

The Characteristics of the CH Number Method in Liquid Scintillation Counting

Wu Xue Zhou

ABSTRACT

The main characteristics of the CH number method in liquid scintillation counting is described in the paper. The CH number method is compared to the methods of H number channel ratio, and spectral index widely used in liquid scintillation counting.

Key words: CH number, H number, spectral index, channel ratio.

INTRODUCTION

Liquid scintillation counting is widely used in many fields. It is an important method in radionuclide metrology. This chapter describes a new approach to measure zero probability and radionuclide activity.^{1,2} Four (LS)-coincidence national standards have been established with which ^3H (hexadecane), ^{14}C (hexadecane), and tritium water national standards solution are calibrated.

A new quench monitor method—CH number method 3 was described for measurement of ^3H and ^{14}C activity. The relative measurement of radionuclide activity with LSC and calibration of a series of quenched standard are now being researched, particularly for quench monitor method.

The research of quench monitor method in LSC is very important. At present there is H number, spectral index, and channel ratio etc. in most popular quench monitor methods.

The characteristics of CH number method will be introduced here, and a comparison of CH number with other quench monitor methods will be made.

The combined uncertainty of radionuclide activity measurement with CH number method is small, an important parameter for radionuclide metrology.

The uncertainty in measurement results generally consists of several components that may be grouped into two categories according to the way in which their numerical value is estimated: 1. Those evaluated by applying statistical method to a series of repeated determinations and 2. those evaluated by other means.

Table 1.

Quench Monitor Method	Uncertainty Component of	
	A (%)	B (%)
CH number	0.20	0.10
Channel ratio	0.60	0.45
H number	0.50	1.06
Spectral Index (tSIE)	0.40	0.86

CH number method is a new quench monitor method in LSC; it is a relative measurement method. The components of B must include a component (about 1%) due to activity measurement of a series of quenched standards. It has to be excluded, when combined uncertainty of measured radionuclide activity is compared with different quench monitor methods to obtain an efficiency calibration curve, with which the activity of a quenched standard series is measured. The components of A and B for measured activity of a series of quenched standards would be obtained with CCl_4 as quench agent. The glass vial has two types made separately in China and the U.S. A series of quenched standards generally consists of ten sources with different of quench agents.

The results of measured activity of a series of quenched standards are shown in Table 1.

Because the content of quench agents is different with different series of quenched standards, the uncertainty component of measured activity is not quite exact.

Independent of Color Quench with CH Number Method

Measured samples usually have color, so it is important to measure the color sample activity. The CH number method measures the activity for a series of color quenched standards which make up the efficiency calibration curve. The color quenched agent is methyl red, the content of which is from 0 to 300 L. The results of measured activity of a series of color quenched samples is shown in Table 2.

Table 2 shows that the difference between the mean result of measured

Table 2.

Number of Series	Standard Deviation of Mean (%)	Difference Between the Mean of Measurement of Activity of a Series Standards and Standard Value (%)
88092721 —29	0.20	—1.10
88092221 —31	0.20	—0.54
88092721 —29	0.37	—0.70

activity of a series of colour quenched sample with CH number method and standard value is about 1%. The other is quite large.

Independent of Volume Sample with CH Number Method

Different cocktail volumes may affect activity measurement, but not for the CH number method. The three ^3H cocktail sample volumes (10 mL, 6.6 mL, and 4.4 mL) are measured by CH number and tSIE. The maximum difference between activity of the three samples was 2% for CH number method, and 3.4% for tSIE.

Independent of Vertical Position of Sample Measured

The vertical position of sample measured is varied from 0 to 23 mm. Maximum variation of measured sample activity with CH number method is about 0.6%. Because the phototube is symmetrical, the sample position measured could be varied about 23 mm, without varying the results of measured activity.

Independent of High Count Rate with CH Number Method

Measuring the activity of high sample count rate reduces statistical count and saves measurement time in radionuclide metrology. When counting a sample with high activity, the counting uncertainty is reduced, allowing for a more statistical measurement within a given measurement. The count time for high activity samples can be reduced and still yield good counting statistics; whereas, lower activity samples require longer count times to produce similar statistics. A series of quench standards, total activity 1700 Bq, were used to determine the activity of a sample containing 3800 Bq. The measurement results were unaffected.

The activity of short half-life radionuclides are also measured with CH number method. Many short half-life radionuclides are very useful, particularly many electrical capture radionuclides widely used in medicine. The correction of short half-life radionuclide decay is considered in calculation programs of the CH number method. The uncertainty component due to half-life measurement is the only need to consider.

Tritium water activity is measured with an efficiency calibration curve calibrated with ^3H n-hexadecane series of quenched standards. Also measured activity of ^{60}Co is used with a ^{14}C n-hexadecane efficiency calibration curve. The difference between measurement result of activity and standard value is less than 3% for tritium water and ^{60}Co .

CH number method is a new quench monitor method that has many advantages over other methods. It also has other advantages which would be researched further.

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REFERENCES

1. Song, L., X.Z. Wu, et al. *Nucl. Inst. and Meth.* 175:503 (1980).
2. Wu, X.Z., L. Song, et al. *Int. J. Radiat. Appl. Instrum. Part A* Vol 38, No 10:891 (1987).
3. Wu, X.Z., *Nucl. Elec. and Det.* (in press).