Title
19F(α,n) thick target yield from 3.5 to 10.0MeV

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Addendum to "^{22}Na production cross sections from the ^{19}F (α,n) reaction"

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In 1984, we reported ^{22}Na production cross sections based on measurements of thick-target neutron yields from the ^{19}F(α,n) reaction. Recently, there has interest in knowing the actual thick-target yields for applications such as assaying contents of UF_6 canisters using passive neutron counting techniques.[1,2] Here we report the results of our original thick-target neutron yield measurements over the energy range of E_α = 3.5 – 10.0 MeV. As stated in our original paper and described in more detail in Ref. 3, we used several different techniques to determine our neutron detection efficiency to be 5.5 $\pm$ 0.3 % independent of neutron energy over the range we studied. One of these methods was to bombard a thick PbF_2 target with 10.0 MeV alpha particles. The neutron yield was measured during this bombardment and later the target was gamma counted to determine the ^{22}Na activity produced. The gamma-ray detection efficiency was determined using two different calibrated ^{22}Na sources. The neutron detection efficiency determined in this manner agreed to within $\pm$ 3.5% with those obtained by our other techniques.

In Table I we report our thick-target neutron yields as measured from a PbF_2 target. We then used the stopping powers of Andersen and Ziegler[4] to convert these yields into those expected from alpha bombardments of thick F_2 and UF_6 targets. Although we both used PbF_2 targets, our inferred results for F_2 are systematically higher than those of Bair and Gomez del Campo[5] by amounts that range from 54% to 35% as E_α increases from 4 to 8 MeV. These differences could, at least in part, be due to differences in the stopping powers used. Note that Bair and Gomez del Campo did not report their measured PbF_2 yields or those expected from UF_6. However, as pointed out by Heaton *et al.*[6], our results are in good agreement with those of Feige *et al.*[7], as well as those reported by Sampson[8]. We also checked our technique by measuring thick-target (p,n) yields from Cd, Ta, and Pb at proton energies ranging from 5.5 to 9.5 MeV and comparing our results to those of Elwyn *et al.*[9]. Our data agree with those of Elwyn *et al.* to within $\pm$ 2.5%. We thus are confident of our results and believe that our thick-target neutron yield from UF_6 will be useful for assay applications.

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Table I. Thick-target neutron yields from alpha-particle induced reactions in units of neutrons per 10^6 alphas. Uncertainties are estimated to be ± 5%. Alpha energies are given in the laboratory frame. Note: 9.00E-2 = 9.00×10^{-2}.

E_α (MeV)	Target		
	PbF_2	F_2	UF_6
3.50	9.00E-2	2.65E-1	1.54E-1
3.75	2.08E-1	6.17E-1	3.58E-1
4.00	4.11E-1	1.23E+0	7.11E-1
4.25	6.17E-1	1.84E+0	1.07E+0
4.50	1.02E+0	3.06E+0	1.77E+0
4.75	1.50E+0	4.52E+0	2.61E+0
5.00	1.96E+0	5.92E+0	3.41E+0
5.25	2.66E+0	8.07E+0	4.64E+0
5.50	3.45E+0	1.05E+1	6.03E+0
5.75	4.37E+0	1.33E+1	7.62E+0
6.00	5.31E+0	1.62E+1	9.28E+0
6.25	6.68E+0	2.05E+1	1.17E+1
6.50	8.00E+0	2.46E+1	1.40E+1
6.75	9.40E+0	2.89E+1	1.65E+1
7.00	1.08E+1	3.34E+1	1.90E+1
7.25	1.28E+1	3.96E+1	2.25E+1
7.50	1.46E+1	4.51E+1	2.56E+1
7.75	1.66E+1	5.12E+1	2.91E+1
8.00	1.86E+1	5.76E+1	3.27E+1
8.25	2.05E+1	6.36E+1	3.60E+1
8.50	2.23E+1	6.90E+1	3.90E+1
8.75	2.43E+1	7.56E+1	4.27E+1
9.00	2.65E+1	8.24E+1	4.66E+1
9.25	2.90E+1	9.01E+1	5.09E+1
9.50	3.12E+1	9.73E+1	5.49E+1
9.75	3.42E+1	1.06E+2	6.00E+1
10.0	3.64E+1	1.13E+2	6.39E+1