

Radioactive decay essay sample

[Science](#), [Chemistry](#)



One basic reaction in nuclear chemistry is the process of radioactive decay. In radioactive decay, an atom of one element emits an alpha or beta particle to become an atom of a different element. In alpha decay, the atom emits an alpha particle composed of two protons and two neutrons – a helium nucleus. The resulting atom will have two less protons and two less neutrons resulting in an atomic weight of four lower than the original atomic weight (Woods 2006). The loss of two protons means that the nucleus now belongs to a different element as shown by the following example.

In beta decay, the atom emits a beta particle composed of a single electron. Since the electron has a negative charge, one neutron will convert itself into a proton to keep the overall charge constant. The atom will have the same atomic weight but will have one more proton (Woods 2006). Therefore, the atom will become an atom of the succeeding higher element in the periodic table as demonstrated by the following reaction:

While alpha and beta decay may constitute the breaking apart of atoms, they are not the same as nuclear fission. In nuclear fission, a very unstable atomic nucleus is hit with a high velocity particle causing it to break apart into smaller nuclei and release energy in the process. Alpha and beta decay are natural processes that have been occurring on earth for millions of years. On the other hand, earthbound nuclear fission is only man made – either as controlled nuclear fission in power plants or as destructive power in atomic bombs (Woods 2006). One such reaction is demonstrated by the following nuclear chemistry equation:

In this example, a neutron strikes a nucleus of Uranium-235. The speed of the neutron causes the Uranium nucleus to break apart into a Krypton and Barium as well as another three neutrons. The breaking apart of the uranium nucleus also releases a large amount of energy,. These three neutrons will strike other uranium nuclei which in turn release more energy and more free neutrons, propagating the process in a chain reaction.

Harnessing such energy is the key to the operation of nuclear fission power plants on Earth. Nuclear chemistry is also one of the key sources of free energy in the Universe via nuclear fusion happening in the core of stars. Hydrogen and Helium atoms are combined under the intense heat and pressure of the Sun's core in nuclear fusion. These two atoms account for roughly 99% of the matter in the universe. The other elements are formed from the by-products of the fusion of these elements within the cores of stars – a process called nucleogenesis (Ennis 2006). One example reaction of nucleogenesis is the following fusion of Hydrogen and Helium to form Lithium.

As we have seen, nuclear fission and fusion are two major types of nuclear reactions. Both reactions release large amounts of free energy making them potential sources for energy on Earth. Fission releases this energy through the breaking apart of atoms and fusion releases this energy through the combination of nuclei. Heavy nuclei such as Uranium are commonly used in nuclear fission while a lighter nucleus such as Hydrogen is used in nuclear fusion. Only nuclear fission has been successfully used to produce electricity in a power plant (Warrick 2006).

The critical factor for harnessing nuclear reactions for energy production is controlling them. Humanity has seen how easy it is to initiate nuclear reactions. Fission reactions are initiated by accelerated neutrons hitting unstable atomic nuclei. Fusion reactions are initiated by heating the atomic nuclei to a very high temperature. The problem is containing these reactions as unchecked nuclear reactions are essentially nuclear bombs (Warrick 2006).

Nuclear fission reactions in nuclear reactors used in power plants are controlled via the use of control rods and graphite moderators. A graphite moderator slows down the free neutrons and in the process slows down the chain reaction of nuclear fission. Control rods made of boron coated steel are also inserted into the nuclear reactor to control the reaction. Neutrons which strike these control rods are absorbed and are thus unable to initiate further nuclear reactions. Inserting the rods fully into the reactor allows them to absorb all neutrons and effectively stops the reaction. Retracting the rods allows more free neutrons to propagate and allows the nuclear fission to proceed. As the rods are pulled farther from the reactor, less free neutrons are absorbed and the reaction happens at a faster pace (Woods 2006).

Currently, we only have the ability to produce energy from nuclear fission. Nuclear fission gives us a cheap and emission free way of generating electricity. Uranium is much more abundant than fossil fuels. Additionally, nuclear fission does not emit greenhouse gases in the process. However, nuclear fission leaves nuclear waste which is highly dangerous and will need specialized containment for a very long period of time. Nuclear fusion is a

better process for generating energy since the fuels – hydrogen and helium – are the most abundant elements in the universe, its by products are only radioactive for up to 100 years compared to thousands of years for nuclear fission waste, and fusion reactors are also much more safe due to the lower amounts of fuel involved (Warrick 2006).

The challenge for containing nuclear fusion is the high temperature involved. The gases need to be heated to a very high temperature not dissimilar to the temperature at the core of stars for fusion to occur. This raises the challenge of containing the gases as the gases must be contained by a strong magnetic field to prevent leakage through the reactor structure. Secondly, the reactor structure must be made of a very heat resistant material to withstand the temperatures involved. While scientists are busy working on nuclear fusion, these technologies are not yet available to us hence the lack of a working fusion reactor (Warrick 2006).

Bibliography

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