standards diesel off-road mobile machinery.

European standards toxicity	American standards toxicity
Stage I (1999).	Tier 1
Stage II (2001).	Tier 2
Stage IIIa (2004).	Tier 3
Stage IIIb (2012)	Tier 4i
Stage IV (2014)	Tier 4f

Thus, in 1999 the EU was enacted emission regulations and off-road vehicles smoke SH Stage I, which were later replaced by regulations Stage II, and later - Stage IIIa, operating in the EU by the end of 2011 in the North America were similar administrative rules, but with a different name (see. Table. 1 and Fig. 1). In particular, by the end of 2011 there were Tier 3 standards, and on January 1, 2012, both systems standards have entered a new phase: the EU rules came into effect

Stage IIIb, and in the US and Canada - Tier 4i (Interim). In 2014 they will change the standard Stage IV and Tier 4f (Final) respectively.

So, January 1, 2012 year marked the entry into force of new rules and toxicity of smoke VG. This - the next stage of measures aimed at reducing emissions normalized pollutants such as nitrogen oxides (*NOx*), Particulate matter (soot), unburned hydrocarbons (*CnHm*) And carbon monoxide (*CO*) Or, as it is called, carbon dioxide. We emphasize that from January 1, 2012 the new environmental standards relating to all silsko- and forestry equipment (diesel silsko- and forestry tractors, self-propelled chassis, combines and ishyh self-propelled machines), and the introduction of regulations Stage IIIb (Tier 4i) for tractors and machinery capacity of 177-762 hp contribute to reducing emissions of nitrogen oxides (*NOx*) To 15% soot particles - up to 3%, which is essentially a challenge for manufacturers of engines and machines. In addition, the 2014 rules take effect Stage IV (Tier 4f), Which should reduce NOx emissions in addition to 3%.

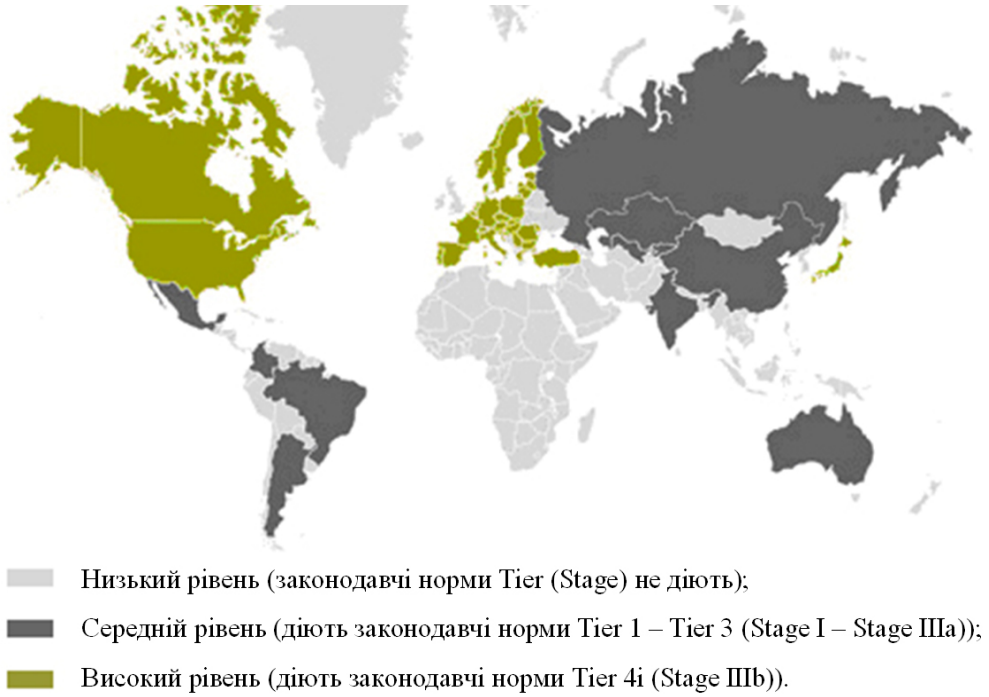

Fig. 1. Map enactment of legislation toxicity and smoke SH-road diesel-propelled vehicles as of January 1, 2012

Environmental standards Stage I / II set thresholds of toxicity and smoke SH, coming directly from the diesel engine and are not subject to any further processing (see. Table. 2). This toxicity SH measured by methods ISO 8178C1 - 8-mode cycle, and is determined in g / (kW·h). Engines that meet the standards Stage I / II, shall be tested on fuel containing 0.1 ... 0.2% (by weight) sulfur.

Standards Stage III, which in turn are divided into two levels - Stage IIIa and Stage IIIb, and Stage IV emission norms VG diesel engines off machines presented in Table. 3, 4 and 5 respectively. These values do not apply to railway engines and marine engines operated on inland waterways. Standards Stage IIIb limit the maximum content of carbon black value of 0.025 g / (kW·h), ie 90% compared with Stage II. To fulfill this condition, it is assumed that the engine exhaust system will obladnuvatymutsya Particulate Filter. In Stage IV standard also introduces a strict restriction on the content of SH *NOx*: Not more than 0.4 g / (kW·h) to perform which is obviously necessary obligatory treatment of viral hepatitis in the exhaust system.

2. The rules of environmental standards Stage I / II for off-road diesel engines.

Category	Net power *N*KW	Date *	*CO*	*CnHm*	*NOx*	*PM*
			g / (kW·h)			
		Stage I				
A	≤ 130 *N* ≤ 560	January 1999	5.0	1.3	9.2	0.54
B	≤ 75 *N* <130	January 1999				0.70
C	≤ 37 *N* <75	April 1999	6.5			0.85
		Stage II				
E	≤ 130 *N* ≤ 560	January 2002	3.5	1.0	6.0	0.2
F	≤ 75 *N* <130	January 2003	5.0			0.3
G	≤ 37 *N* <75	January 2004		1.3	7.0	0.4
D	≤ 18 *N* <37	January 2001	5.5	1.5	8.0	0.8

* Performance standard Stage II of January 2007 also applies to engines that run on fixed modes.

3. The rules of environmental standard Stage IIIa for diesel off-road vehicles.

Category	Net power *N*KW	Date *	*CO*	*NOx* + *CnHm*	*PM*
			g / (kW·h)		
H	≤ 130 *N* ≤ 560	January 2006	3.5	4.0	0.2
I	≤ 75 *N* <130	January 2007	5.0		0.3
J	≤ 37 *N* <75	January 2008		4.7	0.4
K	≤ 19 *N* <37	January 2007	5.5	7.5	0.6

* Dates for engines that run on fixed modes: January 2011 - for categories H, I and K; January 2012 - J. category

4. Rule environmental standard Stage IIIb for diesel off-road vehicles.

Category	Net power *N*KW	Date *	*CO*	*CnHm*	*NOx*	*PM*

			g / (kW·h)			
L	≤ 130 *N* ≤ 560	January 2011	3.5		2.0	
M	≤ 75 *N* <130	January 2012		0.19	3.3	0,025
N	≤ 56 *N* <75	January 2012	5.0			
P	≤ 37 *N* <56	January 2013		4.7 *		

**NOx* + *CnHm*.

5. The rules of environmental standards for Stage IV diesel off-road vehicles.

Category	Net power *N*KW	Date *	*CO*	*CnHm*	*NOx*	*PM*
			g / (kW·h)			
Q	≤ 130 *N* ≤ 560	January 2014	3.5	0.19	0.4	0,025
R	≤ 56 *N* <130	October 2014	5.0	0.19	0.4	0,025

Together with the Environment Agency US (EPA) developed a new method of testing engines for off-road vehicles unsteady modes NRTC. The new technique is used in parallel with the old method of testing for steady NRSC (ISO 8178C1).

Methods NRTC (unstable conditions) should be used for the determination of carbon black in VG in Stage IIIb and IV of engines, except engines that run on fixed modes. For a manufacturer NRTC can be used to determine on Stage IIIa of gaseous toxic substances in VG in Stage IIIb and IV. Methods NRSC (steady state) should be used for measurements at Stage I, II and IIIa, including engines running at steady state, as well as Stage IIIb and IV for the measurement of gaseous toxic components.

The following rules of perspective 2012-2016 yy Euro 6, Stage IV and Tier 4 will sooner or later be adopted in Ukraine, and we consider it useful to talk about them as well.

Environmental standards EU, US and Japan are very similar and largely harmonized in terms of toxic constituents and in terms of commissioning, but still there are differences, for example, methods for measuring smoke dispersal modes of the engine.

Standards Euro 6 is yet to be drawn up and approved, but we can say that stricter requirements will be significant. It should be noted that to measure toxicity in SH certification for compliance with Euro 6 introduced new cycle (methods) test: instead ETC (European Transient Cycle), likely to be introduced new cycle WHTC (World Harmonized Transient Cycle). In testing under this cycle speed and engine load are generally smaller, so the temperature will be lower viral hepatitis. However, at low temperatures VG is known to decrease the amount of ammonia formed from a solution of urea and catalytic converter loses some of its effectiveness. Consequently, limited and decomposition *NOx*. Additionally WHTC cycle includes "cold" mode in the first part of the cycle in which *NOx* neutralized less. As a result, the level of *NOx*

increases in viral hepatitis as a friend, "hot" part of the cycle can not compensate for the increase of toxic components.

Requirements environmental standards for off-road equipment Stage IV, EEV and Tier 4 standards for such transmission cars Euro 5 and 6 and US'7, US'10Only the timing of entry into force of the first delayed by about three years in relation to others. Restrictions on levels of *NOx* VG and soot in the "main" and "off" standards differ considerably not (see. Table. 5, 6, 7 and 8).

6. The rules of harmful substances under Tier 4 standard.

Net power	Date of entry	*CO*	*NMHC* *	*NMHC + NOx*	*NOx*	*PM*
		g / (kW·h)				
N<8 kW	2008	8.0	-		-	0.40
8 kW ≤ *N*<19 kW	2008	6.6	-	7.5	-	
≤ 19 kW *N*<37 kW	2008	5.5	-		-	0.30
	2013		-		-	0.03
≤ 37 kW *N*<56 kW	2008		-	4.7	-	0.30
	2013	5.0	-		-	0.03
≤ 56 kW *N*<130 kW	2012-2014 yy			-		
≤ 130 kW *N*≤ 560 kW	2011-2014 yy			-	0.40	0.02
Gensets *N* > 900 kW	2011-2014 yy			-	0.67	
All engines except generators *N* > 900 kW	2011-2014 yy	3.5	0.19	-	3.50	0.10
Gensets from 560 to 900 kW	2015			-	0.67	0.03
All engines except generators from 560 to 900 kW	2015			-	3.50	0.04

* NMHC - non-methane hydrocarbons.

7. Terms commissioning cycle NRTC and regulations NTE.

Net power, kW	Date of NRTC	Date NTE
N<56	2013	2013
≤ 56 *N*<130	2012	2012
N> 130	-	2011
N> 560	2011	ND

Note. Engines potuzhnisnyh all categories of operating at constant speed crankshaft at different loads, according NRTC not tested.

Under the new engine testing methods for unsteady modes NRTC (it will apply in parallel with the old cycle NRSC, consisting of eight control modes according to ISO 8178) off-road machines shall be tested

twice - cold and hot start. Total emissions is determined as follows: 10% - collected during testing of cold start and 90% - for testing hot start.

8. The emission rates of hazardous substances as required Euro 4, 5 and 6.

Norm	Date of entry	Method Test	*CO*	*CnHm*	*NOx*	*RM* (Soot)	*Opacity, m-1*
			g / (kW·h)				
Euro 4	October 2005	ESC / ELR	1.5	0.46	3.5	0.02	0.5
Euro 5	October 2008	ESC / ELR	1.5	0.46	2.0	0.02	0.5
Euro 6	January 2013 *	WHTC / ELR	1.5	0.13	0.4	0.01	ND

* Exposure Draft (as of December 16, 2008).

Under the new engine testing methods for unsteady modes NRTC (it will apply in parallel with the old cycle NRSC, consisting of eight control modes according to ISO 8178) off-road machines shall be tested twice - cold and hot start. Total emissions is determined as follows: 10% - collected during testing of cold start and 90% - for testing hot start.

Tier 4 Standards do not require the use of a closed crankcase ventilation engines in off-road vehicles, but the certification toxicity crankcase gases in engines with open crankcase is measured and added to the emissions VG.

Cycle Emissions measurement of off-road vehicles consists of the same continuously provided for the European Stage IV norms and described in the standard ISO 8178. In addition, the rules also provide for Tier 4 off-road vehicles under test NRTC - loop unstable conditions. Cycle NRTC test involves cold start. Total emissions are counted as follows: 5% - collected during testing of cold start and 95% - for testing hot start. Dates for tests under NRTC presented in Table. 7.

The rules also provide for Tier 4 marks for maximum allowable (NTE), under which emissions are determined without the use of special techniques yakoyist. For most categories of engines under the rules NTE exceed allowed levels of each toxic component VG 1.25 times relative to the specified in the standard. Engines must meet standards and the certification of NTE, and during a lifetime. The goal, which introduced these rules, of course - the engines must have low toxicity not only during the testing cycle under control, but in actual operation.

In the complex requirements of the new standards toxicity important are the requirements of the diesel fuel ULSD (Ultra-Low Sulfur Diesel - Diesel fuel with ultra low sulfur content). At a higher content of sulfur in fuel neutralization of viral hepatitis is less effective, resulting in

toxicity SH may be higher than required by the new standards, because of the high content of sulfates and sulfur dioxide *SO2*. For certification under Tier 4 of 2011 should be used ULSD diesel fuel with sulfur content up to 7.15 ppm. Go with the sulfur content of 2000 ppm to 7.15 ppm conducted in stages between 2006 to 2010 in the EU levels of sulfur in diesel fuel must be reduced from 500 ppm to 15 initially ppm, then to 5 ppm and then to almost 0 ppm. The rules of ULSD EU introduced in 2009 - before the entry into force of Stage IIIb. In Japan, for consumption off-road vehicles ULSD regulations are adopted.

It should be noted that as a result of processing fuels aimed at reducing the amount of sulfur, may decrease its resistance to oxidation, so, obviously, will be required to enter into it protyokyslyuvalnyh additives. Using low-grade diesel fuel, which gave all developed countries have Ukrainian least another few years. However, there will still be a large number of machines operated with diesel engines meeting Euro 2 standards (Stage II) and below. For these old diesel fuel brands are better (especially for cetane number), which must also be taken into account. And the cost of low-grade fuel should be lower (although pricing in Russia and Ukraine vouch unfortunately not possible).

Of course, all of dvyhunobudivni and all the leading manufacturers of tractors and other mobile machinery gradually upgrade their products to comply with environmental standards Stage IIIb (Tier 4i). After all, they, unlike plants CIS can not expect that EU governments and the US will delay the introduction of these rules only for the reason that dvyhunobudivni plants are not willing to invest funds in timely upgrades.

Key technologies, systems and devices to reduce harmful emissions from diesel engines SH following:

-*EGR (Exhaust Gas Recirculation)* - Screening (bypass) SH;

-*SCR (Selective Catalyst Reduction)* - Selective (selective) catalytic SH (recovery using reagent - urea);

-*DOC (Diesel Oxidation Catalist)* - Oxidation catalytic converter;

-*DPF (Diesel Particulate Filter)* - Particulate Filter (sazhovlovlyuvach);

-*VGT (Variable Geometry Turbine)* - Turbocharger with variable geometry;

-*HPCR (High-Pressure Common Rail)* - Cordless System with Fuel high pressure fuel injection (120 (first generation) to 220 (fourth poklolinnya) MPa);

-*ULSD (Ultra-Low Sulfur Diesel)* - Diesel with ultra low sulfur content;

- The use of intermediate cooling air through the intercooler (radiator type "air-air");

- Improving the combustion process by developing more efficient combustion chambers;

- The use of special motor oil;

- New seals valves etc.

Conclusions

Despite already for a long time developing environmental technologies worldwide engine has not decided which technologies - EGR or SCR - today more profitable. Moreover, to fulfill the most stringent environmental standards requirements of both technologies are used in combination.

The use of EGR most often requires the use of two-stage turbocharger with variable geometry VGT and injection pressure increase, which in turn increases the level of operating temperatures in the engine and makes you lift capacity cooling system. This ultimately significantly increases the cost of engines. However, application of SCR involves the installation on the vehicle a number of additional components, using reagent - urea and its availability online refills. This also reduces the power unit.

However, the management of a complex set of environmental equipment is impossible without electronics, which is also known to "not free." Therefore, small cars new environmental regulations create major difficulties because of compact cars had space for additional units destined for disposal VG. Also, they have a much more tangible increase in value because of this modernization. And during the installation of all units neutralization of viral hepatitis in large mobile machines can increase its weight nearly a ton. In addition, the engines high environmental classes can only run on high-quality fuel with low and ultra low sometimes, sulfur, sulfur as "poisons" catalytic converters. Engine oil should also be low ash and low sulfur grade EN590.

The positive side of engines that meet new environmental standards, according to the representatives of almost all dvyhunobudivnyh companies, compared to previous releases engines 3 ... 10% better fuel economy is often increased mezhservisny intervals, simplified maintenance, increased power density and lifetime .

It should be noted that the work to improve diesel engines to ensure their compliance with high environmental standards are maintained and CIS countries, including Russia, Belarus and other countries.

References

1. *Podhurskyy C.* Our nastojashchee and future. Norms toxicity vnedorozhnыh machines / *C. Podhurskyy* // Main means. - 2008. - №1. - P. 12.

2. *Podhurskyy C.* Standartы Evrosoyuza for toxicity otrabotavshyh gases. Vysokonahruzhennыe Diesel engines and buses HRUZOVYKOV / *C. Podhurskyy* // Main means. - 2008. - №2. - P. 41.
3. *Protasov C.* Euro, Stage, Tier. Perspektyvnыe Environmental norms / *C. Protasov* // Main means. - 2009. - №4. - P. 56.

Rassmotrenы Modern Environmental standartы for diesel and selsko- lesohozyaystvennыh tractors and machines samohodnыh Stage and Tier, kotorыe deystvuyut in developing countries Evropeyskoho Union and the United States respectively, and pryvedenы technology, kotorыe pozvoljajut Run norms and toxicity of smoke gases otrabotavshyh, obuslovlennыe эtymy standards.

Tractor, samohodnaya machine engines, diesel, standard toxicity, opacity, ecology, эkonomychnost, rate, Stage, Euro, Tier.

The article is devoted to the resulted modern ecological standards for the diesels of agricultural and forest mobile machines Stage and Tier, that operate in the countries of European Union and the USA accordingly, and technologies which allow to fulfil quotas of toxic gases and exhaust smoke opacity of these standards are analysed.

Tractor, mobile machine, engine, diesel, standard, emissions toxicity, exhaust smoke opacity, ecology, economy, norm, Stage, Euro, Tier.