PROSPECTS FOR HYDROGEN ENERGETICS AND PROBLEMS OF ENVIRONMENTAL PROTECTION IN UKRAINE

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Many countries in the world have limited natural energy resources: hydrocarbons (oil, natural gas, bituminous coal), water resources, wind power and solar energy. Many countries have hidden energy resources, such as oil, natural gas, bituminous coal, peat or some of them. The countries that occupy key positions as to oil reserves and production include: United Arab Emirates (UAE), Iran, Venezuela, Saudi Arabia, Iraq, Kuwait, Libya, Katar, Brazil, China, Russia, Romania, Algeria, Nigeria, Kazakhstan, Ukraine. The estimated global oil exhaustion time in these countries is from 22 (Angola) to 145 (Kuwait) years. The determined oil reserves in Ukraine (Ψ) are 62.8 million m^3, the annual output (q) is 2.8 million m^3, the estimated global oil consumption time (τ) is 22.4 years.

For example, USA, Ψ = 3460.6 million m^3, q = 337.9 million m^3, τ = 10.2 years; China, Ψ = 3816.0, q = 188.9, τ = 20.2; Russia, Ψ = 7723.1, q = 459-470, τ = 16-17; Kazakhstan, Ψ = 861.3, q = 23.7; Saudi Arabia, Ψ = 41212.8, q = 468.0, τ = 88.1; UAE, Ψ = 1550.2, q = 468.0, τ = 120.3.

The second abundant hydrocarbon energy carrier, which will last 70-100 years, is natural gas. The third hydrocarbon energy carrier is bituminous coal. The world coal reserves up to the depth of occurrence of 1800 m are 11723.06 milliard t. In Russia the open coal reserves are 6017.0 milliard t, in Ukraine 146 milliard t, in Kazakhstan 127 milliard t, in the USA 107 milliard t. The coal reserves in the USA that occur at normal depths will be exhausted in 84 years. The coal reserves in the USA up to the depth of occurrence of 1800 m are estimated to be 3.6 trillion t, which will last over 1000 years. The coal reserves in the EEC will last 284 years, in the Republic of South Africa 389 years, in Australia 237 years, in Poland 166 years, in India 106 years.

On the territory of Ukraine, 126 oil deposits with commercial reserves, estimated to be 427.6 million t, and with predicted geological reserves of about 1229 million t have been struck [1]. As is seen from Fig 1, Ukraine possesses commercial oil reserves in the Southern, Western and Eastern regions.

In the Eastern region in the chief oil-bearing Dnieper-Donetsk aulacogen are situated up to 90% of Ukrainian oil and gas production enterprises. At the average oil output of 4.5 million t in recent 20 years, the oil reserves will last 95 years, and in the case of development of the predicted oil reserves of 1229 million t and increase of oil output to 9.0 million t/year, 136 years.

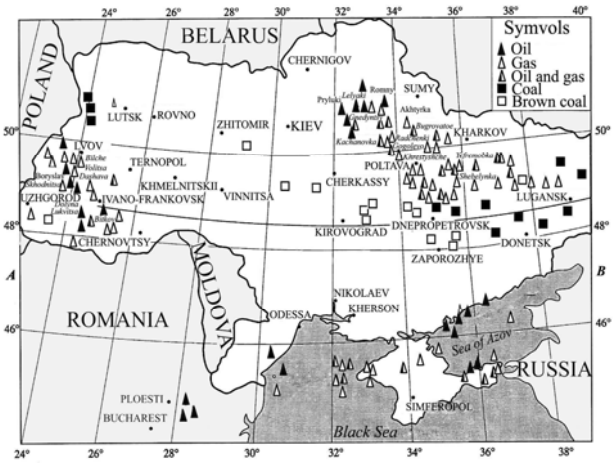

Fig 1. Schematic map of the coal- and oil- and gas-bearing zone and oil, natural gas and bituminous coal deposits in Romania and Ukraine.

The determined natural gas (CH_4) reserves in Ukraine are 1121.3 milliard m^3 [1]. At the average output of 20 million t of CH_4 per year, the gas reserves will last only 40 years. Bituminous coal in Ukraine will last 88 years if the present-day volume of output persists. Ukraine has large coal mine methane reserves.

If the oil, gas and bituminous coal output is increased to the level of satisfaction of needs, the consumption of hydrocarbon reserves will increase by a factor of 3-4. Naturally, the release of carbon, sulfur, nitrogen oxides as well as metal (Pb, As, Zn, Hg, Be, Cr, U) and metalloid (Se, Te, Ge) oxides and even radioactive elements from thermal power stations into the environment will increase. Therefore, releases from thermal power stations (TPS) are a great threat to the ecology of Ukraine.

It is evident from the data, given in Fig 2, on the balance of energy generation and consumption in Ukraine that the bulk of electrical energy is

generated by nuclear power stations (NPS), 47.75% (15.9 milliard kWh), and thermal energy is generated by TPSs (45.66%). The total utilization of renewable energy sources (RES) is 6.59%. The water power of water power stations (WPS) is 6.53%, the geothermal energy of RESs is 3.508×10^{-3} %, solar energy is 0.0063 %; the total percentage of such RESs as bioelectrical energy, biodiesel fuel, biothermal energy, wind power generation is only 9.808×10^{-3} %. It should be noted that in spite of the small contribution of RESs to the Ukrainian power industry, the expenses on its capitalization remain heavy.

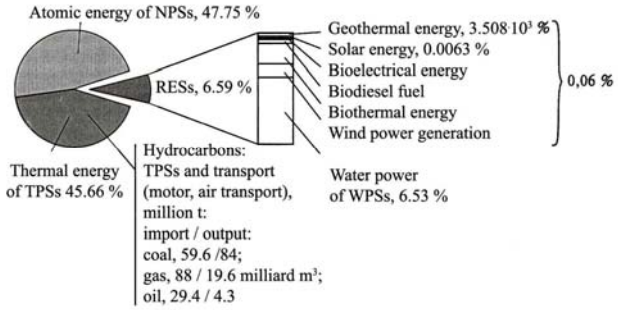

Fig 2. Schematic representation of the balance of energy generation and consumption in Ukraine

It follows that the main energy carriers used in Ukraine are organic: natural gas (89 milliard m^3), coal (52.6 million t), oil (20 million t) and other types of fuel [1, 2]. In addition to considerable reserves of coal (bituminous coal, brown coal, shales), Ukraine possesses large oil reserves, which have not been developed yet [1]. Ukraine must put the production of hydrocarbons: natural gas and oil right, but they must be regarded as sources of chemical raw materials, and one must remember a known phrase of D.I. Mendeleev, who compared oil to banknotes used as a fuel.

It is necessary to actively develop in Ukraine hydrogen energetics using energy-storing substances based on aluminium, magnesium, boron, silicon, iron, etc. Having been activated by various methods (introduction of metals-activators, dispersion, etc), these elements possess a high reactivity and displace actively hydrogen from water at a high rate [1, 2].

Analysis of the consumption of hydrocarbons in the industry and utilities of Ukraine shows that their reserves are finite, and that they will continuously go up in price.

Therefore, it is necessary to develop new inorganic energy carriers, e.g. by reducing hydrogen from water, whose reserves in Ukraine and in the world are infinite and renewable. Hydrogen can be isolated from water in the gaseous state, compressed and stored in gasholders, or it can be liquefied and kept in special vessels for delivery to the consumer. Ten methods of hydrogen production are known [1, 2]. It seems to us that in the future hydrogen will be produced by three methods: with the aid of energy-storing substances (ESS), by electrolysis (energy of NPSs) and photoelectrolysis (in the southern regions of Ukraine and southern countries).

Many hydrogen production methods are not efficient (photoelectrolysis), use hydrocarbons (natural gas, oil) or require heavy capital costs (electrolysis). Therefore, the concept of energy-storing substances, which can be oxidized and reduced many times, i.e. be used as a working substance in hydrogen and power production on a commercial scale, appears to us to be more promising. The paper analyzes three types of highly reactive alloys, which show a high water affinity and perform the functions of ESS. Such alloys include low-temperature (223-273 K), medium-temperature (273-573 K) and high-temperature (573-2273 K) alloys of ESSs. Low-temperature alloys of ESSs can be used in space devices, geological exploration, new technology. Medium-temperature alloys of ESSs can be used in power generation, transport and industry. High-temperature alloys of ESSs can be used in a variety of fields: from terrestrial conditions to energy and hydrogen sources for spaceships, for filling cartridges for fuel cells.

The paper considers in detail the development prospects of hydrogen energetics in Ukraine with hydrogen production on a commercial scale to replace in the future natural gas in power generation, machine building, motor transport and submarine fleet.

References

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