Characterization of the Portable IEC Chamber for the SNM Interrogation System

*Mahmoud BAKR[1], Kai MASUDA[1], Tsuyoshi MISAWA[2], Yoshiyuki TAKAHASHI[2], Norio YAMAKAWA[3], Masaya YOSHIDA[4], Atsushi MATSUDA[3], and Kiyoshi YOSHIKAWA[1]

[1] Institute of Advanced Energy, Kyoto University, [2] Research Reactor Institute, Kyoto University, [3] Pony Industry Co. Ltd, [4] Graduate School of Energy Science, Kyoto University.

The first portable active interrogation system for special nuclear materials (SNM), such as U-235 and Pu-239, is being developed by our group. The system employs an inertial electrostatic confinement (IEC) device as a neutron source. The first prototype of the IEC device, with 17 cm chamber diameter (IEC17), has been fabricated, assembled and is being tested. Preliminary results from the first portable chamber will be presented in this paper.

Keywords: Special nuclear materials, IEC**,** Tensioned metastable fluid detector, Threshold energy neutron analysis.

1. Introduction

Our group is developing the first of its kind, portable, and lightweight active interrogation system for special nuclear materials (SNM), such as U-235 and Pu-239, based on the TENA technique [1]. The inertial electrostatic confinement (IEC) device [2], is employed as a neutron source in the system. The first prototype IEC chamber (IEC17) was fabricated from SUS316L, with 17 cm anode diameter. The grid cathode concentrically placed at the center is assembled from 6 rings of Molybdenum with 8 cm diameter. Due to the potential difference between the cathode and anode, Deuterium (D) ions are derived towards the center of the grids, then a steady-state D-D fusion reactions takes place in order to generate neutrons. Figure 1, shows the first prototype IEC17 with 60 cm height which includes IEC chamber and the feedthrough junction. The challenge in this configuration compared with previous IEC25, developed 10 years ago [3], (130 cm height, with 25 cm anode diameter, and 80 kV applied voltage to generate 1×10^7 neutrons/s, for landmine detection system), is applying higher voltage, up to 120 kV, in smaller size to generate 5 times higher neutrons yield.

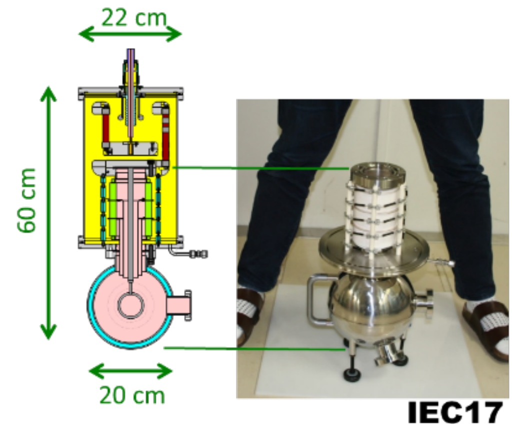

Fig.1 The DD-IEC neutron source for SNM active interrogation system

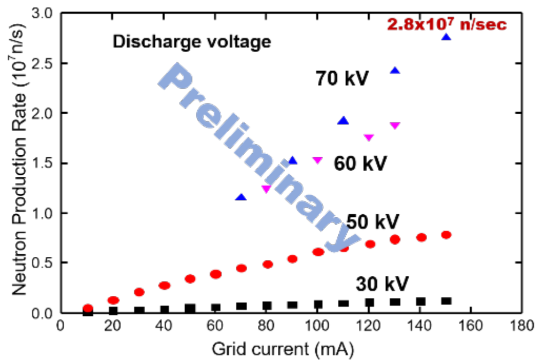

Fig. 2 Preliminary results of NPR from the portable IEC17 chamber

2. Results:

Conditioning of the IEC17 has been conducted up to 110 kV. Preliminary measurements of neutron production rate (NPR) have been carried out at different applied voltage (30-70 kV) and the results are shown in Fig. 2. It can be seen from the figure that $\sim2.8\times10^7$ n/s was already achieved at 70 kV applied voltage and 150 mA current, which is ~60% of the power supply capacity. Therefore, the target NPR for the SNM interrogation system (5×10^7 n/s) is achievable using the present configuration.

3. Future Plan

Titanium will be the successor material for the second prototype with same dimensions. The benefits of using Titanium that it has less weight and is expected to generate higher NPR compared with SUS chamber.

4. Conclusions:

The first prototype IEC17 device for the SNM interrogation has been produced and tested. The neutrons yield from the preliminary test is $\sim2.8\times10^7$ n/s with 60% of the power supply capacity. Titanium chamber will be used in the second prototype for higher NPR.

References

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