Metrological Measurement of ^{99m}Tc Half-life Radionuclide by Germanium Detector

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Abstract: An approach for half-life determination using gamma spectrometry with Ge detector is presented. This measurement reduces the contribution of the type B component on the total uncertainty. The independence of the method with respect to the instrumental interferences or radiochemical impurities was evidenced. The method shows no limitations for the measurements of samples containing a genetically related impurity of concentrations below than 3% with the same energy or very close to the one of the radionuclide to be measured, e.g.,^{99}Mo in a^{99m}Tc sample. The results of half-lives are in good agreement with the literature and the associated uncertainties lower than 0.1 %.

1. Introduction

In the nuclear medicine, the accurate determination of the half-life of radionuclides is important, therefore it contributes for damages reduction caused to the patient during the diagnosis or treatment, due to an unnecessary exposition, causing loss of time, some discomfort and damages to the health. The accurate knowledge of the half-life will advantage the application of futures radiopharmaceuticals, which will be able to replace or become an alternative for those used nowadays, as much in the area of radiodiagnostic as in the radiotherapy, aiming at better results in the exams and a smaller cost of production of the radiopharmaceuticals.

To determine the activity of a radionuclide, independently of the application or purpose, it is necessary to know its half-life and associated uncertainty.

In the recent years, there was an increasing interest in the accurate determination of half-life of gamma emission radionuclides through the spectrometric technique with germanium detector. A Ge detector has a high capability to discriminate energy lines, becoming less dependent of factors as background and instrumental fluctuations. This method has also the advantage to identify qualitatively and quantitatively radiochemical impurities of gamma radiation usually present in the samples to be analyzed.

2. Methodology

Radionuclide to be measured is ^{99m}Tc, it is characterized by gamma emission and has about 6 h of half-life. A procedure for preparation of the liquid sources was adopted. It was used one ampoule source with radioactive solution. One of the spectrum is shown in figure 1.

In half-life determination for ^{99m}Tc the most intense gamma energies was used: 140.5 keV (89.1 %).

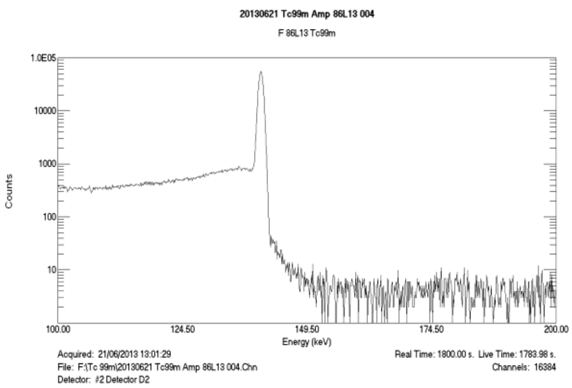

Figure 1: The ^{99m}Tc source spectrum

3. Results

For the set of spectra a graphic ln C versus real time of counting was obtained (C=counting rate). This real time was corrected for the start of counts (figures 2). After computing this data, the half-life value of the radionuclide was determined.

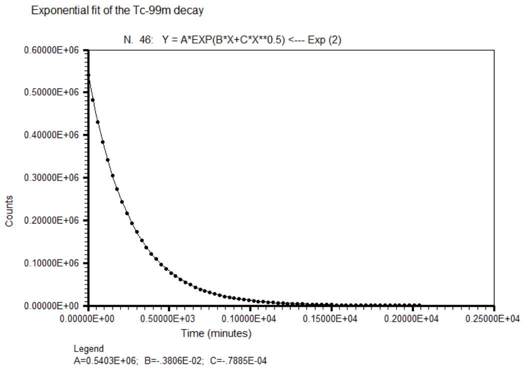

Figure 2: Exponencial fit of ^{99m}Tc decay

After 138 counting set fot the activity decay, it was obtained 6.0088 (5) h of half-life to ^{99m}Tc. The A and B component uncertainties are considered. However, the half-life expected from LNHB is 6.0067 (10) h. Here, it can be evidenced that the determined value of half-life is in good agreement with that published values in the literature.

4. Conclusions

The results obtained show that this method using the gamma spectrometry allows one to determine with accuracy radionuclides half-lives.

With the counting conditions established here for the related method made it possible a reduction in the total value of the uncertainty in the determination of the half-life, while the influence of the B-type component was practically neglected.

It was demonstrated also that when the impurity possess energy line equal or very close to that one radionuclide to be analyzed, the method depends on the previous knowledge of the impurity.

5. References

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