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Optimization of CANDU Reactor Performance Using SEU Fuel

by

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Abstract

High neutron economy and on-power refuelling enable the use of low-fissile fuel, including natural uranium, in CANDU® reactors. While the natural-uranium (NU) fuel cycle provides many advantages, the use of slightly enriched uranium (SEU) in CANDU offers even lower fuel cycle costs and other benefits, such as uprating capability through flattening the radial and axial power distributions.

The radial power form factor in natural uranium CANDU is typically about 0.82. This can be easily increased to 0.87 or higher using SEU, resulting in a potential reactor power uprating of at least 5 %. Recovered uranium (RU), which contains about 0.9 % ^{235}U, is obtained from the reprocessing of spent PWR (Pressurized Water Reactor) fuel. RU is considered a subset of SEU. There may be significant economic incentive to use RU in CANDU because the cost of RU is expected to be less than that of 0.9 % SEU.

AECL has developed the CANFLEX® fuel bundle as the carrier of advanced fuel cycles. CANFLEX provides enhanced operating and safety margins through reduction in peak linear element ratings and a significant improvement in thermalhydraulic margins. The lower linear element ratings with the CANFLEX bundle will also facilitate the achievement of higher burnups with SEU or RU fuel.

Another benefit of using SEU fuel in CANDU is the ability to significantly flatten the axial power distribution using a simple 2-bundle-shift fuelling scheme. Figure 1 shows that the peak bundle power in a SEU CANDU is about 10% lower than that in a NU CANDU for the same channel power. Moreover, the SEU axial power profile peaks towards the coolant inlet end of the channel and decreases along the length of the channel. This inlet-skewed power profile results in higher thermalhydraulic margins, hence higher reactor power than that achievable with the more symmetric NU axial power profile. The declining power history with fuel burnup also facilitates good fuel performance for SEU fuel.

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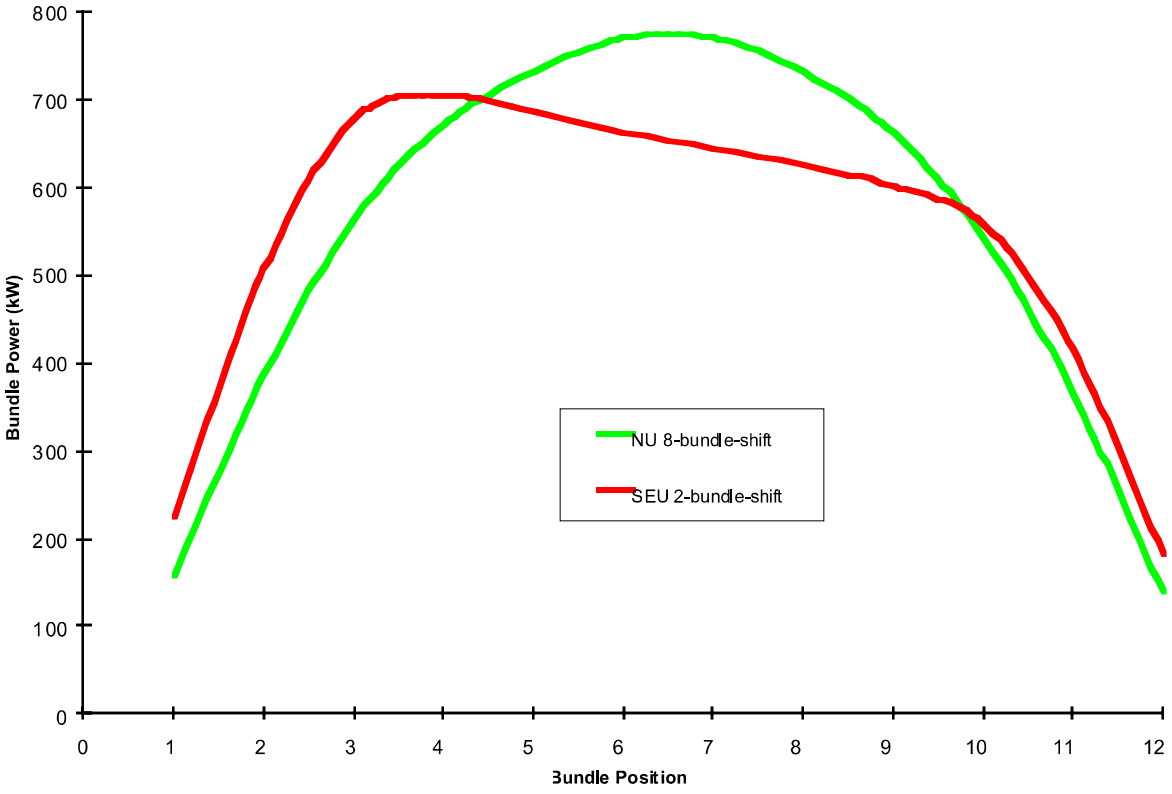

Figure 1: Axial Power Distributions in CANDU NU and SEU Reactors for a Channel Power of 6.5 MW