Contribution ID: **372** Type: **Oral talk (15 min + 5 min questions)**

TARGET DESIGN FOR EXPERIMENTAL INVESTIGATION OF ADS WITH PROTON AND LIGHT ION BEAMS

Tuesday, 12 July 2022 15:00 (20 minutes)

A particle accelerator coupled with a subcritical fission reactor (accelerator driven system - ADS) can realize a safe, clean and efficient source of energy. We showed that in spite of the majority's opinion with respect to the optimal beam for ADS (considered to be proton with energy 1-1.5 GeV) light ion beams at lower energies are more efficient [1-3]. Aspects related with the core structure and composition, the optimal value of the criticality coefficient keff, the particle beam and the accelerator type were analyzed. The larger pitch to diameter ratio possible to achieve in ADS (˜2 for a core cooled with lead or lead bismuth eutectic - LBE) allows to accommodate higher power densities, keeping the coolant velocity below 2 m/s in order to minimize the corrosion effects on the cladding and structural materials. The role of a Be converter with large dimensions (radius 10-20 cm, length 100-120 cm) is emphasized. In the presence of a long Be converter a beam of 7Li with energy 0.2 AGeV is equivalent from the point of view of the net power produced with a beam of 1 GeV proton, and a beam of 0.25 AGeV 7Li is equivalent with a beam of 1.5 GeV protons. This allows to obtain the same net power with a 2.5 times shorter accelerator with lower cost for the power plant building and maintenance. The apparition of a tail towards thermal energy in the neutron spectrum allows to obtain the needed value of the criticality coefficient keff in a given geometry with a lower enrichment, increases the breeding capability of the core and ensures a deeper burning of the actinides in one cycle. Until 25 % of the actinides can be fissioned in one cycle in ADS with Be converter in comparison with 6-7 % that can be achieved in a fast reactor. The analysis of the power evolution after beam stopping and the investigation of possible insertions of positive reactivity during transients concluded that metallic fuel allows a core with keff 0.988, when fuels with melting temperature higher than the clad (as oxide, carbide, nitride) needs a lower value of 0.985 for keff. The maximum energy gain of protons is obtained at 1.5 GeV when they are accelerated in a linac (G ˜14), and at lower energy (0.75-1 GeV) when a cyclotron is used. In both situations ion beams starting with 4He realize higher energy gain than protons. Ion beams offer the possibility to obtain energy gain from 25 (with 0.25AGeV 7Li beam) to 45 (with 0.75 AGeV 16O and 20Ne beam).
A proposal for the design of a target dedicated to the experimental study is presented. The design of the experimental target must reproduce at a small scale the situation in a real ADS. The interest is to determine the minimal dimensions and minimal amount of fuel necessary for a correct reproduction of the ratio of the energy released (amount of fissions) produced with proton and ion beams. Two designs are analyzed. In the first, the target consists of rods from enriched U (15 % 235U) with diameter 2 cm and length 120 cm, distributed in 6 layers (˜200 rods) inside a cylinder from Pb with length 150 cm and radius 70 cm. The central part of cylinder is empty, allowing the placement of different converters. In the second variant the rods are placed in a graphite target, surrounded by a 10 cm Pb blanket. Due to the softer neutron spectrum, the use of graphite target allows to diminish significantly the number of fuel rods (˜20 rods with 15 % 235U).

References:
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The speaker is a student or young scientist

No

Section

1. Applications of nuclear methods in science and technology

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