LSDS Development for Isotopic Fissile Assay in Spent Fuel

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1. Introduction

An accumulation of spent fuels will reach the maximum capacity of current storage soon. Therefore, a storage site must be decided for next generation. As an option to reduce a spent fuel and reuse an existing fissile material in spent fuel, sodium fast reactor (SFR) program linked with pyro-processing is under development in KAERI. A uranium-TRU mixture through a pyro-process is used to fabricate SFR fuel. An assay of isotopic fissile content plays an important role in an optimum design of storage site and reuse of fissile materials of spent fuel.

Lead slowing down spectrometer (LSDS) is being developed in KAERI to analyze isotopic fissile material content. LSDS has several features: direct fissile assay, near real time fissile assay, no influence from radiation background, fissile isotopic assay (not gross total fissile) and applicable to spent fuel and recycled fuel. Based on the designed geometry[1], neutron energy resolution was investigated. The neutron energy spectrum was analyzed as well. Spent fuel emits large number of neutrons by spontaneous fission. Neutron generator must overcome the neutron background to get the pure fission signals from fissile materials. Neutron generator is planned to have compact system with one section electron linac which is easy maintenance, less cost and high neutron yield.

2. LSDS Development

The energy resolution was investigated at the fuel assay area, 2x2 and 4x4 fuel composition. Fissile material has its own fission characteristics at neutron energy. The source neutron slows down in the lead medium by interaction with lead. Lead has the feature to produce the continuous slowed down neutron energy. A good energy resolution is required to get fission signals. Fig. 1 shows the neutron energy resolution in the fuel assay area. The energy resolution is 0.5 at 10keV and 0.6 at 0.3eV and in between 1eV and 1keV, the resolution has ~0.3. The result shows that the different fuel geometry (2x2 and 4x4) has very similar property.

The neutron generator consists of target and electron acceleration part. The proposed target[2] has a cone shape configuration with Ta cylindrical plates. From the several sensitivity tests[2], the following results are obtained: (a) Among several metal targets, Ta and W provide high neutron yields. They also give a similar trend for various types of plate target geometries. (b) A uniform radius with increasing thickness plate types provides the preferable results to produce enough neutron sources. (c) Radius variation does not make a significant change in producing neutron source. (d) The middle part of plate target releases the high neutron and the high energy compared to other part. It requires a forced cooling system with a gas circulation. One section electron linear acceleration system is decided to accelerate electron and produce neutron by hitting on the target. From the intense background from assaying target fuel area, 40MeV electron energy was decided with 500mA beam current to produce 10^{12}n's/sec with Ta target. Ta target is good choice for high yield of neutron and easy maintenance.

3. Conclusion

The LSDS has the power to resolve the fission characteristics from each fissile material. This feature can analyze the content of isotopic fissile. From 1keV to 0.1eV energy range, the energy resolution

is enough to get the individual fissile fission signatures. The dominant fission signature is shown below 1eV for each fissile isotope. The neutron generation system with target was designed to get fission signals by fissile materials. The system was decided to overcome neutron backgrounds and to get good counting statistics.

Finally, an accurate fissile material content will contribute to safety of spent fuel reuse in future nuclear energy system and optimum design of spent fuel storage site. Additionally, an accurate fissile material content will increase international transparence and credibility for the reuse of PWR spent fuel.

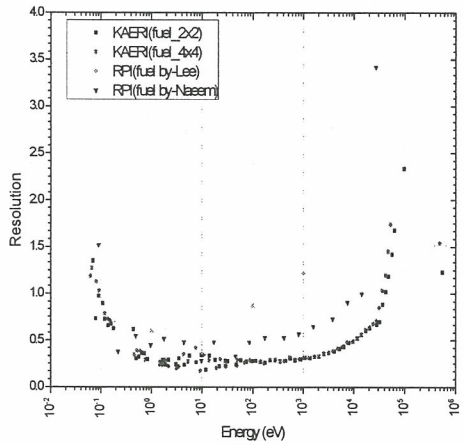

Fig. 1. Neutron energy resolution in different geometry.

4. Acknowledgement

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5. References

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