Development of a portable neutron generator based on inertial electrostatic confinement D-D fusion reaction

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Abstract:

We are developing, the first of its type, a portable active interrogation system for special nuclear materials (SNMs) detection such as U-235 and Pu-239. The system is based on the recently developed technique, threshold energy neutron analysis (TENA) method. Mandatory aspects for the neutron generator to be used for on-site inspection as well as for container screening at ports of entry is intense neutron as 5×10^7 n/s neutron yield in a very compact configuration such as ~25 cm diameter, 60 cm height, and lightweight ~30 kg. The criteria mentioned above are matching the neutron generator based on the D-D fusion reaction from Inertial Electrostatic Confinement (IEC) fusion device. Two prototypes of the DD-IEC fusion device, with 17 cm anode diameter, have been designed, fabricated and tested. The anode of the first device was made from stainless steel, while titanium was chosen to build the second version. The cathode for both versions was made from molybdenum with 6 cm diameter. High voltage and current are required to achieve the target neutron yield from the compact configuration. To cope with that, we used a developed technique called a multistage feedthrough method to enable applying higher voltage and current, up to 120 kV and 300 mA, in a compact configuration. The neutron production rate (NPR) achieved from the 1st prototype was ~2.8×10^7 n/s by applying 70 kV and 150 mA, and from the 2nd prototype was 8.9×10^7 n/s, by applying 75 kV and 70 mA current, which exceeds the target NPR designed for the SNMs interrogation system. The technical developments and challenges to construct and operate the prototypes of the DD-IEC fusion device are discussed together with the experimental results for the NPR measurements.

Keywords:

IEC, fusion, titanium

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