# Analisis *Burnup* terhadap Perangkat Bahan Bakar Reaktor Gama-Float dengan Penambahan Lapisan Torium Menggunakan Kode Neutronika Polaris

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## INTISARI

Departemen Teknik Nuklir dan Teknik Fisika mengembangkan desain PLTN terapung yang disebut Gama-Float. Pengembangan Gama-Float berada pada tahap perangkat bakar di mana desain konfigurasi awal sudah ditetapkan. Sudah dilakukan penelitian untuk menurunkan *excess reactivity* perangkat bakar Gama-Float menggunakan racun bakar $Gd_2O_3$ namun masih memiliki *Moderator Temperature Coefficient* (MTC) di *Beginning of Cycle* (BoC) bernilai positif.

Sebagai upaya menurunkan *excess reactivity* sembari memenuhi parameter keselamatan neutronika berupa koefisien reaktivitas, penambahan lapisan torium dilakukan. Simulasi dilakukan memanfaatkan Polaris dengan variasi lapisan torium 0,01cm hingga 0,1cm dengan langkah 0,01cm menggunakan perlakuan yang mempertahankan dan melebarkan *pitch* seiring peningkatan lapisan torium. Pengolahan data dan pemeringkatan kemudian dilakukan untuk mengamati pengaruh penambahan lapisan torium dan mendapatkan variasi optimal dengan mengamati parameter $k_{inf}$, MTC dan *Fuel Temperature Coefficient* (FTC) seiring *burnup*.

Berdasarkan langkah penelitian, penambahan lapisan torium menunjukkan berhasilnya penurunan *excess reactivity* perangkat bakar Gama-Float sembari menjaga MTC dan FTC di BoC masih bernilai negatif. Selain itu, didapatkan variasi optimal berupa variasi pada konfigurasi 14x14 tebal torium 0,01 cm tanpa pelebaran *pitch* dengan total pembobotan skor 0,768. Variasi paling optimal memiliki parameter $k_{inf}$ BoC bernilai 1,46732, durasi siklus selama 3524,72 hari, FTC di BoC bernilai -1,408 pcm/K, durasi FTC bernilai negatif hingga 4154,70 hari, MTC di BoC bernilai -27,298 pcm/K dan durasi MTC bernilai negatif hingga 4377,46 hari.

***Kata kunci***: torium, *burnup*, koefisien reaktivitas, Gama-Float

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# Burnup Analysis of Gama-Float Reactor Fuel Assembly with Thorium Coating using Polaris Neutronic Code

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## ABSTRACT

The Department of Nuclear Engineering and Engineering Physics developed a floating nuclear power plant design called Gama-Float. The development of Gama-Float is at the Fuel Assembly (FA) stage where the initial configuration design has been determined. Research has been conducted to reduce excess reactivity of the Gama-Float FA using $Gd_2O_3$ fuel poison but still has a positive Moderator Temperature Coefficient (MTC) at the Beginning of Cycle (BoC).

As an effort to reduce excess reactivity that meets neutron safety parameters in the form of a reactivity coefficient, the addition of a thorium coating was carried out. Simulations were carried out using Polaris with variations in thorium coating of 0.01 cm to 0.1 cm with a step of 0.01 cm using treatments that maintains and widens the pitch as the thorium coating increases. Data processing and ranking were then carried out to observe the effect of thorium coating and obtain optimal variations by observing the $k_{inf}$, MTC and Fuel Temperature Coefficient (FTC) parameters within burnup.

Based on the research procedure, thorium coating on Gama-Float FA shows a success on reducing excess reactivity while maintaining a negative MTC and FTC at the BoC. The optimal variation of thorium addition was also obtained. The optimal variation is 14x14 FA configuration with a thorium coating thickness of 0.01 cm without pitch widening with a total weighted score of 0.768. The optimal variation has $k_{inf}$ parameter at BoC of 1.46732, a cycle duration of 3524.72 days, FTC at BoC of -1.408 pcm/K, negative FTC duration up to 4154.70 days, MTC at BoC of -27.298 pcm/K and negative MTC duration up to 4377.46 days.

***Keywords:*** thorium, burnup, reactivity coefficient, Gama-Float

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