Sustainable Energy Systems for Future Transportation

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Abstract. Among the alternative energy sources, of particular importance is hydrogen energy, which is likely to address the acute environmental problem of large cities in the near future, in terms of pollution of the environment, first of all, of air pollution from vehicles.

Among hydrogen-containing raw materials, which can be used in a fuel component, hydrogen sulphide is of particular importance. It is well-known that the Black Sea the largest basin on the planet by the amounts of hydrogen sulphide dissolved in water. In that regard, the Black Sea is the object of the attention of scientists, since its deep waters contain hydrogen sulphide, hydrosuphide and suphide ions in large quantities. The sources of their origin are gases erupted from the volcanic and geological splits existing at the bottom of the sea, as well as organic substances and products of decomposition of microorganisms brought down by the rivers.

In this regard, the Black sea may become a potential source of hydrogen energy, and simultaneously that may improve environmental situation in the Black Sea.

The paper analyzes the challenges existing in the use of hydrogen obtained from hydrogen sulphide of the Black Sea, as an alternative fuel in the internal combustion engines of vehicles, as well as the prospects for addressing these challenges.

Keywords: hydrogen sulphide; hydrogen; alternative fuel.

In recent years, especially when the price of oil reached to $100 per barrel, there has begun to be talk of the alternative to oil. Since such a high price of oil hinders significantly the development of the world economy, more than that, there is a probability that a high price of oil will further deepen current economic crisis, the oil-consuming countries try to replace oil by the relatively cheaper alternatives. The era of low product prices has passed into history. There is a rationale behind this. Oil resources located close to the earth stratum have mostly been extracted already, that is, at the current stage, when new reserves are being developed and open up, oil is extracted from greater depth of the Earth that carries significant cost related issues. On that basis, oil production, in comparison with previous years, keeps getting more expensive. In addition, in major oil-producing countriers, there prevails the tense geopolitical situation. Take even the Libian crisis. In addition, the demand for oil has been significantly increased. Whereas previously in China, India and other Asian countries had been poorly developed, and consequently their industrial-economic potential was low, they recently had achieved a significant economic growth, that, in turn, had resulted in a considerable increase in oil consumption. So, the major oil-consuming countries are pondering about replacing oil by the alternative sources. that end, it is necessary to become familiar with the main energy sources. The energy sources are categorized into the traditional (non-renewable) and non-traditional (renewable) sources. The first of these includes: oil, natural gas, coal and nuclear fuel, and the non-traditional (renewable) energy sources are water, solar, wind, geothermal and biomass energies.

From time immemorial, search and use of the different ebnergy sources have been a matter of discussion and concern to all humanity. Firewood was the main energy source in primitive society.

About 300 years ago, the people started to use extensively coal, and 100 years ago — oil. That was a very important novelty, which fundamentally changed the world. Today, we are witnessing again the same revolutionary transformations — humankind is seeking to replace coal and oil by the renewable energy sources — solar, wind, hydro, geothermal and biomass energies, and also, is starting to think of the investigation and development of more efficient technologies.

Replacement of fossil resources — oil, gas and coal, by other resources has become relevant for several reasons as follows:

1. *Depletion of reserves*. Coal and oil have originated from animal and plant residues deposited in the Earth's crust from time immemorial. That's why they are called "fossil fuel". We do not know what quantities of coal and oil exist on the Earth, although we consume them much faster than is required for their formation that may result in depletion of the world's reserves. According to the United Nations, by the end of the 21st century, a global population is expected to have doubled to about 10-12 billion people. Naturally, population growth will increase the demand for energy, and renewable energy must become the source for meeting the growing energy demand.

2. *Environment*. Consumption of fossil fuel leads to generation of a large amounts of waste, disposal of which often calls for great effort and is not very easy. Extraction of oil, coal and gas requires excavating of large areas. This leads to the contamination of vast areas, plants, animals, birds that grow nearby, and even human beings are exposed to this contamination as well.

3. *Climate change and global warming*. Combustion of fossil resources accelerates the process of global warming. During fuel combustion, there are released harmful substances, different gases, which produce a greenhouse effect and increase the surface temperature of the Earth. The essence of a greenhouse effect is as follows: the sun heats the Earth's surface and the atmosphere. 70% of this heat returns back into space. Greenhouse gases emitted during combustion of fossil fuel, such as carbon dioxide, methane and so on, wrap the atmospheric shell and they are an obstacle to the return of sunbeams back into space, that is, they produce a greenhouse effect. This leads to temperature increases on the Earth.

With regard to nuclear energy (20% of total generated energy). Energy generated by nuclear power plants is cheap, and existing of required raw materials (uranium ores) are huge. It is even more important that there is no air pollution with nuclear power plants, and they do not emit greenhouse gases. In the 1960s, there was a common belief that full transition of the energy sector to the nuclear technologies was only a matter of time (there have been even created the vehicles powered by the miniature nuclear reactor). However, views on nuclear energy are still mixed because of safety concerns.

The nuclear waste, despite their very small quantities, are dangerous: they are radioactive, and their decay may take centuries. They are stored at the special sites, often in the closed mines, so that they do not expose to the environment. Nuclear power plants are the very modern facilities, and they are equipped with the state-of-art security systems, but in spite of that, the accidents still happen (sometimes very serious ones, for example Chernobyl and Fukushima). That is why some countries decided to phase out the nuclear technologies (for example Germany). One more serious danger is that some states, which are considered to be accomplices of terrorism are seeking to use the nuclear technologies for the manufacture of nuclear weapons. In spite of all its threats, nuclear energy remains one of the most effective methods, but public opinion is currently opposed to nuclear energy, and, in a sense, is blocking its further development. The problem also applies to the scope of the use of nuclear energy itself: if, for instance, humankind decided that the world's fossil energy must transit from fossil fuel completely to nuclear energy, it might be necessary to open one medium-sized nuclear power plant every day.

Given all that, the issue of searching and using of alternative resources, which allows us for avoiding the above-mentioned problems, has been pushed into the forefront. It is believed that the 21st century must become a century with the massive use of the renewable energy sources.

Technological progress based on traditional energy, providing humans with many benefits, simultaneously adversely affects the environment. This results in global climatic changes. The Earth's temperature is expected to rise in the coming decades. This may be only two degrees or a little higher, but actually, this will cause the great changes in the processes that take place in nature. Thus, the challenge of searching for a new source of non-traditional energy is a significant objective for both power industry and residential sector.

Where do we get renewable energy? If you have ever been weary from the heat during your standing in hot sunshine, you had experienced the impact of solar energy. Swimming in the sea, when the waves are helping you to swim by moving in the desired direction, you are using wave energy. In windy weather, the complicated movement upwind points to the capacity of wind energy. The heat obtained as a result of wood combustion is the use of biomass energy. The eruption of volcanoes and geysers is the demonstration of energy coming from the heart of the Earth, which is called "geothermal energy". Scientists have been thinking a lot about the use of these energies for heating, cooling, transporting or other purposes. The results obtained and trends in the modern world might be of interest in that regard.

Among the alternative energy sources, of particular importance is hydrogen energy, which is likely to address the acute environmental problem of large cities in the near future, in terms of pollution of the environment, first of all, of air pollution from vehicles [1].

The comparative advantages of hydrogen over gasoline are as follows:

1. Calorific power of hydrogen (28630 kcal/kg) exceeds calorific power of gasoline in 2,8 times.
2. Ignition energy is 15 time lower.
3. The flame front maximum speed exceeds calorific power of gasoline in 8 times.
4. Flame radiation is 10 times lower.

Search of raw materials for hydrogen production and obtaining hydrogen from appropriate raw materials is a pressing challenge. The essential condition for the transition to hydrogen energy is the creation of reliable, efficient and environmental energy equipment operating on hydrogen or hydrogen-containing raw materials. Among hydrogen-containing raw materials, which can be used in a fuel component, hydrogen sulphide is of particular importance. It is well-known that the Black Sea the largest basin on the planet by the amounts of hydrogen sulphide dissolved in water. In that regard, the Black Sea is the object of the attention of scientists, since its deep waters contain hydrogen sulphide, hydrosuphide and suphide ions in large quantities (estimates range between 46 and 80 billion tons). The sources of their origin are gases erupted from the volcanic and geological splits existing at the bottom of the sea, as well as organic substances and products of decomposition of microorganisms brought down by the rivers.

The peculiar characteristic of the Black sea is the total non-existence of life at a depth of about 150-200 m (except some bacteria). As a result of marine environmental studies, it has been established that viability of the Black Sea is diminished and according to the predictions of scientists, by the state of the sea's flora and fauns, and by the chemical composition and extent of contamination of its water, chemical composition, the Black Sea is on the verge of death. Actually, destruction of flora and fauna in the sea is associate with the environmental problem of hydrogen sulphide. The danger of ignition of hydrogen sulphide at sea, and the possibility of using hydrogen, which was obtained as a result of

hydrogen sulphide decomposition, for fuel, have been formed as a single complex problem, and it requires a comprehensive solution. The Black sea may become a potential source of hydrogen energy, and simultaneously that may improve environmental situation in the Black Sea [2].

This energy source also reduces air pollution and the amount of natural gas used. In addition, it contributes to the improvement of socio-economic situation in in the developed countries, as well as ensures that demand for electric power is met. Another advantage of this technology is that it does not have a negative environmental impact. At that time, no any impact on sea-water takes place, no changes in its saltiness and acidity, no balance upset occurs and no waste generation takes place.

Theoretical and experimental studies have resulted in the development of an effective method, by means of which it is possible to take water enriched with hydrogen sulphide and other salts from the bottom of natural reservoirs by separating hydrogen sulphide from water for the purpose of the further dissociation of the latter.

This innovative method is focused on the problem utilizing hydrogen sulphide from the Black Sea, and on its use for the development of hydrogen energy. It demonstrates that taking hydrogen sulphide containing water in large quantities with maximum energy-saving, and separation of hydrogen sulphide from it by environmentally safe method are very real that is confirmed by the appropriate experiment [3].

To achieve this goal, it is necessary to attain the following objectives:

1) To create efficient equipment for the purpose of taking hydrogen sulphide rich water from any depth;
2) To run physical-chemical analysis of water taken from different depths;
3) To develop equipment for obtaining hydrogen sulphide taken from the sea-shore.

The vehicle's hydrogen-powered internal combustion engine, with its design characteristics, is very similar to the current widespread engines running on natural gas (propane). Principle of their operation is almost identical. Thus, in case of the transition from natural gas to hydrogen fuel, the engine is easily readjusted. However, efficiency of this method is lower in comparison with method of using thermal elements.

In the case of using the method of thermal elements, we have a "thermal battery" in the vehicle, i. e. an electric generator, which is the so-called an "everlasting" battery, inside which the hydrogen oxidation reaction occurs, and at the outlet, we obtain pure water vapor, nitrogen and electric power. That is, exhaust gas from such vehicle is environmentally clean, and the concentration of carbon dioxide (CO_2) in it is zero.

In essence, the vehicle running on thermal element is an electric car, which has the more compact batteries. Here, the battery is only required as a buffer for storing energy, which is obtained during the regenerative brake.

Complete elimination of an adverse environmental impact of transport is impossible, although it is possible, and even necessary to reduce this negative impact as soon as possible. All this can be achieved by reconstruction of transport and power engineering equipment, which envisages using alternative fuels, including hydrogen obtained from hydrogen sulphide. Consequently, less quantities of harmful substances will be emitted into the air, and vibration and noise transferred to the environment will be reduced as well.

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