

# Studi Sensitivitas Fraksi *Packing* Partikel TRISO dalam Desain Kritisitas HTR *Pebble Bed*

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## ABSTRAK

HTR adalah reaktor temperatur tinggi yang digunakan untuk produksi listrik dan aplikasi panas proses seperti produksi hidrogen, desalinasi air laut, pengambilan minyak sisa (*enhanced oil recovery*) dan lain-lain. HTR didesain berdasarkan pemanfaatan partikel bahan bakar TRISO yang dapat mencegah secara kuat lepasnya produk fisi bahkan pada temperatur di atas 1600 °C. Fraksi *packing* partikel TRISO merupakan salah satu dari empat parameter kunci yang esensial dalam desain HTR selain radius kernel, densitas kernel dan pengkayaan bahan bakar. Makalah ini mendiskusikan sensitivitas fraksi *packing* partikel TRISO yang berimpak pada pemuatan uranium dalam bahan bakar *pebble*, panjang siklus operasi reaktor dan fraksi bakar maksimum yang bisa dicapai. Dengan kapabilitas program transport Monte Carlo MCNP5, seluruh komponen reaktor, dimulai dari partikel TRISO, dimodelkan secara detail dan eksplisit dan dihitung menggunakan pustaka data nuklir energi kontinu ENDF/B-VI. Hasil perhitungan memperlihatkan bahwa nilai faktor multiplikasi efektif (*keff*) memiliki tendensi semakin bertambah dengan berkurangnya fraksi *packing* partikel TRISO dan semakin berkurang dengan bertambahnya fraksi bakar. Nilai *keff* menurun dengan bertambahnya fraksi *packing* partikel TRISO baik di awal siklus (BOC) maupun di akhir siklus (EOC). Reaktivitas ayun juga sangat sensitif pada fraksi *packing* partikel TRISO. Dari analisis dapat disimpulkan bahwa fraksi *packing* partikel TRISO sangat mempengaruhi performa neutronik desain HTR *pebble bed*. Fraksi *packing* dapat mengubah faktor multiplikasi efektif (*keff*) dan reaktivitas ayun masing-masing dengan kelakukan yang serupa.

Kata kunci: fraksi *packing*, partikel TRISO, HTR *pebble bed*, *keff*, reaktivitas ayun.

## ABSTRACT

HTR is a high temperature reactor used for electricity production and process heat applications such as hydrogen production, desalination of sea water, enhanced oil recovery and so on. HTR is designed based on the utilization of TRISO fuel particles that can prevent strongly the escape of fission products even at temperatures above 1600 °C. TRISO particles packing fraction is one of four key parameters that are essential in HTR design besides radius of the kernel, kernel density and fuel enrichment. This paper discusses the sensitivity of TRISO particles packing fraction that impacts to the loading of uranium in the fuel pebble, the long cycle of reactor operation and achievable maximum fuel burn-up. With the capability of Monte Carlo transport code MCNP5, all components of the reactor, starting from TRISO particles, were modeled in detail and explicit and calculated using the continuous energy nuclear data library ENDF/B-VI. The results show that the value of effective multiplication factor (*keff*) has a tendency to increase with decreasing particle TRISO packing fraction and to decrease with increasing fuel burn-up. *Keff* values decrease with increasing TRISO particle packing fraction both at the beginning of cycle (BOC) and at the end of cycle (EOC). Reactivity swing is also very sensitive on the TRISO particles packing fraction. From the analysis it can be concluded that TRISO particles packing fraction greatly affects the neutronics performance of HTR pebble bed design. Packing fraction can change the effective multiplication factor (*keff*) and the swing reactivity with similar behavior

Key word: packing fraction, TRISO particle, HTR pebble bed, *keff*, swing reactivity.

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