Conceptual Design Study of TRIGA Kartini Reactor using Plate Type Fuel Element

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This research offers a possibility fuel assembly conversion from TRIGA standard fuel rod-type to plate-type for solving the operation problem in TRIGA reactors. In this work, neutronic parameters of the Kartini reactor's core configuration are being simulated, by using SRAC2006. The results show that the new core configuration meets the safety criteria, and gives the better neutron flux and nuclear fuel lifetime for utilization than the existing core.

Keywords: TRIGA Kartini reactor, plate-type fuel, neutronic parameters

1. Introduction: Fuel fabrication of TRIGA standard U-$ZrH_{1.65}$ rod-type fuel assembly has been suspended. In order to operate continuously, it is planned on the future that the Kartini research reactor should change the fuel to U_3Si_2-Al plate-type, because Indonesia has been able to produce that fuel element. The objective of present study is to obtain a new core with plate-type fuel element which fulfills the safety and operation criteria without changing the existing core in a circle with 450 mm of diameter and 100 KWth power. The new concept design is expected to produce the higher neutron flux at the irradiation facility and the more economical compared with existing TRIGA Kartini reactor.

2. Methodology: The collision probability method lattice transport code SRAC-PIJ and the SRAC-CITATION code[1] are used to perform global core calculations. Specification of plate type fuel element shown in Table 1, which is used for the new concept design of Kartini reactor. Several design core configurations i.e. the number of fuel elements (FE), fuel control elements (FC) and reflector materials, can be variedly arranged to optimize the neutronic parameters. The best core configurations will be selected based on the optimum parameters for safe operation and utilization of reactor.

Table 1. Specifications of plate type fuel element

Parameters	*Specifications*
Fuel and cladding	U_3Si_2-Al and $AlMg_2$
U density and enrich.	3.26 gU/cc; 19.75%
Absorber and cladding	Ag-In-Cd and SS-321
Number of fuel plates	21 (FE) and 15 (FC)
FE and FC Dimension	77.1 x 81 x 600 mm

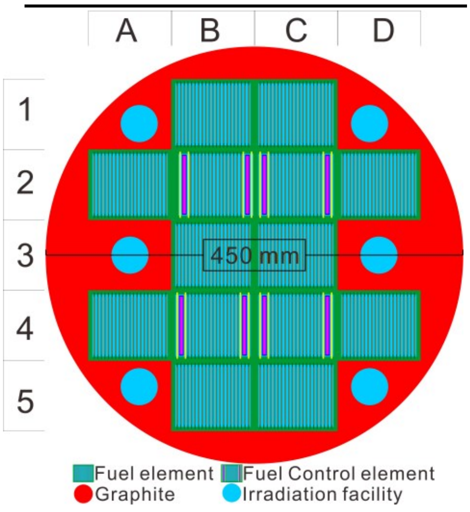

Fig.1 Configuration of selected new core

3. Results and Discussion: The core configuration with 4 fuel control elements on the grid B-2, C-2, B-4 and C-4 shown in Fig.1 is chosen as the best core configuration. Then, graphite reflector is installed surrounding the core. This configuration gives \$12.23 for the sufficient of core excess reactivity and \$28.15 of control rod worth. Values of shutdown margin, stuck rod criteria, total peaking factor respectively are \$7.16, \$7.20 and 1.61; which is fulfilled according to safety criteria. The inherent safety is obtained from the negative feedback coefficient of fuel and moderator, that is -8.01 and -1.89 respectively. Number of irradiation facilities in the core have increased from 2 to 6 pieces, then the maximum of thermal neutron flux at the positions is 2.71E+12 n/cm^{2}s, higher than the existing reactor core 4.68E+1 n/cm^{2}s. At the nuclear fuel lifetime and burn up test, new core configuration that selected will extend the lifetime of the fuel in the core from 18 to 62 GWD/ton of U.

4. Conclusion: Based on the calculation of neutronic parameters, the new core configuration concept of Kartini reactor with 12 FE and 4 FC of U_3Si_2-Al plate-type fuel elements meets the safety criteria. The conceptual gives the greater thermal neutron flux at irradiation facilities and the longer lifetime of fuel than the existing core configuration.

Reference: [1]K.Okumura, et al, SRAC2006: A Comprehensive Neutronics Calculation Code, JAEA-Data/Code 2007-004, 2007.