The contribution of radioisotopes in secular equilibrium in the Transport Index of fissile uranium compounds in different enrichments

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Abstract

This work shows the contribution of radioisotopes in secular equilibrium in the transport index (TI) of some fissile uranium compounds: uranium oxides UO_2, U_3O_8 and uranium silicide U3Si$_2$, taking into account the different enrichment grades.The range of enrichment (E%) studied was 3,4,5,7,10,20,30,40,50,93 and 100.

Initially, the cell of optimum moderation ratio was built, since it represents the most reactive of the system (consisting of uranium), with maximum infinitive multiplication factor k∞,in certain concentration of uranium for each enrichment. This was made using the computer program Gamtec II.

The critical radius of a sphere was calculated for a cell of optimum moderation ratio, in order to calculate the critical mass of the uranium compound or of the uranium element for each specific enrichment. For this the program Citation was used. In this study it was calculated the smallest critical mass of the uranium compound or the smallest critical mass of the uranium element.The objective was to match the largest mass of the uranium with each specific enrichment..The largest safety mass corresponds to 45% the critical mass the compound uranium or uranium element.

Then, we calculated the uranium element safety mass, which it related to a fifth of this mass to the value 50, which corresponds to criticality safety index (CSI).That is, 20% of the safety mass is the value where the transport is carried out with subcritical mass, going in favor of the security.

From the uranium element safety mass (USM) was determined for each enrichment , and it was calculated the mass of ^{235}U, activity ^{235}U and dose rate of ^{235}U, the same items were calculated for the isotope ^{238}U

.The total dose rate was calculated for two isotopes, and applying the transport index definition as the gamma dose rate for the distance of 1m from the packed, it was determined the TI for 20% of the safety mass for each enrichment of the compound studied.

The study of radioisotopes in secular equilibrium have been made with the thorium ^{234}Th and protactinium ^{234}Pa of the uranium series, whose secular equilibrium happens in 100 days.

The actinium series the secular equilibrium with ^{235}U happens after 100 hours.Thus, there was the contribution of these radioisotopes in secular equilibrium in the transport index of compounds UO_2 and U_3Si_2 or uranium element, for each enrichment up to 10% and the U_3O_8 up to 20% of enrichment.

KEYWORDS:fissile uranium compounds. transport index ,enrichment, safety mass, secular equilibrium.

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TABLE 1-Results total dose rate, $\dot{H}$, Transport Index, TI Criticality Safety Index, CSI, to UO$_2$ from uranium safety mass. (USM= uranium safety mass).

E%	USM (kg)	1/5USM (kg)	Mass ^{235}U(g)	MBq ^{235}U	$\dot{H}$ ^{235}U mSv/h	MBq ^{238}U	$\dot{H}$ ^{238}U mSv/h	$\dot{H}$ Total mSv/h	TI	CSI
3	48,0	9,6	288,0	22,8	4,2E-04	115,0	24 E-04	2,8E-03	0,3	1,5
4	24,5	4,9	196,0	15,0	2,7E-04	58,0	12 E-04	1,5E-03	0,2	2,0
5	16,5	3,3	165,0	13,0	2,3E-04	38,7	81 E-05	1,0E-03	0,1	2,5
7	9,9	1,98	138,0	11,0	2,0E-04	23,0	48 E-06	6,6E-04	0,0	3,5
10	5,9	1,18	118,0	9,0	1,6E-04	13,0	27 E-05	4,3E-04	0,0	5,0
20	2,3	0,46	92,0	7,3	1,3E-04	4,5	94 E-06	2,2E-04	0,0	10,0
30	1,4	0,28	84,0	6,0	1,1E-04	2,4	50 E-06	1,6E-04	0,0	15,0
40	1,05	0,21	84,0	6,0	1,1E-04	1,5	31 E-06	1,4E-04	0,0	20,0
50	0,78	0,16	80,0	6,0	1,1E-04	0,9	2,0 E-05	1,3E-04	0,0	25,0
93	0,36	0,07	65,1	5,1	9,3E-05	0,1	21 E-07	9,5E-05	0,0	46,5
100	0,35	0,07	70,0	5,0	9,2E-05	------	-------	9,2E-05	0,0	50,0

TABLE 2 – CONTRIBUTION OF RADIOISOTOPES IN SECULAR EQUILIBRIUM IN THE TRANSPORT INDEX OF UO$_2$

E%	TI	TI in secular equilibrium	Contribution of radioisotopes
3	0,3	2,2	1,9
4	0,2	1,2	1,0
5	0,1	0,7	0,6
7	0,0	0,4	0,4
10	0,0	0,2	0,2
20	0,0	0,0	0,0

OBS:These tables are to explain my abstract.