Radioactivity and its Applications

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Abstract: The discovery of radioactivity has an enormous effect on the development of science and technology. Radioactivity means the particles which emits from nucleus as a result of instability. It experiences the differntiate between the two strongest forces in nature It should not be surprising that there are many other nuclear isotopes which are unstable and emit some kind of radiation. There are many people are dead or even suffer from its effects until now. But the advantage of uranium (U) in energy production, the human safety must always be the first consideration. Radioactivity still remain misunderstood because radioactive radiations and can be very harmed if appropriate precautions are not taken. Radioactive material is invisible so cannot detect from human sense. Somethings are always strikes in our mind that why some foreign countries have its own nuclear bomb and nuclear waste. This article focuses on introduction on radioactivity, how works, types, its application and risks.

Keywords: introduction, isotope, different forms, causes applications, conclusion, references

1. Introduction

Discovery of Radioactivity first Henri Becquerel (1852-1908). During his studies of phosphorescence (1896), found a mineral (uranium) would darken a photographic plate even if the plate was wrapped And Found that this mineral emitted a new kind of radiation (X-rays needed an external stimulus) called radioactivity .After Henri, Discovery of Radioactivity done by Marie (1867-1934) and Pierre (1859-1906) Curie isolated two previously unknown radioactive materials, polonium and radium. Radioactivity was found to be unaffected by chemical and physical testing, showing that the radiation came from the atom itself – specifically from the disintegration or decay of an unstable nucleus

But in 1898 – Ernest Rutherford began studying the nature of the rays that were emitted and can be Classified into three distinct types according to their penetrating power. Alpha decay (α) – positively charged; can barely penetrate a piece of paper. Beta Decay (β) – negatively charged; pass through as much as 3mm of aluminium. Gamma Decay (γ) – neutral; Extremely penetrating. Radioactive material is invisible, has no smell, makes no sound so it cannot be detected by any of our senses.

1.1 Isotopes

Isotopes have the same amount of protons but different amount of neutrons. This means that the same element can have different atomic mass because the proton number and atomic numbers remain same. In case of Helium(He_2^4), it has two protons and two neutrons and its atomic mass is 4 and it has got two electrons orbiting around the nucleus. If we talk about the case of Helium(He_2^5) we can see 1 additional neutron inside the nucleus, and it still has two protons which makes it chemically same as Helium. Finally, those are the isotopes, which have a different neutron number of the same element.

1.1.1 Force Inside the Nucleus called nuclear force

We know that opposite charge are always attracts and like charges are always repel each other. And we also know that protons are positively charged and neutrons have no charge. So, in nucleus there are all number of the protons so the question may arise, how nucleus get stable due to the presence of no. of protons? There is a strong force called nuclear force inside the nucleus which binds all the nucleons with other nucleons. Basically, strong nuclear force attracts protons with protons, attracts neutrons to neutrons and attracts protons with neutrons. so binds these nucleons together. Very next force is the electromagnetic force, which attempts to repel like charges from each other. Electromagnetic force has more dominance over the strong nuclear force, hence nuclear force is much stronger than the electromagnetic force.

1.1.2 Radiation Emission Process: say how nucleus gets stable

When we take the example of(U) Uranium, which has large nuclei, every single nucleon OF Uranium is attracted to every other nucleon by the strong nuclear force. But at the same time, it also repels to every other proton in the entire nucleus by the electromagnetic force. thus nucleus get bigger, and the electromagnetic force is more dominant. That is why some nuclei are unstable and have tendency to break apart which emitsradiation. By emitting the radiation, the nucleus is able to decrease its mass and turn itself into a lighter nuclei , which means the nucleus is no longer at risk and electromagnetic force is no longer overpowering the strong nuclear force. And thus by giving out the radiation nucleus saves itself from immediate destruction by the electromagnetic force.

1.1.3 What Causes Radioactivity?

The main cause of radioactivity is unstable nucleus.

This instability is caused by either an excess of protons or an excess of neutrons due to Radioactive Decay atom become stable due to release some amount of energy and matter in the form of radiation.

The main radiation types are alpha, beta and gamma radiation. Alpha particles are released by proton and Beta particles are released by neutron Gamma rays are mostly emitted along with alpha and beta particles. For Examples-Uranium-238 decays to form Thorium-234. This is an example of alpha decay.

1.1.4 Half-lives

A half- life is the time taken for one half of the unstable radioactive material to decay. Every half-life, the radioactivity of the material becomes weaker .Half-lives vary according to the material. For Examples- beta decay is when carbon-14 decays into Nitrogen-14

1.1.5 Different Forms of Radiation

When we look at the atom, sorry inside the atomic nucleus, both proton and neutron have the relative mass of around one. The proton has the positive charge of magnitude 1 and Neutron has 0 charge which means Neutron is completely neutral. Electron, which is not found in the nucleus, but it is orbiting around the nucleus has a very negligible mass of 1/1836 (compared to proton and neutron) but its charge is significant and has the negative charge of magnitude 1. We have learnt in chemistry that atoms have no net charge because there is an equal amount of protons and electrons, therefore giving zero overall charges since they cancel out.

1.1.6 Alpha Radiation

When a nucleus emits an alpha-particle, it loses two protons and it turns into different particle which has the two proton less. And it loses four over all nucleons, its mass decrease by four .below example explains that a U^{238} nucleus has 92 protons and 238 nucleons in total. It sheds two protons with the alpha particle. Therefore, the resulting element has ninety protons and it loses four nucleons in total so the resulting isotope has 234 nucleons in total. In this case, when U^{238} emits an alpha particle, it turns into Th^{234} with atomic number ninety and mass number 234.

1.1.7 Beta-Radiation

In Beta Radiation there is an emission of an electron. As we know the electron has the negative charge of magnitude



1.1.10 Application of Radioactivity

There are many application of radioactivity which are makes our life easier. They are used in field of education, health, production of energy and for monitoring purpose in the industries. Some of the application are described below.

1.1.10 (1) In medicine

Radioisotopes have found extensive use in diagnosis and therapy. Though many radioisotopes are used as tracers.For

1, therefore the overall charge of the particle is -1. As we know that the mass of an electron is 1/1836, so the overall mass of the particle is also 1/1836. When the electron is emitted, something special happens on the nucleus i.e. a neutron turns into a proton which is quite strange. This means the mass number won't be change rather it will stay completely the same. But the element is going to change because 1 more protons is going to introduce.

$$X_Z^A = Y_{Z+1}^A + e_{-1}^0(\beta \text{ emission})$$

$$^{14}_{6}\mathrm{C} \rightarrow^{14}_{7}\mathrm{N} +^{0}_{-1}e_{(\beta \text{ emission})}$$

The above equation that when c_6^{14} the emits a beta particles, the result is N_7^{14} in which it has the same mass number as isotopes but has one more proton. Symbol of beta particles show that it has zero mass but has atomic number of -1.

1.1.8 Gamma-Radiation

Gamma Radiation is the third form of radiation. It is special types of radiation because it does not emit any particles. which is in, in itself. It does not have any charge and havenot any mass. Nucleus remain completely same after the gamma radiation.

 $\begin{array}{l} X_{Z}^{A} = X *_{z}^{A}(\gamma \operatorname{Ray}) \\ \text{For Example: -} \\ g_{0}^{230} \operatorname{Th} \longrightarrow_{88}^{226} \operatorname{Ra} +_{2}^{4} \operatorname{He} + \gamma \end{array}$

1.1.9 Background Radiation

The radiation which we feel all the time called background radiation. It comes from common sources. We call it background radiation because it does not present any effect that are visible to us but it is practically everywhere. We will not be able to feel it.Some sources of the background radiation are radon gas, x-rays and tracking equipment used in hospitals, Nuclear explosion, cosmic rays.



example iodine-131, phosphorus-32, and technetium-99*m* are among the most important tracers. Physicians employ iodine-131 to determine cardiac output, plasma volume, and fat metabolism and particularly to measure the activity of the thyroid gland where this isotope accumulates. Phosphorus-32 is useful in the identification of malignant tumours because cancerous cells tend to accumulate phosphates more than normal cells do. Technetium-99*m*, used with radiographic scanning devices,

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is valuable for studying the anatomic structure of organs. Such radioisotopes as cobalt-60 and cesium-137 are widely used to treat cancer

1.1.10 (2) In industry

Through nuclear reactor(Nuclear fission reactors) it measure (and control) the thickness or density of metal and plastic sheets, to stimulate the cross-linking of polymers. For example, to measure the effectiveness of motor oils on the wear ability of alloys for piston rings and cylinder walls in automobile engines.

1.1.10 (3)In science

Carbon dating has 15 isotopes, and carbon-14 is famous for being able to tell the age of organisms. Because C-14 isn't taken in by dead matter, and because it has a half-life of about 5,400 years, archaeologists can use it to date fossils and bones. Using the decay curve and the isotopes known half-life the age of the sample can be estimated. Radioisotopes are use as "nuclear clock" to determine the age of objects on an archaeological, geological, and astronomical time scale.

1.1.10 (4) Radioisotopic tracers

Are employed in environmental study i.e water pollution in rivers and lakes and of air pollutionby smokes They also have been used to measure deep-water currents in oceans and snow-water content in watersheds. Traces are basically used in the field of study of plants and animals and also in the medical field.

2. Conclusion

Using the decay curve and the isotopes known half-life the age of the sample can be estimated Lower carbon dioxide (and other greenhouse gases) released into the atmosphere in power generation. High construction costs due to complex radiation containment systems and procedures. Low operating costs (relatively). High-known risks in an accident. Known, developed technology "ready" for market. Long construction time. Large power-generating capacity able to meet industrial and city needs. Target for terrorism (as are all centralized power generation sources). Existing and future nuclear waste can be reduced through waste recycling and reprocessing. Waste lasts 200 – 500 thousand years.

References

- [1] Bjorn Walhstrom, Understanding Radiation, Medical Physics Pub. Corp., 1996.
- [2] Martin, B. R. (31 August 2011). *Nuclear and particle physics: An introduction* (2nd ed.). John Wiley & Sons,
- [3] Naomi Pacachoff, Marie Curie and the Science of Radioactivity, Oxford University Press, 1997.
- [4] Rutherford, Ernest (6 October 1910). <u>"Radium Standards</u> and Nomenclature
- [5] Stabin, Michael G. (2007). "3". Radiation Protection and Dosimetry: An Introduction to Health Physics.
- [6] The ABCs of Radioactivity. A series of experiments on the basic properties of radioactivity.

[7] The creators of the Nuclear Science Wall Chart developed this site. The Discovery of Radioactivity: The Dawn of the Nuclear Age