Loss Of Energy Due To Collision Of Ions With Other Charged Particles

Posted on September 30, 2019

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Introduction

In industrial physics, energy conservation is one of the most critical aspects and procedures. Whenever one is involved in the manufacturing or development of any new electromagnetic component, energy needs to be conserved to avoid losses that can be harmful not only to resource optimization but also to the environment. Since the loss of energy is because of the collision of ions and charged particles, it needs to be better understood for further control and management.

An amount of energy is released as a result of the processes carried out by the ions (Johnson, 2002). The respective paper is being formulated to discuss briefly the process of release of energy when the interaction takes place between the ionization radiations. The paper will only present an overview of the basic theories, phenomena, and processes that result in the production of energy as the product of the reaction. To the naked eye and in the conventional view of a layperson, this energy loss is so insignificant that it can barely be felt or noticed. However, it is essential for physicists and nuclear scientists to observe and study this phenomenon of the release of energy since “the detection of radiation is based on its interaction and the energy deposited in the material of which the detector is made; therefore, to be able to build detectors and interpret the results of the measurement” (Tsoulfanidis, pg. 121), it is essential to have sufficient knowledge of this phenomenon. Furthermore, it is also essential to gain an insight into how harmful or harmless these reactions can be if carried out artificially or naturally on a larger scale.

Generally, ionization radiations are categorized into three main types. These types are Charges (this category includes the electrons, protons, positrons, deuterons, alphas, and heavy ions); photons (this includes the gamma rays or the X rays); and Neutrons (Tsoulfanidis, pg. 121). This classification is done on the basis of the exclusive and unique properties of these ions.

Why Do Ionization Radiations Interact?

When a charged particle starts moving in space, it starts interacting with the positive and the negative compositions of the atom as well. These constituent particles are electrons (i.e., negative in nature) and protons (i.e., positive in nature). Every time the charged particle has an interaction with

any of these particles, it loses some of the energy that was charged into it. After the continuous loss of energy, the charged particle stops. This finite distance covered by this particle is known as the *range* (Tsoulfanidis, pg. 122). This range is dependent on three factors. The factors are the type of the particle, the energy charged into the particle, and the medium through which the particle was traversing. Logically, there is no probability that the charged particle will not interact with any other atom while traversing through any medium. However, here, it is essential to know that since the neutron and the gamma rays are physically neutral, they may go through the matter while revealing no interaction. Therefore, their range can also not be measured (Tsoulfanidis, pg. 122).

How The Energy Is Lost By The Charged Particles

Coulomb Interactions

The first mechanism that explains the loss of energy is the Coulomb Interaction. This interaction generally takes place between the electrons and the nuclei. As per the researchers, the interaction carried out between the charged particle and the electrons is more significant as compared to the interaction taking place with the nuclei. In the process of Coulomb Interactions, the Coulomb force is exerted. As a result of this force, often the energy is transferred from the mobile particles to the bound electrons (Tsoulfanidis, pg. 123). Consequently, excitation or the ionization phenomenon can occur in the bound, quantized electrons. The collisions or the interactions that result in the excitation or the ionization are known as the Inelastic Collisions (Tsoulfanidis, pg. 123).

Bremsstrahlung Energy

The second mechanism of energy loss is known as the Bremsstrahlung phenomenon. This emits energy as a result of electromagnetic radiation. This process takes place during the deceleration or the acceleration of the charged particle. As a result of this motion, the particle is bound to produce electromagnetic emissions, and the kinetic energy is lost (Tsoulfanidis, pg. 124). The particles involved in this process are photons having energy from zero up to the level where it equals the kinetic energy of the charged particle. Another interesting observation is that the energy produced by the light particle is greater if both of the particles are traveling through the same medium. Moreover, if the medium through which the particle is traversing has a higher atomic number, more energy will be emitted. Furthermore, energy loss is also observed as a result of the Bremsstrahlung emissions (Tsoulfanidis, pg. 129).

Energy Due To Ionization And Excitation

The third mechanism deals with the loss of energy due to the ceasing power exerted as a result of the ionization and excitation processes. It was previously described that ionization and excitation happen

as a result of the exertion of the Coulomb force (Johnson, 2002). As a result of ionization and excitation, the charged particles start colliding with several hundred million electrons. Each of these millions of interactions has a different amount of energy loss, which is practically impossible to measure individually. Therefore, the average of the energies is measured per distance traversed (Tsoulfanidis, pg. 129). It is essential to view the designated formulas required to find the type of interaction being carried out.

Conclusion

The ions are constantly in motion in the free space; however, they are not visible to the naked eye. As they traverse through space, they collide and interact with other matter and charged particles. As a result of the collisions and interactions, energy is lost from the moving ions. This continues to happen until the ions stop at a finite distance. This distance is known as the range of the ion. The collision and the interaction can be of several types, most of which are beyond the scope of the paper. However, some basic mechanisms of interactions and causes of energy loss are Coulomb Interactions, Bremsstrahlung, excitation, and ionization. Furthermore, the types of interactions that photons have with matter are the Photoelectric effect, Compton Effect, and pair production. There are many other mechanisms as well that are well beyond the scope of the paper.

References

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