PERSPECTIVES NUCLEAR ENERGY IN AZERBAIJAN: PRO AND CON

A. A. Bayramov

National Academy of Science, Institute of Physics, Baku, Azerbaijan,
E-mail: bayramov_azad@mail.ru

1. BACKGROUND

Advance of the world prices on the main energy carriers, limitation of reserves of hydrocarbon fuel, and an aggravation of a global concurrence for sources of energetic raw have reanimated an attention to nuclear energy (NE) in the world. Moreover, in the modern conditions to become clear, that ensuring of global energetic safety is impossible without the active evolution of atomic energy in the near future 30-40 years [1].

The fission energy of heavy nucleuses - uranium and thorium is the single energetic sources capable in large scale for a long time safety to provide mankind by qualitative energy. Therefore the evolution of energy in XXI century should be planed so that NE has been established with all indispensable attributes of a fuel cycle and the elements of structure indispensable for safety, ecologically reasonable, energy-wise and economically effective functioning in conditions of non-proliferation.

Let's note by the way, that at incineration of fossil coal and oil, having by sulphide content about 2,5 %, up to 400 million ton sulfur dioxide gas and nitric oxides is annually formed, i.e. about 70 kg harmful gas on each tellurian in a year. Usage of power of a nuclear energy, development of nuclear energy removes an acuteness of this problem.

It is a very important fact, that the atomic energy has proved the economic efficiency practically in all regions of globe.

Nuclear power plants (NPP) of the world make all approximately 375 GW the electric power. The NPP has been built in 1960 in the USSR. By 1970 number of NPP was 116, to 1980 - 135, to 1990 - 328. The maximal number of NPP has been built in middle of 1970th years. According to the International Agency on Atomic Energy (IAAE) in 2002 there were 438 NPP in the world. Less than quarter from all NPP are in the USA - 104. In France there were 59 NPP, in Japan - 53, the Great Britain - 35. Russia with the 29 NPP takes the fourth place in this list, Germany - the fifth (19). There are in South Korea 16 NPP, in Canada - 14, in Ukraine - 13, in Sweden - 11. There are less than ten NPP in the other countries. For example, there are only 10 NPP in China. In a number of the countries of the world, for example, in Germany and the Great Britain some of NPP were closed. France and Sweden, have actually introduced the moratorium on construction of new NPP.

France is the country most dependent on nuclear power where NPP ensure production of 76,4 % of the electric power consumed to her. Lithuania is on the second place (73,7 %), - Belgium is on the third one (56,8 %). In the countries of the former USSR: there is Ukraine (47,3 %), Armenia (33 %), Russia (14,9 %). For comparison: Japan on 33,8 % is depended on nuclear energy, Finland - on 32,1 %, Germany - on 30,6 %, the Great Britain on 21,9 %, the USA - on 19,8 %, India - on 3,1 %. China takes the thirtieth place in this list - the nuclear energy ensures needs of the country only on 1,2 % [2,3].

From this point of view, in the present paper perspectives of evolution of nuclear energy in Azerbaijan are reported. In 50 years hydrocarbon fuel will been exhaust in Azerbaijan, and because NE evolution is actually just now. Alongside with such alternative and renewable kinds of energy for Azerbaijan as solar and wind, NE is the most actual in a wide commercial scale as ecological pure energy resource. It is in detail introduced nuclear fuel cycle.

2. NUCLEAR FUEL CYCLE

1 kg of natural uranium substitutes 20 ton of coal. World reserves of power resources include 355 Q, where Q is unity of heat energy, equal $Q=2{,}52\times10^{17}$ kcal equal 36×10^{9} tons of equivalent fuel (t.e.f.), i.e. fuel with a calorific of 7000 kcal/kg so that stores of power resources include $12{,}8\times10^{12}$ t.e.f.

From this amount approximately 1/3 i.e. $4{,}3\times10^{12}$ t.e.f. can be extracted with usage of the modern machinery at the moderate cost fuel-extraction. On the other hand the modern needs for power supplies include $1{,}1\times10^{10}$ t.e.f./year, and grow with rate of 3-4 % in a year, i.e. each 20 years are doubled.

The main perspectives of nuclear energy development today are coupled to evolution of the fast neutrons reactor, cooled by molten metals (sodium, etc.). In this reactors a condition of reproduction of fuel is realized, i.e. making of quantity of divided isotopes of plutonium ^{239}Pu exceeding quantity of consumable isotopes of uranium ^{235}U. The parameter describing reproduction of fuel is termed as plutonium coefficient. It indicates how much acts of atoms ^{239}Pu are created at capture reactions of neutrons in ^{238}U- on one atom ^{235}U, absorbed a neutron and radiation turning into ^{235}U.

Unique in the world operating industrial fast neutrons reactor BN-600 is exploited on the Beloyarsk NPP in Russia. In judgment of technicians when the process engineering of fast neutrons reactor of the safety fourth generation will be tested on really acting exemplars, making the widescale safety nuclear power will start based on a closed fuel cycle.

Nuclear fuel cycle is consisted not only of Nuclear Power Plant (NPP), but also of a great many of the factories (Fig.1): 1) RR - at reactor reservoir, 2) recycling plant, 3) FM - fuel manufacture plant, 4) enrichment plant, 5) LAWR - low-activity waste reservoir, 6) conversion (UO_2 extraction) plant, 7) uranium ore production plant, 8) mixture UO_2 and Pu_{O2} oxide and making fuel, 9) mortuary of high-level and medium-active waste [4,5].

It is necessary to note, that now NE is been considered as quasi-renewed energy technology. It is interlinked by that organized in a regime of a vicious fuel cycle on actinides (thorium, uranium, plutonium, etc.) NE structure can work at steady reproduction and even increasing in the necessary level of neutron potential of system. Fuel resources (uranium and thorium) of NE in this case practically are not restricted. Besides in structure of NE it is possible to establish system of the high-temperature nuclear reactors capable efficiently enough to produce hydrogen from water [6].

3. NUCLEAR ACCIDENTS AND NUCLEAR SAFETY

The history of nuclear energy is also history of accidents [7-10]. Many similar incidents a long time were unknown of the public. Only after accident on the Chernobyl NPP in 1986 more or is less public began to speak about accidents on the NPP. For example, in 1976 on the NPP in Greysvald, Germany, there was a fire which could lead to serious leakage of radiation. However then catastrophes managed to be avoided.

The history with the largest accident on chemical centre "Mayak" (it is known also under title Chelyabinsk-65, and now - Ozersk city) which has happened in 1957 is indicative. Nowadays it is considered, that up to 500 thousand person have gained the significant radiation exposures. The radioactive cloud has been delivered by a wind on territories of the Chelyabinsk, Sverdlovsk and Tyumen areas. More than 10 thousand person has been evacuated. About 100 thousand hectare of agricultural lands has been excepted from use. The government of Russia has confirmed these data only in 1992.

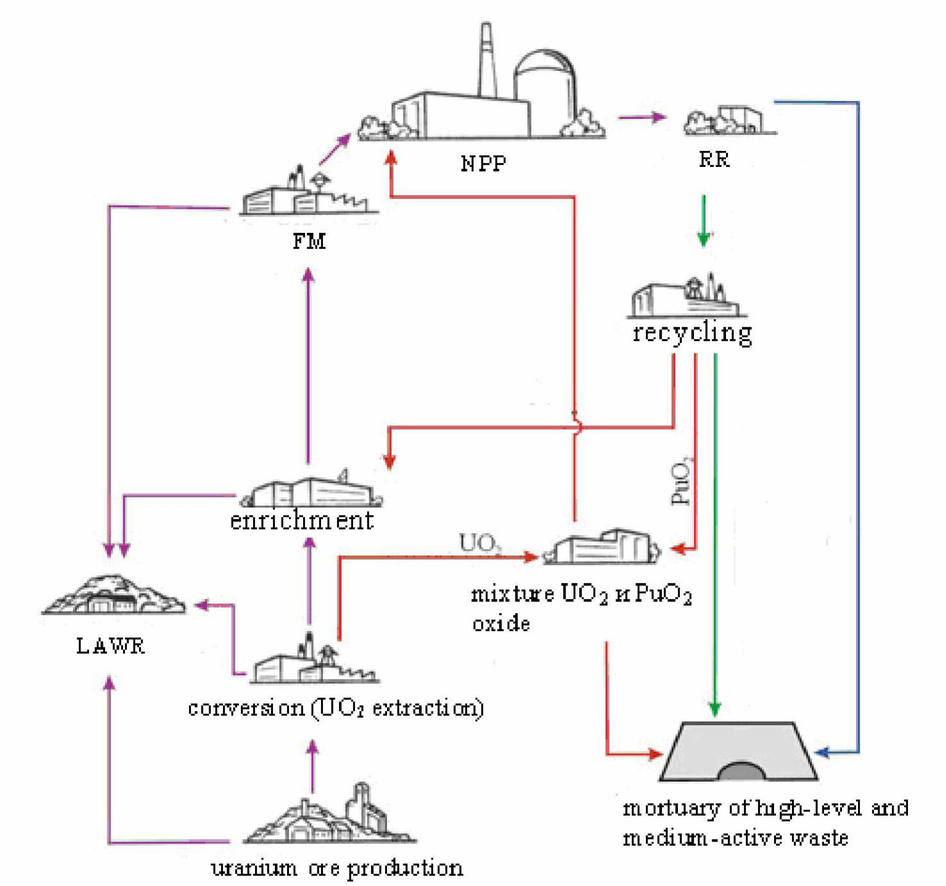

Fig.1. Nuclear fuel cycle: NPP – nuclear power plant; RR- at reactor reservoir FM- fuel manufacture; LAWR- low-activity waste reservoir;

Also other similar catastrophes in the USSR are known: for example, large-scale accident has happened in 1966 on atomic ice breaker "Lenin". Nearby 30 seamen has perished, and the emergency reactor afterwards has been overflowed in Kar sea. And at last, the largest accident on the Chernobyl NPP in 1986 as a result of which some hundreds thousand person have suffered, including nearby 20000 person from Azerbaijan, participated in abandonment of accident aftereffects.

The number of incidents with nuclear materials in the former USSR was rather significant. On one only the NPP of Russia over a period of time 01.01.91 till 12/31/2000 there were 1187 breakdowns in-process the NPP.

The NPP is considered safety, if:

- Radiation action from it on staff, population and an environment at normal operation and design accidents does not result in the to overflow of the conventional values;
- Radiation action is limited up to comprehensible values at heavy (unplanned) accidents.
  For example, at exploitation of the NPP admissible diurnal gaseous surges should be no more, indicated in table 1 [11,12]:

Table 1.

Nuclides	Admissible emission, Cu/day.
Mixture of inert radioactive gases (argon, krypton, xenon).	3000
^{131}I (gaseous and aerosol phase).	0,06
Mixture of long-living nuclides	0,09
Mixture of short-living nuclides	1,2

Normatively documentation on safety in nuclear energy ascertains the quantitative guidelines of an estimation of security level of concrete NPP. First of all it is the quantitative values of those technical indexes which are normalized i.e. to which the certain quantitative demands are fixed. These values should not exceed (or to be less) some set limits. The output for normalized limits is considered as an output for limits of safety. Instances of such limits can be:

- Minimum number of reserved systems of safety;
- A maximum quantity of radioactive emissions for a day, month, year;
- To the limit frequency rate of a made current flow, etc.

These characteristics, as a rule, are applied on already acting stations. Also here special tests are applied: probability of large radioactive environmental emissions and probability of a core disruption of the reactor in current of year, and also probability of death of the person owing to accident on the NPP. Account of numerical values of the pointed parameters is carried out for each generating unit separately on the basis of methods of the probability analysis of the safety, recommended IAAE.
Maximum values of such integral safe criterions for one reactor are:

- Probability of radioactive emissions - 10^{-7}/year;
- Probability of failure of a fissile region - 10^{-5}/year;
- Unique risk for health - $1,65\times10^{-4}$/Rem.

4. CONCLUSION. PRO AND CON.

1. The Nuclear Energy is a way in the future.
2. All accidents are coupled to breakdown of normative operating instructions of the NPP.
3. In the near future the perspective industrial NPP with a closed cycle and completely safety will start to be exploited.

Thus, alongside with such renewable members in Azerbaijan as solar and wind, the development of NPP is actual.

In closing, we shall recall history of our primeval grandparent: all animals panically are afraid of fire (it is possible to get burned to perish). However our grandparent has accustomed fire and became the homo sapiens. In spite of the fact that people till now perish from fire; the evolution of mankind cannot be without evolution of power engineering, including Nuclear Energy.

5. REFERENCES

1. Uranium 2005: Resources, Production and Demand. A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency. Nuclear Energy Agency. 2005,388 p.
2. Safety of Geological Disposal of High-level and Long-lived Radioactive Waste in France. An International Peer Review of the “Dossier 2005 Argile” Concerning Disposal in the Callovo-Oxfordian Formation. Nuclear Energy Agency. 2005, 80p.
3. Nuclear Energy Data 2006. Nuclear Energy Agency. 2006, 100 p.
4. Advanced Nuclear Fuel Cycles and Radioactive Waste Management Nuclear Energy Agency.2006, 248 p.
5. Disposal of Radioactive Waste: Forming a New Approach in Germany. Nuclear Energy Agency. 2006, 116p.
6. Nuclear Production of Hydrogen. Nuclear Energy Agency. 2005, 412p.
7. Indemnification of Damage in the Event of a Nuclear Accident Workshop Proceedings, Bratislava, Slovak Republic, 18-20 May 2005. Nuclear Energy Agency. 2005,152p.
8. International Nuclear Law in the Post-Chernobyl Period. Nuclear Energy Agency. 2006, 244 p.
9. Nuclear Power Plant Operating Experiences from the IAEA/NEA Incident Reporting System 2002-2005. Nuclear Energy Agency. 2006, 56 p.

10. Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After. Nuclear Energy Agency. 2006, 80 p

11. Depleted uranium. Bulletin of materials. WHO. №257, 2001.

12. Richard A. Meserve. Nuclear Safety. IAEA BULLETIN 47/2, 2006.