



NATIONAL UNIVERSITY OF CIVIL  
DEFENCE OF UKRAINE

# INTERNATIONAL SCIENTIFIC APPLIED CONFERENCE “PROBLEMS OF EMERGENCY SITUATIONS”

SELECTED PEER-REVIEWED EXTENDED ARTICLES  
BASED ON ABSTRACTS PRESENTED AT THE  
INTERNATIONAL SCIENTIFIC APPLIED CONFERENCE  
“PROBLEMS OF EMERGENCY SITUATIONS” (PES)

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## Determination of Thermophysical Properties of Alternative Motor Fuels as an Environmental Aspect of Internal Combustion Engines

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**Keywords:** ecological safety, environment protection technologies, reciprocating internal combustion engines, alternative motor fuels, thermophysical properties, phase equilibrium, mathematical model, perturbation theory, forecasting.

**Abstract.** The article analyzes the state of the global problem of the fuel and energy crisis and environmental pollution by the combustion products of hydrocarbon fuels of industrial and transport power plants. To ensure the energy security of the state, the Cabinet of Ministers of Ukraine developed and adopted the «Energy Strategy of Energy Saving of Ukraine for the period until 2030», which was updated in 2008, to protect the country from energy risks. In addition, the Cabinet of Ministers of Ukraine approved the «Concept of a targeted scientific and technical program for the development of the production and use of biological fuels». To increase the efficiency of using alternative motor fuels, as one of the aspects of solving the problem, an original method and results of calculating the thermophysical properties of a wide class of such motor fuels (hydrogen, natural gas, biogas, mine gas, coke, blast furnace and synthesis gas, etc.) are proposed. A description of the developed mathematical model for determining parameters of phase equilibria and thermophysical properties of dense molecular systems (dense gases and liquids) is given. Calculation procedures are based on the thermodynamic theory of disturbances without the involvement of empirical parameters. Features of the proposed method are: limitation of initial information, high accuracy, the possibility of application in any practically important ranges of states. Calculation errors are at the level of traditional experimental errors.

### Introduction

In ecology, pollution is defined as a violation of the optimal state of the living environment. When considering environmental pollution [1, 2], a distinction is made between natural pollution caused mainly by catastrophic causes (volcanic eruptions, earthquakes, dust storms, mudflows, etc.), and anthropological pollution caused by human activity [3, 4]. As a result of human activity, 98 % of natural substances go to waste and only about 2 % constitute a useful social product.

Protection of atmospheric air [5], water resources [6, 7] and soil from contamination by various pollutants is one of the main tasks of preserving the quality [8, 9] of the environment for current and future generations of people [10, 11].

At the same time, the development and implementation of environmentally friendly technologies [12, 13], according to the world's leading forecasters, is a vital necessity of humanity, that is, it has a global character [2].

The main causes of anthropogenic environmental pollution in the industrialized countries of the world are the fuel and energy complex, industry [14, 15], and transport. Moreover, reciprocating internal combustion engines (RICE) used in motor vehicles are the main pollutants of the atmosphere of cities with carcinogenic and mutagenic ingredients. These substances can cause changes in hereditary properties in the human body, disrupting the genetic programs of cells [16].

The European Parliament made changes to the rules for controlling harmful emissions of RICE.

The article analyzes the state of the global problem of the fuel and energy crisis and environmental pollution by the combustion products of hydrocarbon fuels of industrial and transport power plants. To ensure the energy security of the state, the Cabinet of Ministers of Ukraine developed and adopted the «Energy Strategy of Energy Saving of Ukraine for the period until 2030», which was updated in 2008, to protect the country from energy risks. In addition, the Cabinet of Ministers of Ukraine approved the «Concept of a targeted scientific and technical program for the development of the production and use of biological fuels». To increase the efficiency of using alternative motor fuels, as one of the aspects of solving the problem, an original method and results of calculating the thermophysical properties of a wide class of such motor fuels (hydrogen, natural gas, biogas, mine gas, coke, blast furnace and synthesis gas, etc.) are proposed. A description of the developed mathematical model for determining parameters of phase equilibria and thermophysical properties of dense molecular systems (dense gases and liquids) is given. Calculation procedures are based on the thermodynamic theory of disturbances without the involvement of empirical parameters. Features of the proposed method are: limitation of initial information, high accuracy, the possibility of application in any practically important ranges of states. Calculation errors are at the level of traditional experimental errors.

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