Electrochemical Method for Production of Bromine-82 Radiotracer in Organic Phase for Use in Oil Industry

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Keywords: electrochemistry, radiotracer bromine-82, organic compound labelling.

This report presents a methodology was performed by means of the electrochemical oxidation reaction of bromide ions, in the chemical form of potassium bromide (KBr). The bromine-82 isotope was obtained by neutronic activation, the procedure was carried out using the Argonauta reactor. The electrochemical synthesis is a process of non-spontaneous reaction, where the migration of chemical species is related to the supply of a voltage value to the system in order to reach the oxidation potential of the chemical species for the reaction to occur [1]. In the present work, the organic phase labelling process with radioactive isotope bromine-82 requires the conversion of bromide ions (Br-) into bromine (Br2), by a halogenation process. The bromine obtained as is inserted in the carbonic chain of oil derived from petroleum [2, 3].

Figure 1. Representation of the experimental apparatus of electrochemical synthesis for organic phase labeling with bromine-82

Approximately 5g of potassium bromide salt was irradiated in the Argonauta reactor, for 240 minutes with a neutron flux of 10^9 n cm^{-2} s^{-1}. The organic and aqueous phase samples from the experiments were taken at intervals of 7.5 minutes up to the limit of 45 minutes, with a volume of 0.5mL. The samples were analyzed, in the Radiopharmaceuticals Division – DIRA, using the gamma spectrometry technique with the Hight Purity Germanium Radiation Detector CANBERRA, model: 2530. The sample analysis time was set to 20 minutes. The Table 1 shows as a result the rate of consumption of bromide ions in solution.

Table 1 - Results regarding the gamma spectrometric analysis of organic phase samples

Interval (minute)	γ = 0,547 MeV			γ = 0,787 MeV			γ = 1,35 MeV		
	CPS*	Area	% error	CPS	Area	% error	CPS	Area	% error
7,5	1589	10290	0,59	1369	9652	0,91	115	891	0,8
15	1606	10314	0,84	1406	9620	0,87	153	1208	0,82
22,5	1646	13421	0,73	1534	10988	0,84	220	1783	0,81
30	1898	18218	0,83	1652	20140	0,85	305	3642	0,9
37,5	1964	19235	0,75	1705	20416	0,9	322	3521	0,82
45	1974	19751	0,78	1723	20732	0,87	331	3637	0,88

*CPS: Counts per second

An initial sample of the aqueous phase was taken at initial time (t_0) as a reference value for analysis of subsequent samples. In the organic phase no sample was taken, because at this time the bromine-82 was dispersed in the electrolyte in aqueous phase. The results obtained after the analysis of the samples in the hyperpure germanium detector of the photopics in the energies 0.547; 0.777 and 1.35 MeV. The samples was analysed by triplicate. The yield was calculation based on the area of the count curve relative to sample which corresponds to the end of the experiment. The area of the photopeaks was calculated, which corresponds to 56.43%, 60.96% and 56.42%, thus having the average value of 57.94%, which was considered the yield obtained. Based on the results, the proposed methodology is feasible to produce bromine-82 radiotracer in organic phase for industrial use.

References

[1] VOGEL, A. Química Analítica Quantitativa (1981).
[2] RAO, V.R.S, ERDTMANN, M.G, PETRI, H. Preparation of radioactive bromamine-t by isotope exchange with radioactive bromine (1989).
[3] CHOPPIN, G., LILJENZIN, J., RYDBERG, J., EKBERG, C. Radiochemistry and Nuclear Chemistry (2013).