

Molecular Hydrogen Yields from the Alpha Self-Radiolysis of Nitric Acid Solutions Containing Plutonium or Americium

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Table 1. Isotopic composition of plutonium stocks.

	²³⁸ Pu (%)	²³⁹ Pu (%)	²⁴⁰ Pu (%)	²⁴¹ Pu (%)	²⁴² Pu (%)	²⁴¹ Am (%)	specific α - decay power (MeV g ⁻¹ s ⁻¹)
Isotope specific activity (Bq g ⁻¹)	6.34×10 ¹¹	2.30×10 ⁹	8.42×10 ⁹	3.81×10 ¹²	1.46×10 ⁸	1.27×10 ¹¹	-
α -branching ratio (%)	100	100	100	0.00245	99.9995	100	-
α -decay energy (MeV)	5.487	5.149	5.155	4.816	4.890	5.479	-
Pu1-Pu11	0.26	70.20	24.06	3.50	1.18	0.80	3.34×10 ¹⁰
Pu12-Pu29	0.18	72.63	23.26	2.77	0.93	0.22	2.65×10 ¹⁰
Pu30-Pu33	0.33	66.20	27.01	3.98	1.54	0.95	3.77×10 ¹⁰

Table 2. Plutonium experiments: experimental conditions and calculated $G(H_2)_a$ values.

expt.	total nitrate ^a (mol dm ⁻³)	total sulphate (mol dm ⁻³)	[Pu] (g dm ⁻³)	[Pu] (mM)	$G(H_2)_a$ (molecules 100 eV ⁻¹)
Pu1	8.4×10^{-3}	0.75	11.7	48.9	1.06 ± 0.07
Pu2	1.0×10^{-3}	0.75	11.7	48.9	1.06 ± 0.06
Pu3	1.8×10^{-4}	0.75	11.7	48.9	1.11 ± 0.06
Pu4	3.0×10^{-2}	0.75	11.7	48.9	1.08 ± 0.07
Pu5	5.0×10^{-2}	0.75	11.7	48.9	0.96 ± 0.06
Pu6	8.0×10^{-2}	0.75	11.7	48.9	0.93 ± 0.00506
Pu7	1.0×10^{-1}	0.75	11.7	48.9	0.97 ± 0.06
Pu8	1.5×10^{-1}	0.75	11.7	48.9	0.87 ± 0.06
Pu9	2.0×10^{-1}	0.75	11.7	48.9	0.82 ± 0.06
Pu10	7.8×10^{-1}	0	12.8	53.3	0.64 ± 0.04
Pu11	1.28	0	12.8	53.3	0.46 ± 0.04
Pu12	2.24	0.0	38	160	0.19 ± 0.01
Pu13	2.14	0.0	38	160	0.19 ± 0.01
Pu14	2.36	0.0	3.8	16	0.18 ± 0.02
Pu15	2.35	0.0	3.8	16	0.19 ± 0.01
Pu16	2.38	0.0	0.38	1.6	0.16 ± 0.01
Pu17	2.41	0.0	0.38	1.6	0.16 ± 0.02
Pu18	2.47×10^{-1}	0.75	38	160	0.78 ± 0.06
Pu19	2.47×10^{-1}	0.75	38	160	0.85 ± 0.05
Pu20	2.26×10^{-1}	0.05	3.8	16	0.85 ± 0.05
Pu21	2.26×10^{-1}	0.75	3.8	16	0.92 ± 0.05
Pu22	2.31×10^{-1}	0.83	0.38	1.6	0.86 ± 0.07
Pu23	2.34×10^{-1}	0.83	0.38	1.6	0.89 ± 0.07
Pu24	5.49×10^{-3}	0.75	38	160	1.15 ± 0.07
Pu25	5.49×10^{-3}	0.75	38	160	1.11 ± 0.07
Pu26	4.55×10^{-3}	0.83	3.8	16	1.34 ± 0.07
Pu27	4.55×10^{-3}	0.83	3.8	16	1.39 ± 0.08
Pu28	4.49×10^{-3}	0.83	0.38	1.6	1.29 ± 0.09
Pu29	4.35×10^{-3}	0.83	0.38	1.6	1.28 ± 0.09
Pu30*	0.1	0	0.06	0.26	0.85 ± 0.03
Pu31*	1.0	0	0.06	0.25	0.33 ± 0.02
Pu32*	4.0	0	0.05	0.23	0.10 ± 0.01

Pu33*	6.0	0	0.05	0.21	0.06 ± 0.003
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^a Total nitrate concentration includes the contribution from plutonium nitrate and nitric acid.

*Single hydrogen sampling measurement method.

Table 3. Americium experiments: experimental conditions and calculated $G(H_2)_a$ values.

expt.	total nitrate ^a (mol dm ⁻³)	total sulphate (mol dm ⁻³)	[Am] (g dm ⁻³)	[Am] (mM)	$G(H_2)_a$ (molecules 100 eV ⁻¹)
Am1	3.0×10^{-2}	0.75	0.015	3.6×10^{-3}	1.27 ± 0.15
Am2	3.0×10^{-2}	0.75	0.015	3.6×10^{-3}	1.41 ± 0.09
Am3	8.2×10^{-4}	0.75	0.015	3.6×10^{-3}	1.42 ± 0.13
Am4*	0.10	0	0.015	3.6×10^{-3}	0.95 ± 0.05
Am5*	1.0	0	0.015	3.6×10^{-3}	0.34 ± 0.02
Am6*	3.0	0	0.015	3.6×10^{-3}	0.11 ± 0.01
Am7*	6.0	0	0.015	3.6×10^{-3}	0.08 ± 0.01

^a Total nitrate concentration includes the contribution from plutonium nitrate and nitric acid.

*Single hydrogen sampling measurement method.

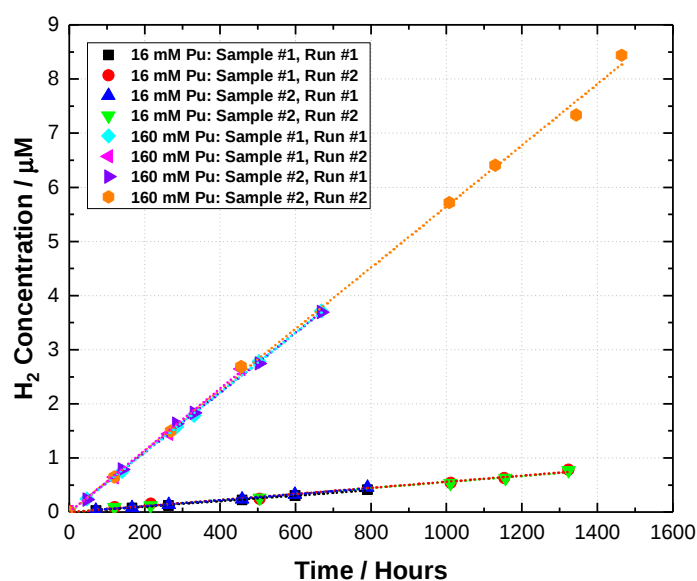


Figure 1. Example plot of measured molecular hydrogen generated over time for duplicate solutions and repeat measurements.