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IBI (India) = 4.260
OAJI (USA) = 0.350

SOI: [1.1/TAS](http://s-o-i.org/1.1/TAS) DOI: [10.15863/TAS](https://doi.org/10.15863/TAS)

International Scientific Journal Theoretical & Applied Science

p-ISSN: 2308-4944 (print) e-ISSN: 2409-0085 (online)

Year: 2019 Issue: 08 Volume: 76

Published: 06.08.2019 <http://T-Science.org>

QR – Issue



QR – Article



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ENVIRONMENTAL ISSUES OF RADIOACTIVE ORE MINING IN KAZAKHSTAN MINING INDUSTRY

Abstract: In this work the authors present information highlighting the importance of nuclear energy development. The Republic of Kazakhstan is one of the world leaders in reserves of uranium deposits, the use of which, as a source of energy, helps to accelerate the pace of development of the country's economy. At the same time, the extraction of radioactive ores entails a number of environmental issues that require serious objective assessment of the extent of the radioactive hazard.

Key words: minerals; ore; enriching; energy sources; power mediums; ecological problems; unprocessed in the carriers of energy; uranium; thorium; proceeded in energy sources; atomic (nuclear) energy; radio-activity; method of the underground down hole lixiviating.

Language: English

Citation: Zhunisbekov, S., Jakiyayev, D. K., & Zhashen, S. Z. (2019). Environmental issues of radioactive ore mining in Kazakhstan mining industry. *ISJ Theoretical & Applied Science*, 08 (76), 32-36.

Soi: <http://s-o-i.org/1.1/TAS-08-76-5> **Doi:**  <https://dx.doi.org/10.15863/TAS.2019.08.76.5>

Classifiers: Metallurgy and energy.

Introduction

Over the past 100 years there has been unprecedented human intervention in nature. For his needs human mines minerals in increasing number bringing to surface huge masses of ore and dead rock. The mined ores get enriched; useful elements get distracted from them. The wastes of their processing pollute atmosphere and water resources, dumps of dead rock and other types of wastes occupy vast areas of lands.

Energy resource mining plays a special part in mineral mining. This is a requirement of life, since one of the main indicators of potential for development of any civilized society is the indicator of its energy capacity; energy is the basis of the existence of modern civilized humanity.

Materials and Methods

According to statistics over the past 30 years the world's electricity per capita consumption has doubled [1]. Taking into account the fact that the population of the Earth is increasing almost exponentially, energy consumption will grow at the same rate, which means that we should expect huge increase in production of energy sources - energy carriers of heat and electric energy. Production of conventional energy sources, and especially their use, cause enormous environmental problems. In such fast growing countries as China, South Korea, and Japan, thick seasonal smog becomes a traditional national disaster. In addition to direct contamination of the air and water basins as a result of use of organic energy sources there

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is a growing radiation background at their waste dump sites.

Thus the increase of production of heat and electrical energy grows into a problem of paramount importance. This problem is inextricably linked with the problem of primary energy sources and determination of the main directions of energy development in general. Any modern person presents the list of primary energy sources: non-renewable organic energy carriers (coal, oil, natural gas, peat, etc.), renewable (unconventional) energy sources (hydroelectric power, solar, wind, tidal, geothermal, etc.) and atomic (nuclear) energy.

Currently there is large number of global energy development forecasts for the near future, but almost all experts are unanimous that in the coming decades humanity will face complete depletion of reserves of conventional fossil energy sources. According to the same estimates the world reserves of organic energy sources (oil, natural gas, peat, etc.) in the coming years will not be able to provide the required growth in energy production. And only stocks of coal as a source of primary energy can be used for about 150–200 years [1].

In other words humanity faces the most complicated problem of inevitable depletion of natural energy resources. This task is preferable to solve without loss of pace of economic development. The great natural scientist, geologist and philosopher of the twentieth century V. I. Vernadsky who devoted much of his life to studying the laws of civilization development on Earth, concluded back in 1911: "The emphasis on using exclusively organic fuels for energy development is a predetermined dead-end road" At about the same time equally great chemist D.I. Mendeleev concluded "... to fire the furnace with oil is equivalent to firing with banknotes!"

Solution of issues of energy supply of population and economy will depend on the choice of right direction of energy development.

Most of highly developed countries have already made a choice in the direction of energy development in favor of priority development of atomic (nuclear) energy. The need for nuclear energy development is dictated not only by the factor of organic resources depletion. Equally important is the extent of impact of energy production method on public health and environment, i.e. environmental safety factor.

Nuclear power, as it may seem unexpected to many, has a clear advantage here! Under normal operating conditions it is safer for public and environment than fossil fuel burning based energy.

Comparing the environmental effects of nuclear and thermal power plants of the same electric capacity the scientists obtained amazing data: only radiation emissions from coal-fired plants are 10-20 times more hazardous than modern nuclear power plants. And this is without taking into account the emission of other harmful products of coal combustion.

The estimates made in the USA for a coal-fired thermal power plant with 1 million kW capacity show that during its operation within a year there are released about 2 billion of lethal doses of toxic substances which are dispersed in the atmosphere and accumulate in the environment without decomposing. Annual dose of radiation exposure of the population within 20 km radius from a normally operating nuclear power plant, measured at hundreds of plants over the past 40 years, was 20 times lower than in the same area around a coal-fired thermal power plant of the same capacity [1].

In addition, other undesirable and even dangerous phenomena associated with coal-fired thermal power plants are untold or "forgotten" in society. For example in our republic the basis of energy is formed by thermal coal stations operating on Ekibastuz coals. Experts know that this coal is very ashy, the coal itself in it is only about 35%, and the rest is mineral impurities - ash! When burning it 17–19 million tons of ash is emitted annually into the atmosphere which contains a huge amount of pollutants and toxic substances including fine uranium aerosols [5]. These emissions cover vast areas. Thus according to press reports the harmful aerosol emissions from Ekibastuz GRES power plant are recorded even in the territory of Western China. Only 20% of ash stays in installed fly-ash collectors at these plants, the rest of the mass flies into the pipe. But hazardous wastes caught in the fly-ash collectors are not disposed in any way, and they are also carried from the dumps to surroundings by the wind. According to expert estimates over 300 million tons of such waste has been accumulated in ash dumps! Are they not environmental problems to be urgently addressed?!

Thus using the example of Kazakhstan, replacement of a coal-fired thermal power plant of 2 000 MW capacity with an equivalent nuclear power plant will lead to coal consumption reduction by 11.5 million tons per year; ash emissions - by 3.6-4.9 million tons per year, carbon dioxide - by 24.2-28.9 million tons per year, sulfur oxides - by 115 thousand tons per year, nitrogen oxides - by 210 thousand tons per year and natural radionuclides - 40 times less! [8].

At present there is burned around 10 billion tons of equivalent fuel per year in the world whereon about 35 billion tons of oxygen is consumed. The calculations of environmental scientists show that when this situation continues, if proven reserves of fossil fuels are burned, the concentrations of carbon dioxide in the atmosphere will more than double [1,2]. Thereat the Earth temperature will increase by 1-3 degrees due to "greenhouse effect" which will lead to significant climate change.

In this matter there is no need even to explore any environmental models or visit paranormalists. Nature itself is already giving us unequivocal signals of trouble. Even due to current slight increase in the

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Earth's temperature (only by 0.7 degrees) evaporation of global ocean has increased, and continents are flooded by unprecedented rains or smothered with snow. Arising at that catastrophic snow drifts and floods take away human lives paralyzing traffic flow and economy of some states. The power of hurricanes and their frequency has doubled [2]. Unusual dangerous natural phenomena began to appear in many regions. For example, in Russia and Kazakhstan, there began to appear destructive tornadoes that have never been seen here.

One of the alternative energy sources are the so-called renewable sources (energy of water, wind, tidal power, solar energy, geothermal sources, etc.), which do not produce greenhouse gas emissions into the atmosphere. But according to the experts of World Energy Council (WEC), in the immediate future these sources will not be economically competitive for broad-scale utilization. WEC takes up the position that even with proper financial support the share of renewable energy sources in global energy supply by 2020 will not exceed 5% of the required amount of electricity.

Analysis of characteristics of these sources shows that their use will allow solving only certain applied problems of energy supply at the regional level. And there is also no talk about large-scale development of hydropower for Kazakhstan. There is already a shortage of water for household needs only.

Solar energy development will require a huge amount of very expensive and scarce materials (approximately 60 tons of cadmium and 90 tons of tellurium per 100 km² battery). Damage to the environment in production of these not near environmentally safe materials for solar panels will reduce to zero the seeming environmental friendliness of this type of energy. Thus greenhouse gas emissions from the production of silicon cells for solar panels reach very significant values, which are not taken into account by many environmentalists.

By contrast the nuclear power is developed all over the world. Projects of nuclear reactors with absolute safety warranty have already been developed, and are able to almost completely "burn" all uranium or thorium while organizing closed fuel cycle with regeneration of spent fuel, i.e. to increase the energy output from the same amount of uranium by 200 times!

Operation of available and even under construction reactors has been provided with fuel for many hundreds of years only on the basis of proven uranium reserves. Besides there are uranium reserves in the depths of the Earth and the waters of the global ocean, thousands times outnumbering explored ones. Over time humanity for its needs will learn to cost-effectively extract this uranium too. Thorium can also be used as fuel for nuclear reactors, as its reserves in the Earth depths are ten times more than uranium.

Besides at present there is active development of thermonuclear energy which has even more extensive almost limitless fuel resources and incomparably smaller level of radiation hazard. Reaction of light nuclei synthesis accompanied by enormous release of energy can proceed almost without neutron release. Radioactivity level of such a synthesis reactor can be thousands of times lower than that of a modern nuclear fission reactor, and possibility of explosive reactions in it is practically excluded.

Another important economic aspect - according to WEC estimates, nuclear electric power is much cheaper than electric power produced from oil as well as coal and gas (due to high costs for fossil fuel extraction and transportation which will constantly increase). Another major advantage of nuclear power is stability of electric power prices in the long run. Cost structure of electric power generation in the nuclear power industry differs significantly from the pricing structure in other types of energy economies. It is related to the fact that the cost of nuclear power is mainly determined by capital investments into construction of a nuclear power plant, and not fuel costs, in contrast to oil, gas and coal. The fuel component in total cost of electric power produced by nuclear power plants is not above 25%, and for thermal powerplants operating on organic fuel is at the level of 50-80%. This circumstance leads to increased sustainability of nuclear electric power price in regards to variations of fuel price.

Stability of electric power prices over a long period of time will create extra important factor of investment attractiveness of Kazakhstan.

We see clear advantages of nuclear energy these days already. Comparing the frequency of accidents in various branches of human work activity the statisticians were convinced that according to this indicator the practical use of atomic energy takes place in line with the clothing, food and weaving industries. At that the share of radiation accidents does not exceed 10% in this figure (including Chernobyl and Fukushima accidents). Comparison of losses for society (in the form of the number of deaths and days of disability) in various types of electric power generation speaks again in favor of nuclear energy.

Environmentally harmful impact of coal-fired thermal power plants and very high investments required for its reduce put coal-fired thermal power plants in noncompetitive conditions. To generate equal amount of electric power, 1.5-3 million tons of fossil fuel (oil or coal) are required to be mined and transported annually, compared to 200 tons of uranium fuel [6].

All arguments of nuclear energy opponents are reduced to one - radiation hazard. Sensitivity and overly biased reaction of the population and part of ignorant "experts" is caused by lack of knowledge of real state of affairs. Radioactivity fear, especially widespread after the accident at Chernobyl nuclear

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power plant and Fukushima-1, gradually develops into radiophobia.

Given these circumstances, IAEA(International Atomic Energy Agency) has conducted an objective international examination of emergency response measures at Chernobyl nuclear power plant and Fukushima -1. Twenty world-known experts from ten countries conducted thousands of analyses and measurements for 18 months, and summing up a huge amount of factual material wrote a report, from which it follows that many of the environmentally harmful factors were significantly overestimated!

On the other hand not many people know that production of oil and natural gas is accompanied by radioactive isotopes rise to Earth surface including the long-lived Ra-226 and Ra-228 with their decay products [2,8]. The fact of accumulation of other environmentally hazardous materials and elements is often untold, even at the stage oil and gas refining. For example, there has already been accumulated more than a million tons of sulfur around the oil fields in Western Kazakhstan!

According to the US Environmental Protection Agency, in the oil-and-gas fields of Louisiana State and other southern states the oil-water mixture pumped to the Earth surface is 5–20 times more radioactive than water that is allowed to be discharged from nuclear power plants. In the reservoirs of this state into which water was discharged after its separation from oil, the concentration of radium at the bottom is the same as in the old nuclear weapon factories!

Such radioactive anomalies are also known in the oil fields of the CIS and Kazakhstan (the fields of Apsheron, Tataria, Kalmykia, Atyrau oblast, Mangyshlak) [5]. Countrywide in Kazakhstan, in the areas of 22 largest fields where oil is currently being produced, 267 sites of radioactive pollution have been identified with the dose rate from 100 to 17000 mcR/h (please note that with values of 100 mcR/h and over, the land sites within production landfills of mines are subject to reclamation in accordance with Sanitary Rules requirements).

Thus in terms of radiotoxicity per unit of generated energy a normally operating nuclear power plant has thousand-fold (a thousand times) less environmental impact than the oil fields [2].

US experts considered that if safety standards approved for the nuclear industry were applied in the oil and gas industry, the cost of radioactive decontamination of oil and gas fields would reach billions of dollars, and oil and gas production would be unprofitable! [2].

All these facts indicate that nuclear energy positions in terms of environmental protection are quite strong.

With this in mind, most countries in the world are stepping up the pace of construction of nuclear power plants with a focus on nuclear fuel use.

Kazakhstan has not yet used its unique potential of available huge amount of the cheapest fuel for power plants, relying on very illusive priority in production and use of fossil fuels, the reserves of which will run out in the coming decades. By that time Kazakhstan may irretrievably fall behind in development of nuclear power technologies and will only act as a mere supplier of raw materials to developed countries.

Currently Kazakhstan has one of the world's largest uranium raw material base, which allows to provide not only domestic needs, even with the maximum development of nuclear power industry, but also leads the republic into the ranks of the world's largest uranium exporters [3].

Career (open) and mine methods of uranium mining practiced before the 80s of the last century are not used now. These technologies turned out to be economically and environmentally unprofitable. Nowadays a cost-effective and environmentally friendly method of drill hole in-situ leaching (ISL) is being used [3].

Peculiarity of the advanced method of drill hole in-situ leaching (ISL) is that in this case the whole technological chain is excluded: opening of ore bodies and formation of dumps, blasting operations, transportation of rock mass, crushing and grinding of uranium ores, sorting at radiometric monitoring stations - (RMS) and crushing. Only one hydrometallurgical process of uranium ore processing is preserved - leaching of uranium. In addition this whole process is transferred from surface to underground. It is clear to what extent this method is more economical and more environmentally friendly than all the ones available before; no waste remains on the earth surface(no open cuts, waste dumps, temporary roads, enrichment plants, heavy machinery and other technological facilities). Another important feature of acid leaching method is use of the selective leaching process for low-grade uranium ores. [4].

The environmental advantage of drill hole in-situ leaching method (ISL) is that "uranium mining" takes place underground by dissolving natural minerals of uranium and pumping it to the surface. All the wastes of "production" remain underground!

This method allows extracting useful components from ores practically not disturbing the ecology, retaining even the surface layer of soil and without disturbing the hydrogeological environment in the area. Absence of blasting operations, of open mine workings, mine shafts, dumps of "dead" rocks and substandard ores, turns the term "mine" into a purely conventional notion [4].

Nevertheless uranium mining projects provide for annual deductions on average - 6.77% of mining costs for remediation activities on completing of field exploitation.

Groundwater reclamation is not performed at the fields, as it has been proven by numerous and years long researches that ISL does not disturb the natural

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balance in the underground hydraulic system of the region. There is a conclusion of State Ecological Expertise of the Republic of Kazakhstan on purity of this technology as a proven fact.

About 21% of the world's explored reserves of uranium are concentrated in our republic - this is the second place in the world. Unique uranium deposits allow our republic to confidently take the leading place in the cheapest fuel mining with a further prospect for its increase. Our domestic experts have invaluable experience and uranium raw material mining technologies practically at any morphology of ore deposits and bodies to depths of up to 1000 meters. We have our own developed uranium mining and

processing industry with a full nuclear-fuel cycle, which will allow providing domestic nuclear power industry with raw materials produced inland.

Development of nuclear power industry will contribute to ensuring environmental and energy security and independence of Kazakhstan. Development of nuclear power industry will objectively lead to increase in technological level of domestic machine engineering, strengthening of the country's scientific and technological potential and creation of new high-tech sectors of economy.

Stability of electricity tariffs over a long period of time provided by nuclear power industry will create additional investment attractiveness of Kazakhstan.

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