World Academy of Science, Engineering and Technology
International Journal of Nuclear and Quantum Engineering
Vol:11, No:09, 2017

A Multipurpose Inertial Electrostatic Magnetic Confinement Fusion for Medical Isotopes Production

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Abstract : A practical multipurpose device for medical isotopes production is most wanted for clinical centers and researches. Unfortunately, the major supply of these radioisotopes currently comes from aging sources, and there is a great deal of uneasiness in the domestic market. There are also many cases where the cost of certain radioisotopes is too high for their introduction on a commercial scale even though the isotopes might have great benefits for society. The medical isotopes such as radiotracers PET (Positron Emission Tomography), Technetium-99 m, and Iodine-131, Lutetium-177 by is feasible to be generated by a single unit named IEMC (Inertial Electrostatic Magnetic Confinement). The IEMC fusion vessel is the upgrading unit of the Inertial Electrostatic Confinement IEC fusion vessel. Comprehensive experimental works on IEC were carried earlier with promising results. The principle of inertial electrostatic magnetic confinement IEMC fusion is based on forcing the binary fuel ions to interact in the opposite directions in ions cyclotrons orbits with different kinetic energies in order to have equal compression (forces) and with different ion cyclotron frequency ω in order to increase the rate of intersection. The IEMC features greater fusion volume than IEC by several orders of magnitude. The particles rate from the IEMC approach are projected to be 8.5 x 10^{11} (p/s), ~ 0.2 microampere proton, for D/He-3 fusion reaction and 4.2 x 10^{12} (n/s) for D/T fusion reaction. The projected values of particles yield (neutrons and protons) are suitable for medical isotope productions on-site by a single unit without any change in the fusion vessel but only the fuel gas. The PET radiotracers are usually produced on-site by medical ion accelerator whereas Technetium-99m (Tc-99m) is usually produced off-site from the irradiation facilities of nuclear power plants. Typically, hospitals receive molybdenum-99 isotope container; the isotope decays to Tc-99mwith half-life time 2.75 days. Even though the projected current from IEMC is lesser than the proton current from the medical ion accelerator but still the IEMC vessel is simpler, and reduced in components and power consumption which add a new value of populating the PET radiotracers in most clinical centers. On the other hand, the projected neutrons flux from the IEMC is lesser than the thermal neutron flux at the irradiation facilities of nuclear power plants, but in the IEMC case the productions of Technetium-99m is suggested to be at the resonance region of which the resonance integral cross section is two orders of magnitude higher than the thermal flux. Thus it can be said the net activity from both is evened. Besides, the particle accelerator cannot be considered a multipurpose particles production unless a significant change is made to the accelerator to change from neutrons mode to protons mode or vice versa. In conclusion, the projected fusion yield from IEMC is a straightforward since slightly change in the primer IEC and ion source is required.

Keywords : electrostatic versus magnetic confinement fusion vessel, ion source, medical isotopes productions, neutron activation

Conference Title : ICNE 2017 : International Conference on Nuclear Engineering

Conference Location : Paris, France

Conference Dates : September 21-22, 2017