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Strategic Assessment Aspect of Vehicles' Technical Condition Influence upon the Ecosystem in Regions

Ramil Khakimov [1a]*, Sergei Shirokov [1b], Elena Vetrova [2c], Alexey Zykin [1d]

[1] *Saint Petersburg State Agrarian University, Peterburgskoe highway, Saint Petersburg, 196601, Russia*
[2] *Saint Petersburg State University of Economics, 51 Sadovaya str., Saint Petersburg, 191023, Russia*

Abstract

This paper presents complex methodology of quantity measurements for single and gross emissions of hazardous substances contained in vehicle exhaust gases and generated by the vehicle itself in urban and agro-industrial conditions in order to gain general understanding of combustion products impact on the ecosystem of individual town and region in general. In particular, especially critical is technical condition of motor vehicle fleet and regional ecology, namely air, soil, water and farmlands used to produce farm crops which constitute food security of the population and of the state in general. This paper presents analysis of harmful ecological impacts and solution approaches aiming to improve ecological and food security of the region under consideration.

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Keywords: Ecosystem; vehicle; technical condition; agro-industrial complex; exhaust gases; emissions; tests.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: haki7@mail.ru [a*], agro@spbgau.ru [b], vetrovaelenik@gmail.com [c], zykinalex@mail.ru [d]

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1. Introduction

RF overland transport which is covering 51-57% of all haulage including agro-industrial purpose shipments is playing a specific role in (i) ecological chain of emissions generation and (ii) environmental impact; vehicles constitute 4-7% in this issue and tendencies (further ecosystem contamination) cause concern of specialists employed in the sphere of ecology, agro-technologies and soil sciences [Khakimov et al. (2015)]. Technical condition being one of most critical vehicle operational characteristics should comply with respective urban and out-of-town operational requirements. This paper is aimed (i) to improve monitoring and ecological aspects of engine operation in urban and out-of-town conditions using data-entropy analysis of exhaust gases (which is characterizing gas engine technical condition) and (ii) to consider the models of combining vehicle/engine (V) dynamometric loading with methane-air mixture supply in the outlet [Khakimov (2012)].

2. Main text

The developed model was tested with two objects which are employing one and the same engine but differ between each other in testing principle. Unique character of this experiment consists in superposing the data obtained as a result of two tests -(i) engine bench test and (ii) dynamometric test of vehicle equipped with the same engine with simulation of vehicle urban operation mode aiming to measure single and gross emissions of hazardous substances (HS) and exhaust gases (EG). In the latter case, the model is being tested in combination of bench and dynamometric tests with simulation of vehicle field operation conditions aiming to measure hazardous substances and exhaust gas emitted by the engine. In both cases, engine operation modes considerably differ between each other, furthermore, in the second case the engine load is almost doubled due to increase of wheel rolling resistance coefficient *(f)*. Field roads relating to road classes IV and/or V sometimes have road slopes (α) which may have different ascent and descent angles worsening vehicle engine dynamic characteristics and causing 2-3 times increase of hazardous substances and exhaust gas emission if compared with urban operation mode and considerably affecting the environment (air, water, soil) [Khakimov (2010)].

Special attention is given to technical condition of vehicle operated in urban and field environment which factor may to a greater or lesser extent affect the environment. In our case, the proposed model envisages employment of data-entropy analysis of hazardous substances and exhaust gas allowing to comprehensively evaluate engine's technical condition and systems. Data-entropy analysis of engine emitted hazardous substances and exhaust gases means complex approach aimed to measure the complete unit service life characteristics allowing to evaluate current condition and estimate ultimate technical condition of vehicle under consideration [Zeinetdinov (2013)]. Let's consider the research results from the point of view of (i) vehicle technical condition and (ii) environmental impact produced by the vehicle. Actual vehicle's speed in urban condition is within 20-80 km/h which characteristic may be practically implemented in laboratory condition [Dybok and Khakimov ((2015)].

Hazardous substances correlation (when simulating urban and out-of-town modes) should be performed with consideration of applicable regulatory requirements.

According to special Technical Regulation of the Customs Union, vehicle engines put into circulation within RF territory should have minimum ecological standard class V.

Compliance (of vehicles and engines installed on them) to above Regulation requirements shall be verified by the Certificate of Conformity issued according to the procedure set forth by applicable RF legislation or by and official statement regarding approval of the type of vehicle and/or engine provided by the Rules of United Nations Economic Commission for Europe (UNECE Rules).

Certification procedure (methods of certification tests and emission standards) has been set forth by UNECE Rules and includes: UNECE Rules No. 24 (24-03); UNECE Rules No. 49 (49-02, 49-03, 49-04); UNECE Rules No. 83 (83-02, 83-03, 83-04, 83-05); UNECE Rules No. 96 (96-01) [Borovikov et al. (2012)].

Use of normative standards to precisely determine actual emissions of hazardous substances and exhaust gases reduces the research to a limited framework, namely: 1) technical condition of vehicle, 2) design features of engine and vehicle 3) dynamic pattern of vehicle engine load characteristics in different climatic conditions, 4) fuel type (gas, diesel, gasoline) influence on combustion process and engine emission characteristics.