Analisis Keselamatan Kritikalitas Teras Silindris Stacy dengan Perhitungan Transport Monte Carlo

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ABSTRAK

Serangkaian eksperimen telah dilakukan di fasilitas STACY dan banyak parameter fundamental larutan uranil nitrat pengkayaan rendah didapatkan. Kritikalitas merupakan salah satu parameter utama dalam prediksi karakteristik neutronik eksperimen STACY selain reaktivitas level larutan, reaktivitas void, parameter kinetik dan reaktivitas temperatur yang mendominasi fenomena *transient* dalam kondisi abnormal. Eksperimen kritikalitas yang dikerjakan di teras STACY menggunakan larutan uranil nitrat berpengkayaan 235U 9,97% dengan tangki silindris berdiameter 80cm dan tinggi 150cm. Sebanyak 8 konfigurasi kritis STACY dalam kondisi tanpa reflektor (*unreflected*) dan dengan reflektor air (*water-reflected*) dipilih dalam makalah ini untuk perhitungan keselamatan kritikalitas dengan program transport Monte Carlo MCNPX. Untuk seluruh konfigurasi, perhitungan MCNPX memperlihatkan konsistensi yang baik dengan kecenderungan memproduksi *k*eff di bawah estimasi. Bias perhitungan dengan data eksperimen (*k*eff = 1) untuk konfigurasi dengan reflektor air, yakni 0,01-0,18%, sedikit lebih baik dibandingkan untuk konfigurasi tanpa reflektor (0,14-0,41%). Hasil perhitungan MCNPX yang lebih baik daripada prediksi MCNP-4C menyimpulkan bahwa, MCNPX lebih layak diaplikasikan dalam analisis keselamatan kritikalitas larutan uranil nitrat di fasilitas daur bahan bakar nuklir komersial.

Kata kunci**:** kritikalitas, larutan uranil nitrat, STACY, teras silindris, MCNP-4C, MCNPX.

ABSTRACT

A set of experiment has been done at STACY facility and many fundamental parameters of uranyl nitrate solution have been found out. Criticality is one of main parameters in predicting neutronic characteristic of STACY experiment beside solution level reactivity, void reactivity, kinetic parameter and temperature reactivity which dominates transient phenomenon in abnormal condition. Criticality experiment performed at STACY core uses 9.97% 235U -enriched uranyl nitrate solution with 80-cm-diameter cylindrical and 150-cm-height tank. Eight critical configurations in unrelected and water-reflected conditions were selected in this paper for criticality safety calculation with Monte Carlo transport code MCNPX. For all configurations, MCNPX calculations show good consistency with the trend of producing underestimated *k*eff. Calculation biases with experimental data (*k*eff = 1) for water-reflected configurations, i.e. 0.01-0.18%, were slightly better than those of unreflected configurations (0.14-0.41%). MCNPX calculation results which are better than the prediction of MCNP-4C concludes that MCNPX is more eligible to be applied to criticality safety analysis of uranyl nitrate solution in commercial nuclear fuel cycle facility.

Key word: criticality, uranyl nitrate solution, STACY, cylindrical core, MCNP-4C, MCNPX.

DAFTAR PUSTAKA

[1] Yoshihiro Miyoshi (Sep 20-24, 1999), Experimental Program of STACY for Criticality Safety Research on Low Enriched Uranyl and Plutonium Nitrate Solution, *Proceedings of The Sixth International Conference on Nuclear Criticality Safety (ICNC'1999)*, Versailles, France, **2**, 512.

[2] Yuichi Yamane, Yoshihiro Miyoshi, Shouichi Watanabe, *et al*. (2003), Critical Experiments on 10% Enriched Uranyl Nitrate Solution using 80-cm Diameter Cylindrical Core, *Journal of Nuclear Technology*, **141[221]**.

[3] Kotaro Tonoike, Yoshihiro Miyoshi, and Toshihiro Yamamoto (2002), Kinetic Parameter β_{eff} /l Measurement on Low Enriched Uranyl Nitrate Solution with Single Unit Cores (600Ø, 280T, 800Ø) of STACY, *Journal of Nuclear Science and Technology*, **39[11]**, 1227.

[4] Yoshihiro Miyoshi, Toshihiro Yamamoto, Kotaro Tonoike, Yuichi Yamane, Shouichi Watanabe (Oct 20-24, 2003), Critical Experiments on STACY Homogeneous Core Containing 10% Enriched Uranyl Nitrate Solution, *Proceedings of The Seventh International Conference on Nuclear Criticality Safety (ICNC'2003)*, Tokai, Japan.

[5] J.S. Hendricks, G.W. McKinney, *et al*. (Apr 11, 2008), *MCNPX 2.6.0 Extensions*, LA-UR-08-2216, Los Alamos National Laboratory.

[6] J.S. Hendricks, S.C. Frankle, J.D. Court (1994), *ENDF/B-VI Data for MCNP*, Los Alamos National Laboratory Report, LA-12891.

[7] J.F. Briesmeister, *ed*. (Apr 2000), *MCNP: A General Monte Carlo N-Particle Transport Code, Version 4C*, LA-13709-M.

[8] Zuhair, Suwoto, Tagor M. Sembiring (15 Sep 2005), Perhitungan Transport Monte Carlo dalam Keselamatan Kritikalitas Teras Silindris STACY, *Prosiding Seminar Nasional Ke-11 Teknologi dan Keselamatan PLTN serta Fasilitas Nuklir*, Malang.

[9] Japanese Nuclear Data Committee (2002), Activity Report of Japanese Nuclear Data Committee in Period of April 1999 to March 2001, *Nihon-Genshiryoku-Gakkai Shi, Journal of Atomic Energy Society*, Japan, **44[1]**, 106.