

MINOR ACTINIDES TRANSMUTATION INFLUENCE ON PROLIFERATION RESISTANCE OF THE SPENT NUCLEAR FUELS

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Abstract: There are two major approaches to enhancing the proliferation resistance of nuclear systems. One is increase of the discharged spent fuel burn-up in the advanced light water reactors, which could reduce the spent fuel for storage and increase Pu-238 and Pu-240 isotopes ratio, and the other approach is use of transuranic nuclides (Np-237 and Am-241) in the high burn-up fuel, which can drastically increase the Pu-238/Pu isotope ratio through transmutation process. Burning minor actinides of Np-237 and/or Am-241 in the high burn-up fuel and their consequent transmutation to Pu-238 is so called Minor Actinides Reduction Approach.

Keywords: minor actinide, proliferation resistance, spent nuclear fuel, transmutation.

1.

[1].

2.

• - 96%

0.9 % -235, 0.711%

;

- - 1 %
- -

242 248, -47% -249 -3% 252, -237, -241, -243 -50%, [2].

- 0.1 %

2.9 %

30 -). () [3].

(300 20 000) [3].

3.

() [7].

237 -241 (-238)

[8].

-238 -240,

-235, 20%.

1

[6].

-239, -240 -241. -238 -
30 MWd/kg. -238

(). -238

[9]. -241

-241,

242

1.

[9].

| | Pu-238 | Pu-239 | Pu-240 | Pu-241 | Pu-242 |
|-----------|-----------|--------|---------|--------|-----------|
| () | 87.7 | 24 100 | 6 560 | 14.4 | 376 000 |
| (kg) | 10 | 10 | 40 | 10 | 100 |
| (kg/sec) | 2 600 000 | 22 | 910 000 | 49 | 1 700 000 |
| (watt/kg) | 560 | 1.9 | 6.8 | 4.2 | 0.2 |

-238, -240 -242

-238

2

2.

[9].

| | | | | |
|--|-----------|--------|---------|---------|
| | : | | | |
| | (kg/sec) | 66 000 | 360 000 | 570 000 |
| | (kg) | 3 | 8 | >20? |
| | (watt/kg) | 2.5 | 11 | 13.7 |
| | (watt) | 8 | 100 | >300? |

4.

237 -238 -240, -241

-238/ -241

-237 / -238 . . MARA (*Minor Actinides Reduction Approach*) [6].

5.

()

()

237

-238,

-241

MOX

-240,

[4].

-238

(-237).

(

),

10
100

6.

()
-1000, PWR w15x15 CANDU,
()
PWR (w15x15)

PWR (w14x14),
-1000 CANDU,

3.

3.

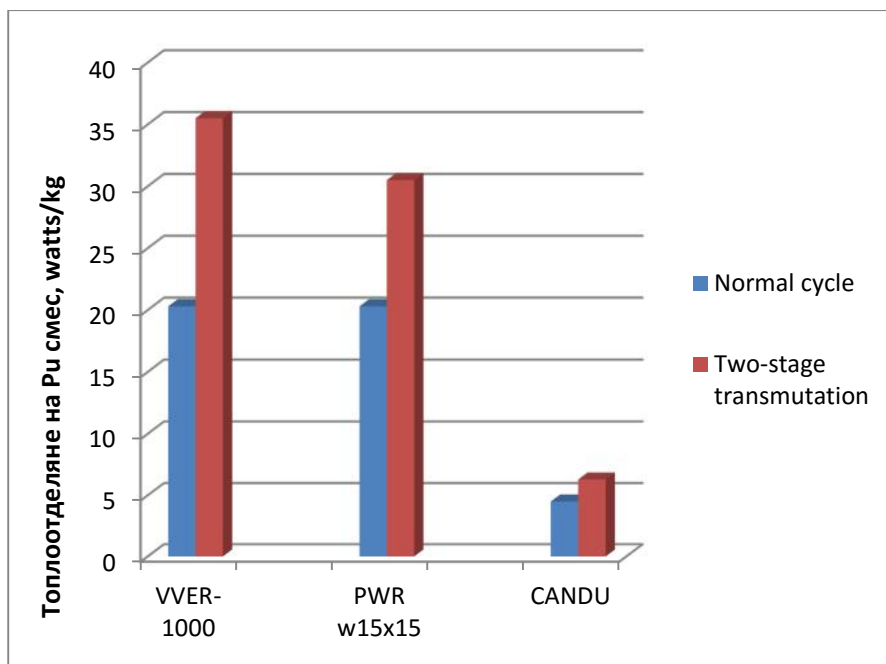
-1000, PWR (w15x15) CANDU.

| | VVER-1000 | | PWR (w15x15) | | CANDU | |
|---------------|-----------|----------|--------------|----------|----------|----------|
| Pu | | | | | | |
| Pu 238 | 3.05% | 5.78% | 3.05% | 5.86% | 0.16% | 0.48% |
| Pu 239 | 49.02% | 48.08% | 49.67% | 48.32% | 57.51% | 57.28% |
| Pu 240 | 24.40% | 23.64% | 24.63% | 23.94% | 31.89% | 31.80% |
| Pu 241 | 14.97% | 14.49% | 14.75% | 14.29% | 7.30% | 7.29% |
| Pu 242 | 8.56% | 8.01% | 7.90% | 7.59% | 3.14% | 3.15% |
| Pu , watts/kg | 20.3 | 35.5 | 20.3 | 35.5 | 4.5 | 6.3 |
| Pu , kg/sec | 4.47E+05 | 5.02E+05 | 4.38E+05 | 5.02E+05 | 3.48E+05 | 3.57E+05 |

PWR (w15x15), 75% (-1000 PWR (w15x15)), 12.3% (1000) 14.6% (PWR (w15x15)). CANDU 40% 2.8% -238

PWR, 1/4

1 2.



1.

Pu

-1000, PWR (w15x15) CANDU

-1000,

PWR (w15x15)

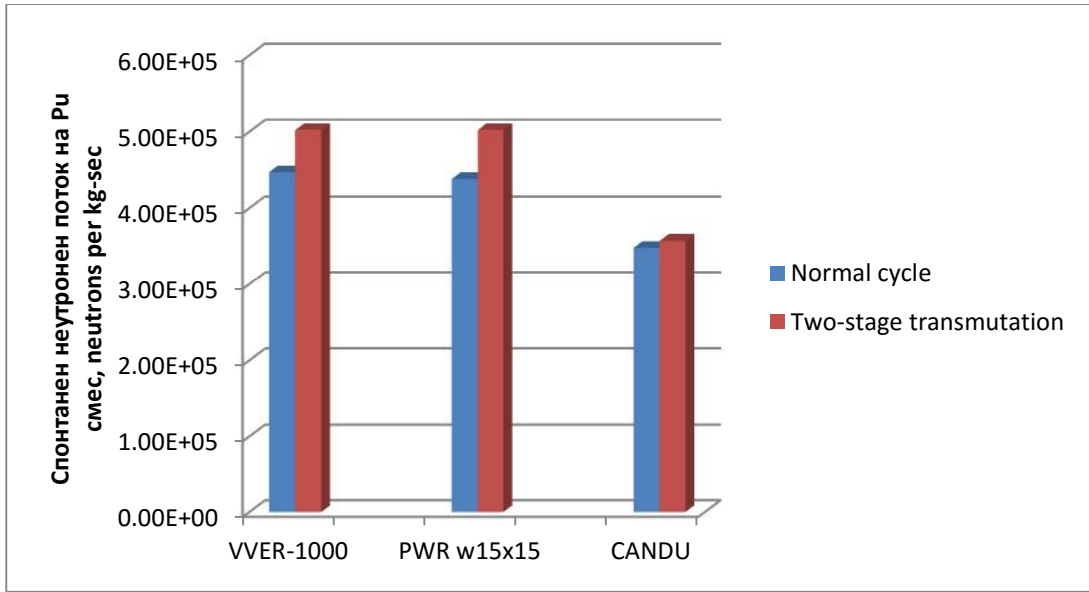
CANDU.

-238

CANDU

PWR (w15x15) e (14.6%),

- 2.8%.



2.

Pu

-1000, PWR (w15x15) CANDU

3

, PWR (w15x15)

PWR (w14x14),

-1000

CANDU,

3.

PWR (w15x15)

PWR

(w14x14),

-1000

CANDU

| | PWR (w15x15)/PWR (mox14x14) | | VVER-1000/CANDU | |
|----------------------|-----------------------------|-----------------|-----------------|-----------------|
| <i>Pu</i> | | | | |
| <i>Pu</i> 238 | 3.05% | 3.07% | 3.05% | 3.93% |
| <i>Pu</i> 239 | 49.67% | 39.00% | 49.02% | 33.64% |
| <i>Pu</i> 240 | 24.63% | 30.96% | 24.40% | 33.62% |
| <i>Pu</i> 241 | 14.75% | 17.29% | 14.94% | 11.36% |
| <i>Pu</i> 242 | 7.90% | 9.68% | 8.56% | 17.45% |
| <i>Pu</i> , watts/kg | 20.3 | 20.8 | 20.3 | 25.4 |
| <i>Pu</i> , kg/sec | 4.38E+05 | 5.26E+05 | 4.47E+05 | 7.05E+05 |

PWR,

, ()

PWR,

20%

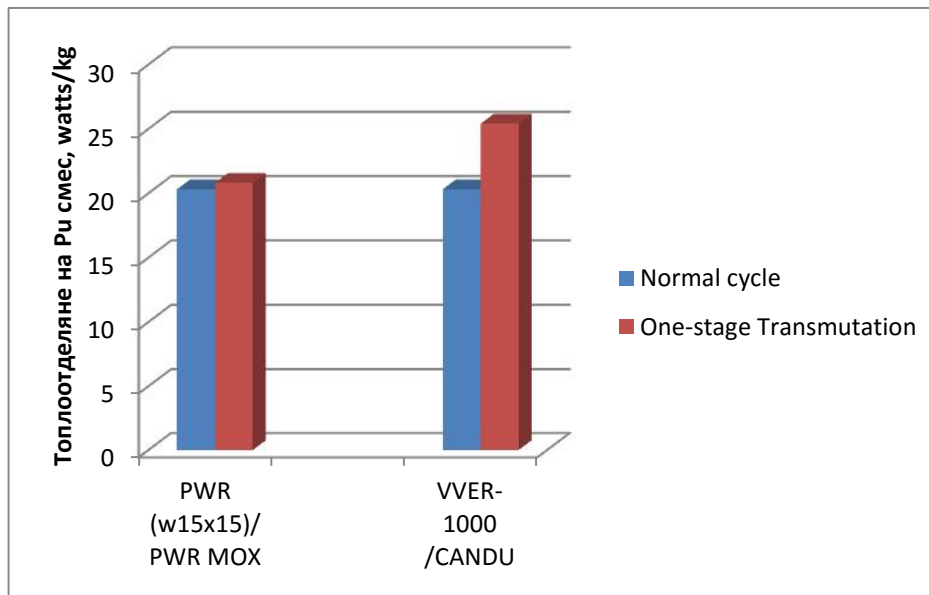
240 , -
 -240.
 2.2%,
 -237 (-237),
 -238.
 CANDU
 CANDU . DUPIC

(Direct Use of spent PWR fuel In Candu),

CANDU,

[5].

58%
 25%
 CANDU
 3 4.



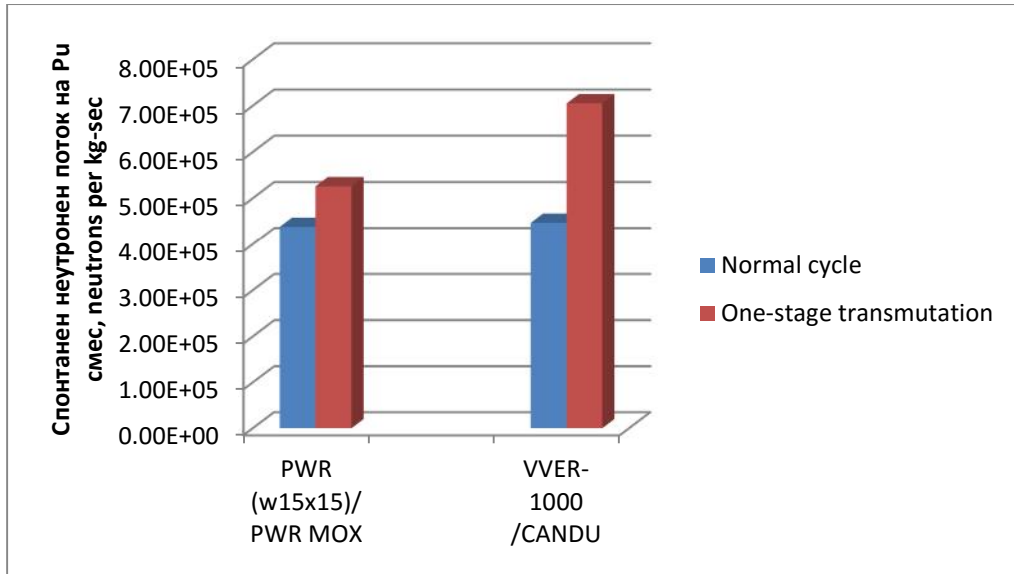
3.

PWR (w14x14),

-1000

Pu
 PWR (w15x15)

CANDU



4.

Pu
PWR (w15x15)
PWR (w14x14), -1000 CANDU

7.

(MARA),
 -237 -241
 ;
 • ;
 • , /
 • ;
 240/ -238/ -
 , MARA

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