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ATOMIC BATTERIES: A COMPACT AND LONG LIFE POWER SOURCE

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ABSTRACT

The energy demand has been increased tremendously in last few decades, though new renewable technologies are adopted but they are not sufficient to fulfill the demand hence there is a need of new power sources. Nuclear energy drawn attention in last century, most of the nuclear powerplants are now working on the nuclear chain reactions but another method to harvest nuclear power is "Nuclear batteries or Atomic Batteries" does not have attention even though it is much safer and stable than chain reaction.

This paper shade light on working, characteristics and advantages of atomic batteries and its applications in various fields.

Keywords: Atomic batteries, Radioisotope Generators, Nuclear energy

I. INTRODUCTION

Atomic batteries are the devices which produce electricity from radioactive material. Even though atomic batteries are producing electricity from radioactive material as in nuclear powerplants their mechanism are much different than the electricity production from nuclear fission reaction. In nuclear fission reaction electricity is produced from steam generated from heat liberation due to chain reactions but atomic batteries work on radiations from radioactive material for the electricity generation. Atomic batteries are also called as nuclear batteries or radioisotope generators. The concept of atomic batteries is known to us from a century when scientists Moseley and Harling found out that the high voltage difference can be achieved by using radioactive material Radium.[1] This study shows that it is possible to produce electricity from the radiations of radioactive materials which motivated many scientist to pursue research on atomic batteries.

The atomic battery becomes a very popular concept as it has potential to provide electricity for longer periods. The atomic battery will generate electricity from radioactive decay of radioactive material hence as long as material emits radiations, electricity generates. As half life period of radioactive materials is in terms of decades it will capable to provide power for 10 to 20 years. For example Tritium isotope has half life of 12.32 years while Ni-63 isotope has half life of 100 years which shows that atomic batteries equipped with theses isotopes can proved electricity for this much longer periods. [] No other energy source is capable to provide that much life as compared to atomic batteries. Hence to obtain higher battery life radioactive isotope with long half life will be selected, the isotopes with short half life will have low life but they will posses high power. Alongwith the long life atomic batteries also have advantages like compact size and high energy density. Size of the atomic batteries is very compact as compare to other energy sources of same capacity. Atomic batteries have very high energy densities as compared to other energy sources. It has 10 times more energy density than

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hydrogen fuel cell and thousand times higher than chemical batteries.[3,4] Atomic batteries are also researched for the advantage that the radioactive isotopic material required for this atomic battery can be obtained from radioactive waste of the nuclear fission reaction from the nuclear reactor. Hence atomic batteries can be also useful for the disposal of waste from the nuclear reactors. It shows that the atomic batteries have so many advantages due to which it can be preferred but it also have some disadvantages like very high cost and lower conversion efficiencies.

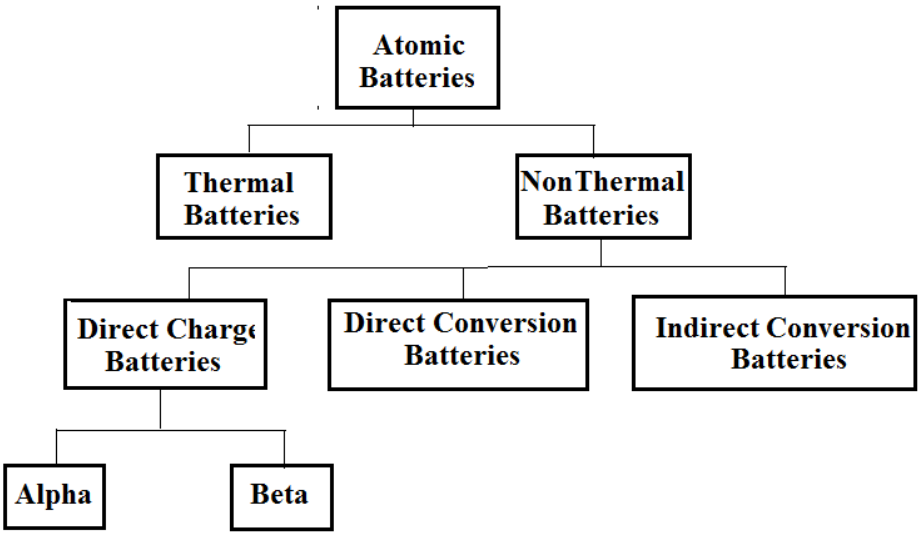

Fig. 1 Classification of Atomic Batteries

Fig. 1 shows different types of atomic batteries which use radioactive decay of isotopes to produce electricity using different methods.

II. DIFFERENT TYPES OF ATOMIC BATTERIES

Depending on the mechanisms adopted for production of electricity different Atomic batteries has been classified;

2.1 Thermal Atomic Batteries:

Thermal atomic batteries are also known as Radioisotope Thermo electric Generators (RTG). In this type heat energy emitted from radioactive decay of unstable isotope is used for electricity generation. Heat emitted by radioactive decay is given to thermo an electric generator which converts heat into electricity. Generally PU-238 isotope is used for this type of batteries. This battery is adopted to provide electric power to the space ships of NASA in last century. It is observed that, the efficiency of these devices is near to 10%. [5]

2.2 Non Thermal Atomic Batteries:

Non thermal Atomic Batteries extract energy of radiations from isotope and it is converted into electricity. In this type of batteries electricity is not the function of temperature. These batteries are further divided into three types namely direct charge batteries, indirect conversion batteries and direct conversion batteries.

ISSN: 2454-9665

2.3 Direct Charge Batteries:

In this method charge on the radiation particles is directly used for electricity production. As we know that radioactive isotopes produces electric charges, these charges can be used to charge a electric conductor which will develop a electric field. Using this electric field continuous electricity can be produced.

2.4 Direct Conversion Batteries:

Direct conversion batteries uses the radioactive decay of isotope to generated electricity directly, in this there will be no intermediate process involved. In direct conversion type batteries the current is developed from the charge on alpha and beta particles from radioactive decay. In this battery the charge on beta or alpha rays in the radiations will generate potential differences which will results into an electricity generation. Beta rays are nothing but the product electron which is ejected from the nucleus of isotope with very high velocity, as beta particle itself a electron by using this negative charge the electricity can be produced. Beta particles will enhance the electron hole generation across the semiconductor junction which will cause the flow of electrons through external circuit attached across junction and hence electricity will be generated. Direct charge batteries using beta particles for electricity generation are known as Betavoltaic Devices. In direct charge batteries there are also alphavoltaic devices which use alpha radiations to produce electricity from semiconductor junctions. Electricity can also be generated from secondary electrons irradiated from the surface.

2.5 Indirect Conversion Batteries:

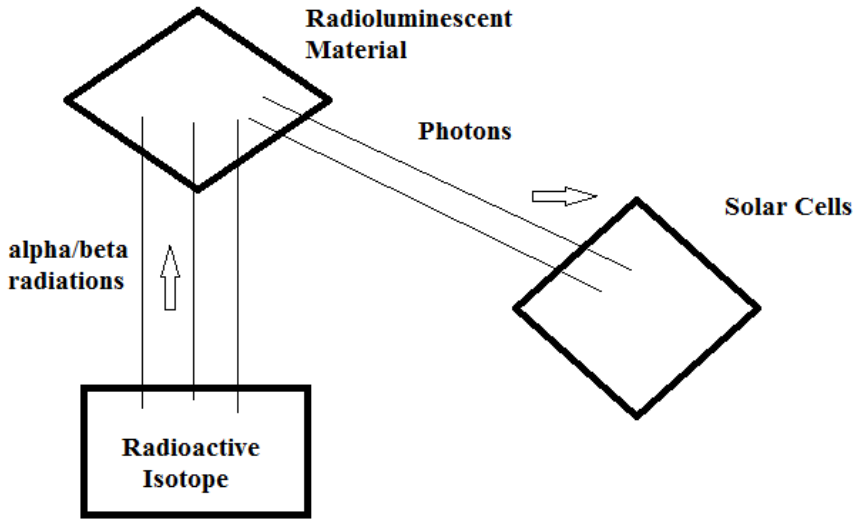

Fig. 2 Mechanism of Indirect Conversion Batteries

Indirect conversion is a basically two stage conversion process in which the first stage deals with conversion of alpha and beta particles into photons and second stage involves conversion of photons into electricity. In this process alpha or beta radiations first fall on the radio luminescent material where light is produced due to bombardment of beta particles, Beta particles collide on atom of radio luminescent material which results into increase in energy level of the electron. To maintain the stability, this gained energy will be released by the

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electron in the form of photons. Theses photons then will be sent to solar cells where the electricity will be generated in photovoltaic cells.

III. CONCLUSIONS

Atomic batteries have very long life and high capacities which make suitable for the space applications and underwater applications also theses are safe and compact. Atomic batteries can be fueled from the wastage from nuclear reactors that is the products of nuclear fission reactions which helps to radioactive waste disposal. But as the cost of atomic batteries is very high it cannot be adopted in industrial or domestic applications hence efforts has to be made to reduce cost of atomic batteries.

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