International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 02 ISSUE 12 Pages: 200-209
SJIF IMPACT FACTOR (2021: 5.478) (2022: 5.636)
METADATA IF – 7.356

Journal Website: http://sciencebring.com/index.php/ijasr

Research Article

THE IMPORTANCE OF NUCLEAR REACTIONS AND THEIR ROLE IN THE DEVELOPMENT OF PHYSICS

Submission Date: December 15, 2022, **Accepted Date:** December 20, 2022,
Published Date: December 25, 2022
Crossref doi: https://doi.org/10.37547/ijasr-02-12-28

Sh.Sh. Abdullayev
Assistant, Fergana Polytechnic Institute, Fergana, Uzbekistan

ABSTRACT

In this article, the law of conservation of mass in nuclear reactions and intensive interaction due to the effect of nuclear forces, as a result of which nuclear changes occur, are described in detail through evidence.

KEYWORDS

Neutron, nucleus, reaction, energy, isotope, uranium, plutonium, phosphorus.

INTRODUCTION

When two nuclei or a nucleus and a particle come close to each other within 10-15 m, they intensively interact due to the effect of nuclear forces, as a result of which nuclear changes occur. These processes are called nuclear reactions, a nuclear reaction can be written as:

$$X + a \rightarrow У + в \quad \text{ёки} \quad X(a;в)У ,$$

International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 02 ISSUE 12 Pages: 200-209
SJIF IMPACT FACTOR (2021: 5.478) (2022: 5.636)
METADATA IF – 7.356

where X is the initial nucleus, - reactive particle, - a particle released in a nuclear reaction, U - a nucleus formed in a nuclear reaction, and particles can be neutrons, protons, alpha-particles, gamma-quanta, light nuclei or other elementary particles [1-7].

The first nuclear reaction was carried out by Rutherford in the process of bombarding with nitrogen ⍰-particles, producing oxygen and protons, i. e.

$$_7N^{14} + _2He^4 \to _8O^{17} + _1H^1$$

or it can be expressed in a more compact form N14(⍰,r)O17

In all nuclear reactions, an elementary particle (e.g.⍰-photon) comes out [8-17]. The products of most nuclear reactions are also radioactive; they are called artificial radioactive isotopes. The phenomenon of artificial radioactivity was discovered in 1934 by French physicists Frederic and Irene Joliot Curie [15-21]. The neutron addition reaction of phosphorus 15R31 is an example of obtaining radioactive isotopes. in such addition⍰-a photon is emitted and the radioactive isotope of phosphorus 15R32 is formed:

$$_{15}P^{31} \to n \to _{15}P^{32} + \gamma$$

The half-life of phosphorus isotope T1/2=14,3 days, ⍰-the decay of the nucleus of the isotope accompanied by the emission of particles leads to the formation of the stable isotope of sulfur $_{16}S^{32}$:

$$_{15}P^{32} \to _{16}S^{32} + \beta^- .$$

Let's see how conservation laws are enforced in nuclear reactions.

1. The total charge of the particles involved in a nuclear reaction is equal to the total charge of the particles created in the reaction.
2. The total number of nucleons in the particles undergoing a nuclear reaction is preserved after the reaction, that is, it is equal to the total number of nucleons of the particles formed in the reaction (Table 1) [22-27].
3. Conservation of mass in nuclear reactions.

Table 1. Nuclear reaction

Nuclear reaction	Electric charge	The number of nucleons
$N^{14}+\alpha\rightarrow O^{17}+R$	7+2=8+1	14+4=17+1
$N^{2}+N^{2}\rightarrow Ne^{3}+n$	1+1=2+0	2+2=3+1
$Li^{7}+R\rightarrow Ve^{7}+n$	3+1=4+0	7+1=7+1
$S^{32}+n\rightarrow R^{32}+R$	16+0=15+1	32+1=32+1
$Ve^{9}+\gamma\rightarrow 2Ne^{4}+n$	4+0=2·2+0	9+0=2·4+1

law (and the law of conservation of energy) is fulfilled. In that case, let's designate m_x and m_a based on the rest masses of the particles undergoing a nuclear reaction, mu and mv of the particles formed in the reaction. Let us denote their kinetic energies respectively, T_x, T_a, T_u, and T_v.

RESULTS AND DISCUSSION

As a result, the sum of the total energies of the reacting particles is equal to the sum of the total energies of the particles formed in the reaction as follows.

$$m_xc^2+T_x+m_ac^2+T_a=m_yc^2+T_y+m_bc^2+T_b\,.$$

If we group substances, this expression appears as follows

$$\left[(m_x+m_a)-(m_y+m_b)\right]c^2=(T_y+T_b)-(T_x+T_a)$$

The energy released or absorbed in a nuclear reaction is called reaction energy, i.e.

.

$$Q=\left[(m_x+m_b)-(m_y+m_b)\right]c^2=(T_y+T_b)-(T_x+T_a)\,.$$

If Q>0, an increase in the kinetic energy of particles is observed. In that case, at any value of (Tx+Ta), an exoenergetic reaction takes place.

If Q<0, an endoenergetic reaction occurs. in this case, due to the decrease in the kinetic energy of the particles, their mass at rest increases. Therefore, the kinetic energy of the reacting particles should be large enough, i.e.

$$(T_x+T_a)=|Q|+(T_u+T_v)$$

the condition must be fulfilled. Only the awakened core can split into two parts or break apart. To shame the kernel, for example, it- it is necessary to spend enough energy on it by the method of shooting (bombardment) with particles or protons. As previously stated, the best effective nuclear fission weapon is neutrons, because they are electrically neutral and do not experience the electrostatic repulsion of the nucleus. By the 40s of the 20th century, thanks to the experiments and theoretical research of several scientists (E. Fermi, I. Joliot-Curie, P.

Savich, O. Gan, Strassman, O. Frisch, L. Maitner), uranium bombarded with neutrons nuclear fission reaction was discovered. Based on the nuclear droplet model, this reaction can be explained as follows [28-32].

The uranium nucleus, which has added neutron n to itself, becomes excited and deforms. If the excitement is not so great, then the nucleus□by emitting photons or neutrons, gets rid of excess energy and returns to the specific state. In this case, the shape of the drop changes from spherical to ellipsoidal and then back to spherical. If the waking energy is large enough, then an elongated shape similar to the stretch between the two parts of a splitting liquid drop appears in the nucleus. The nuclear forces acting on the very thin part of the stretching nucleus are no longer able to oppose the Coulomb repulsion forces of the charged parts of the nucleus with the same sign. As a result, the elongated core breaks off and breaks into two "pieces" that fly in opposite directions at high speed. In addition, during fission, 2-3 neutrons, called instantaneous neutrons, are released from the nucleus. Most instantaneous neutrons have an energy of 1-2 MeV. Energy 1, Neutrons with energy greater than 5 MeV are called fast neutrons, and neutrons with energy less than 1.5 MeV are called slow neutrons. Neutrons with very low energy are called thermal neutrons. Fragments of a fissioning nucleus become radioactive: they□-photons, □-emit particles and neutrons; these neutrons are called delayed neutrons to distinguish them from instantaneous neutrons.

The nuclei of all circular elements can split into two parts under the influence of neutrons. From a practical point of view, the most important fissile materials are uranium 92U238, actinouranium 92U235, an artificial isotope of uranium 92U233 and plutonium 94Ru239. 92U235, 92U233 and 94Ru239 nuclei fission under the influence of fast and slow (including thermal) neutrons, while the 92U238 nucleus fissions only under the influence of fast neutrons. Uranium 92U235 is more likely to decay into isotopes of krypton and barium, releasing three neutrons:

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{36}Kr^{93} + {}_{56}B_{a}^{140} + 3n$$

In order to realize the possibility of using nuclear fission energy, it is necessary to create such conditions that the reaction can continue on its own after it has started, that is, the reaction has the character of a chain. For example, 2-3 neutrons produced during the fission of a round Uranium-235 nucleus help to carry out such a reaction. For example, each of the 2-3 neutrons released during the fission of the first nucleus causes the fission of new nuclei. As a result, 6-9 new neutrons are created. These neutrons, in turn, allow other nuclei to split, and so on. Such a reaction is called a chain reaction of cleavage. The theory of the chain reaction of uranium-235 fission was developed in 1938 by Ya.B.Zelpdovich and Yu.B.Khariton. of uranium. Although 2-3 neutrons appear in the fission of each nucleus, not all of them cause the fission of other nuclei. Part of the neutrons can be absorbed by the nuclei of the non-fissionable mixture in the nuclear fuel, and another part of the neutrons can leave the surface of the fuel volume without colliding with its other nuclei. Therefore, the chain reaction of uranium nuclear fission does not occur all the time. For the chain reaction to occur, the fragment of the 92U235 isotope must first be large enough. When the size of a piece of uranium is large enough, most of the neutrons released during the fission reaction will react until they reach the edge of the piece of uranium. Neutrons of uranium also help the chain reaction to take place. In general, the rate of development of a chain reaction is characterized by the value of the coefficient K. The multiplication factor is the ratio of the number of neutrons produced in the fission of a generation to the number of neutrons produced in the fission of the previous generation. If K>1, a chain reaction develops. At K<1, the reaction is quenched. When K=1, the reaction proceeds at one rate. Isotopes of uranium or plutonium are used in the chain reaction. For example, natural uranium contains 99.282% of the 92U238 isotope, 0.7121% of the 92U235 isotope, and 0.06% of the 92U234 isotope. In the impact of fast neutrons, all of these isotopes are split, while slow neutrons can only cause fission of the 92U235 isotope. Neutrons with energy less than 1 MeV can be absorbed by the U238 nucleus and U239 is produced. But U239 isotope- as a result of decay

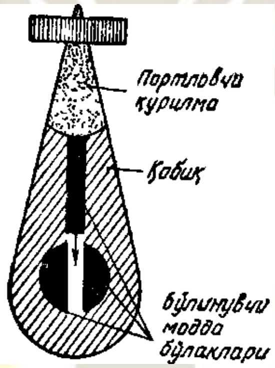

Figure 2.

$$ {}_{92}U^{238} + n \rightarrow {}_{92}U^{239} \overset{\overset{\beta-}{\rightarrow}}{\longrightarrow} {}_{93}Np^{239} \overset{\overset{\beta-}{\rightarrow}}{\longrightarrow} {}_{94}Pu^{239} . $$

Pu^{239} well, the same U^{235} split under the influence of slow neutrons. So, U^{235} or Pu^{239} chain reaction can be carried out using nuclei. Only neutrons leaving the active zone without participating in the reaction should be reduced. Therefore, if the size of the active zone is increased, sufficient conditions will be created for the chain reaction at some of its values. The mass of a fissile substance of this size is called critical mass (μcr).

For example, pure U^{235} mkr for a fissile substance consisting of⍰It should be 9 kg.

If K>1 when the condition m>mkr is fulfilled, the chain reaction uncontrollably takes place during the explosion of an atomic bomb. The structure of an atomic bomb is schematically depicted in Figure 23.2. In it, the fissile material is prepared in the form of two or more pieces. The total mass of these particles is greater than the critical mass, but the mass of each particle is less than the critical mass. Therefore, a fission chain reaction does not develop in each fragment. When a simple explosive device placed in a bomb detonates, these fragments are added and conditions are created for the chain reaction to take place. The first neutrons needed to start the fission reaction are always "lost" in the fissile substance. For example,

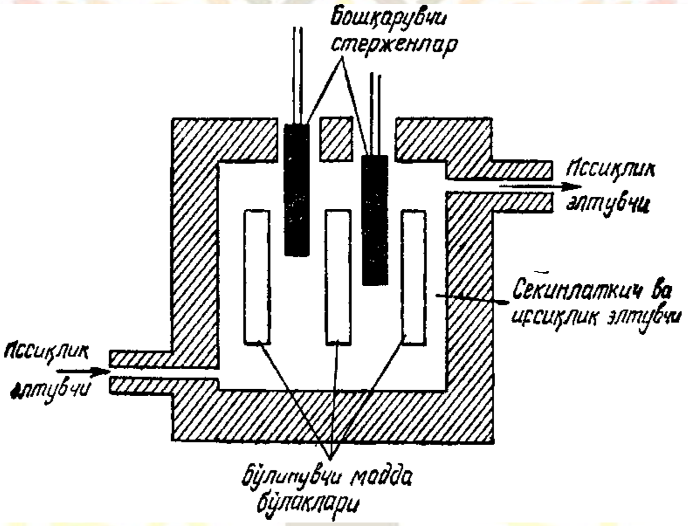

Figure 3

In addition, due to the influence of cosmic rays, neutrons are constantly created along with various particles. When an atomic bomb explodes, the temperature in the explosion zone reaches several million degrees because of the extremely large energy released in a very short time. Under the influence of such heat, the substance in the explosion zone turns into vapour. As a result of the rapid expansion of the superheated spherical gas, a very powerful shock wave is created, which corrodes and burns objects in its path. A device used to carry out controlled fission chain reactions is called a nuclear reactor. In such devices, it should be possible to start a chain reaction at values of the neutron multiplication factor K slightly greater than 1. Now we will get acquainted with reactors operating under the influence of thermal neutrons, which are widely used in modern energy. The main element of the reactor is fissile material. As a fissile material in modern reactors, we use isotope-enriched natural uranium. Thermal neutrons effectively cause it to split. Therefore, heat is converted into neutrons by slowing down the fast neutrons produced in the fission reaction. Graphite or distilled water (D2O), and sometimes ordinary water (N2O) are used as retarders.

Figure 3 shows a simplified scheme of the reactor active zone filled with a retarding substance. In the retarder, pieces of fissile material in the form of detergent or plates are placed. The speed of the chain reaction can be changed using control levers. These rods are made of materials that absorb neutrons intensively (for example, boron or cadmium). Changing the value of K is achieved by inserting more or less of the control rods into the active zone.

CONCLUSION

In conclusion, it can be said that the main part of devices based on the use of nuclear energy are nuclear reactors. As an example, let's get acquainted with the principle of operation of a nuclear power plant. The energy released in the chain fission reaction is transferred to the heat carrier that circulates the active zone. The heat exchanger transfers this energy to the water in the heat exchanger, as a result of which the water turns into steam. This, in turn, activates the tube of the generator. It turns into the water in the condenser after passing through the tube and goes back to the heat exchanger. In this way, nuclear energy is converted into electricity.

REFERENCES

1. Nasirov, M. X., Axmadjonov, M. F., Nurmatov, O. R., & Abdullayev, S. (2021). O'lchamli kvantlashgan strukturalarda kvazizarralar. Oriental renaissance: Innovative, educational, natural and social sciences, 1(11), 166-174.
2. Tolaboyev, D. X., Abdullayev, S., & Xidirov, D. S. (2021). Standart ko'rinishdagi izotrop jismlarning o'tkazuvchanligi. Oriental renaissance: Innovative, educational, natural and social sciences, 1(11), 565-570.
3. Tolaboyev, D. X. O. G. L., Mirzayev, V. T. L., Axmadjonov, M. F., Abdullayev, S. S. O. G. L., & Raximjonov, J. S. O. G. L. (2022). Yarimo'tkazgichlarda ichki nuqtaviy nuqsonlarining termodinamikasi. Oriental renaissance: Innovative, educational, natural and social sciences, 2(4), 231-240.
4. Rakhimjanov, J. S. O., Mirzarahimov, A. U., Abdullayev, S. S. O., Nematov, H. M. O., & Khidirov, D. S. (2022). Моделирование математического фантома в программном комплексе "fluka" с интерфейсом "flair". Oriental renaissance: Innovative, educational, natural and social sciences, 2(4), 241-250.
5. Нурматов, О. Р., Абдуллаев, Ш. Ш., & Юлдашев, Н. Х. (2021). Временная релаксация фотоэлектретного состояния в фотовольтаических пленках cdte: ag, cd, cu и sb2se3: se. Central asian journal of theoretical & applied sciences, 2(12), 315-322.

6. Гайназарова, К. И., Набиев, М. Б., Усмонов, Я., Усмонов, С., & Абдуллаев, Ш. (2030). Легирование термоэлектрических материалов на основе bi2тe3-bi2se3 используемых в термогенераторах концентрированного солнечного излучения. Янги материаллар ва гелиотехнологиялар, 69.
7. Sh, A. S., & Meliboyev, I. A. (2022, December). Fizika fani amaliy mashgulotlarida, labaratoriyalarida o‘quvchilar mavzuni teranroq anglashi uchun suniy intellekt jihozlardan foydalanish. In Conference Zone (pp. 423-428).
8. Teshaboyev, A. M., & Meliboyev, I. A. (2022). Types and Applications of Corrosion-Resistant Metals. Central asian journal of theoretical & applied sciences, 3(5), 15-22.
9. Mamirov, I., Sobirov, A., Xasanov, A. S., & Meliboyev, I. (2022, September). Raqamlashib Borayotgan Zamonaviy Oliy Ta’limda Pedagogning Kasbiy Kompetentsiyalarini Rivojlantirishning Zamonaviy Mexanizmlari. In Conference Zone (pp. 8-11).
10. O‘G‘Li, M. I. A. (2022). Gazdan xavfli ishlarni xavfsiz olib borishni tashkillashtirish bo ‘yicha xavfsizlik tiziml. Ta’lim fidoyilari, 4(7), 36-40.
11. Meliboyev, I. A. (2022). Azot oksidli chiqindi gazlarni katalitik zararsizlantirish usuli. Pedagog, 1(3), 257-261.
12. Abduraxmon o‘g‘li, M. I. (2022, December). Farzand tarbiyasida ona tiling tutgan o‘rni. In Conference Zone (pp. 461-465).
13. Abdruraxmon o‘g'li, M. I. (2022). A Method of Catalytic Neutralization of Exhaust Gases with Nitrogen Oxides. Eurasian Research Bulletin, 14, 21-24.
14. Abdruraxmon O‘g'li, M. I. (2022). Occupational diseases in industrial enterprises: causes, types and principles of prevention. International Journal of Advance Scientific Research, 2(10), 1-9.
15. Xakimov, O., & Xasanov, A. S. (2022). Defoliant olish jarayonini fizik kimyoviy asoslari. Scientific progress, 3(6), 61-63.
16. Xasanov, A. (2022). Bo‘lajak muhandis-texnolog mutaxassislarning kasbiy kompetensiyalarini rivojlantirishda hayot faoliyati havsizligi. Science and innovation, 1(B6), 605-607.
17. Xasanov, A. (2022). Kelajak muhandis-texnologlarga kasbiy kompetensiyalarini chet tilari orqali rivojlantirishning yechimlari. Science and innovation, 1(B6), 601-604.
18. Xasanov, A. S. (2022). Yengil sanoat va to‘qimachilik korxonalarida zararli ishlab chiqarish omillarni kamaytirish va ishchi hodimlar, jamoat salomailigini saqlashda bo‘lajak muhandislarning o‘rni. International journal academic research, 1(5), 58-62.
19. Xasanov, A. S. (2022). Role of future engineers in light industry and textile enterprises reduction of hazardous work factors and protection of workers and

public health. International Academic Research Journal Impact Factor 7.4, 1(5), 58-62.

20. Qurbonova, U. S., Jalilov, L. S., Sobirov, A., & Xasanov, A. (2022, November). Professional fiziklarini tayyorlash. In Conference Zone (pp. 31-44).

21. Xasanov, A. S., & Sharipova, U. A. (2022, December). Karbamid ishlab chiqarish tsexlarida va laboratoriyalarda atmasferaga chiqadigan ammyak miqdorini aniqlash insonlar hayotini havfdan saqlashning muhim omilidir. In Conference Zone (pp. 530-541).

22. Qurbonova, U. S., Jalilov, L. S., Sobirov, A., & Xasanov, A. (2022, December). Xavfsiz kelajakni ta'ininlash va iqtisodiyot tarmoqlari. In Conference Zone (pp. 375-403).

23. Xasanov, A. S., Voxidov, B. R., & Qayumov, O. A. (2022). Mineral va texnogen xom ashyolardan vanadiy boyitmasini olish texnologiyasini ishlab chiqish. Oriental renaissance: Innovative, educational, natural and social sciences, 2(9), 319-326.

24. Кобилов, Э. Э., Шамсиев, А. М., & Юсупов, Ш. А. (2006). Декомпрессия желудочно-кишечного тракта при острой спаечной кишечной непроходимости у детей. Детская хирургия, (4), 17-19.

25. Fayzullaev, N. I., Akmalaev, K. A., Karjavov, A., Akbarov, H. I., & Qobilov, E. (2020). Catalytic Synthesis Of Acetone And Acetaldehyde From Acetylene In Fluoride-Based Catalysts. The American Journal of Interdisciplinary Innovations and Research, 2(09), 89-100.

26. Кобилов, Э. Э. (2006). Острая спаечная кишечная непроходимость у детей: диагностика, лечение и роль лапароскопии (Doctoral dissertation, ГОУВПО" Российский государственный медицинский университет").

27. Meliboyev, I. A. (2022). Oliy ta'lim muassasalarida modulli o 'qitishning axamiyati. Pedagog, 1(3), 333-336.

28. Домуладжанова, Ш. И., Мелибоев, И. А., & Мамиров, И. Г. (2022, November). Способы и устройства по производству извести. In Conference Zone (pp. 327-337).

29. Садыков, В. М., Сабиров, Б. У., & Кобилов, Э. Э. (2005). Морфологическая характеристика жизнеспособных эхинококковых кист. IBN SINO–AVICENNA, (1-2), 49.

30. Sh, A. S., & Meliboyev, I. A. (2022, December). Fizika fani amaliy mashgulotlarida, labaratoriyalarida oʻquvchilar mavzuni teranroq anglashi uchun suniy intellekt jihozlardan foydalanish. In Conference Zone (pp. 423-428).

31. Джабборов, Ш. Р., Киргизов, И. В., & Кобилов, Э. Э. (2009). Биохимические показатели крови у больных с осложнённым эхинококкозом печени. Материалы XVI съезда педиатров России «Актуальные проблемы педиатрии». М, 107.

32. Abduraxmon o‘g‘li, M. I. (2022). Materiallar kristalidagi nuqsonlar va ularni aniqlash usullari. Pedagog, 1(3), 413-415.