

Internal Memo
School of Nuclear Engineering
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Date: February 20, 2004
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To: Professor Rusi Taleyarkhan
Subject: Report on the data verification and analysis of the counting data from Beckman liquid scintillation counter.

1. Introduction

The following is the report based on study of the data from Beckman liquid scintillation counter. The data set includes counting results and the analysis carried out on these data.

I had two meetings with (Dr.) Yiban Xu on February 13, and February 14 for this particular task.

The following information/data was available for this task.

The data tables considered for this report include the followings:

(1) The counting results from the Beckman liquid scintillation counter for the experiments listed below with Sample ID.

Table 1. Irridiation/cavitation Tests

Total 4 vial samples; Two for Post and Two Pre irradiation/cavitation tests

Sample ID	Source
D-Acetone 7 hr run 9/19/03	1Ci Pu-Be
D-Acetone 7 hr run 9/24/03	1Ci Pu-Be
D-Acetone 7 hr run 9/26/03	1Ci Pu-Be
D-Acetone 7 hr run 10/3/03	1Ci Pu-Be
D-Acetone 7 hr Run 10/8/03	1Ci Pu-Be
D-Acetone 7 hr run 10/27/03	10 Ci Am-Be
D-Acetone 7 hr run 10/31/03	10 Ci Am-Be
D-Acetone 7 hr run 11/3/03	10 Ci Am-Be
D-Acetone 7 hr run 11/7/03	10 Ci Am-Be
D-Acetone 7 hr Run 11/14/03	10 Ci Am-Be
N-Acetone 7 hr run 9/18/03	1Ci Pu-Be
N-Acetone 7 hr run 10/15/03	1Ci Pu-Be
N-Acetone 7 hr run 10/18/03	1Ci Pu-Be

The Basic Data:

The tables present counting data for each set of vials a total of 10 set of counts in CPM each with 10 minutes counting time. The tables include the ultra-gold cocktail counts as well. The table includes the H# for each count both for ultra-gold sample as well as for

the four samples of D-Acetone/N-acetone. The table also includes the masses of the vials plus cocktail and vial plus cocktail plus acetone.

Analyzed/Calculated Data

The calculated data include DPM, Poisson and Gaussian standard deviation, average values of CPM and DPM, Poisson and Gaussian standard deviation, mass of the acetone, background subtracted CPM and DPM per unit gm (background corrected CPM and DPM with equation : Mean CPM- 0.8* Mean CPM for cocktail) and their Poisson and Gaussian standard deviations, averaged CPM, DPM per unit gm and Poisson and Gaussian standard deviation.

(2) The calculation equations for the mean, Poisson and Gaussian standard deviations, CPM/gm.

(3) Table and Graph of the H# vs counter efficiency (%).

(4) Data table on D-Acetone mass variation and CPM for the following set of measurements

Table 2. Mass Effects on Counting Tests

Sample ID	D-Acetone Volume
2-07-04-1	0.9 mL
2-07-04-2	1.0 mL
2-07-04-3	1.1 mL
2-07-04-4	1.2 mL

This table consists of the basic data on CPM for ten sets of counts, H#, Ultagold CPM and mass data on vial plus cocktail, and vial plus cocktail plus acetone. Processed data include DPM, Poisson and Gaussian standard deviations, averaged CPM and DPM and their Poisson and Gaussian standard deviations, mass of the acetone, background corrected CPM and DPM with equation (Mean CPM- 0.8* Mean CPM for cocktail)

(5) Summary table of the Pu-Be irradiation test with D-acetone, all the tests shown in Table 1 and aggregate result of all D-Acetone irradiation/cavitations tests for D-Acetone

2. Procedures

Data Check:

Each of the above stated data/information was cross checked with the raw data. The copies of the raw data, the print outs from the Beckmann machine, were compared with the tabular data on the excel files. Each data point was verified with Yiban Xu. Some tables were repeat checked for the redundancy and accuracy.

Calculations Check:

The basic equations used in the calculation equations of the mean, Poisson and Gaussian standard deviations, mass, CPM and DPM per gm, background subtraction method were checked.

The excel files were checked for the correctness of these equations and were cross checked with a calculator for some calculations results with the excel file results.

3. Assessment

The following assessment is arrived having followed the above listed procedure and examination of the data.

- (1) The plot of the H# vs the efficiency percent agrees with the data of the calibration of the Beckmann machine. This is used in DPM value calculations.
- (2) The data of the tests in Table 1 were all checked and few entry errors were identified. These were corrected by Yiban Xu. Thus the raw data for the tests on Table 1 have been verified and have the numbers corresponding to original machine output raw data.
- (3) The calculated/processed data of the CPM, in terms of DPM through H# vs efficiency calibration are correct.
- (4) The averaged CPM and DPM per gm values are correct as per calculation method used.
- (5) The Poisson and Gaussian standard deviations calculated values are correct as per calculation method used.
- (6) The procedure for background subtraction for the CPM and DPM based the following equation (Mean CPM/DPM- 0.8* Mean CPM/DPM for cocktail) was used and why a factor 0.8 was used was not clear. However as a procedure to calculate based on these equations were correct.
- (7) The raw data for the tests in Table 2 were all checked and were verified and have numbers corresponding to the machine output data.
- (8) The calculations of the CPM and DPM, Poisson and Gaussian standard deviations for test of Table 2 were verified and are correct as per calculation method used.
- (9) The plots of the CPM/gm vs D-acetone mass, $(\text{CPM} - 0.8 * \text{Bkgground}) / \text{gm}$ vs D-acetone mass, DPM/gm vs D-acetone mass, and $(\text{DPM} - 0.8 * \text{Bkgground}) / \text{gm}$ vs D-acetone mass were verified.
- (10) The consolidated table of the Pu-Be irradiation test with D-acetone, all the tests shown in Table 1 and aggregate result of all D-Acetone irradiation/cavitations tests for D-Acetone was checked and some minor entry corrections were identified and the corrected table was examined. The processed data is verified.

(Rusi , I have mailed you my corrections, in file BeckmanPurdue(Final)-Rusi-Rev1.exl to this table, though they are minor, which are shown in red color on the excel files)

4. Conclusions

- (1) Based on the examination of the data, verification of the data, calculation method and processed data, the data are verified to be correct and agree with the original Beckman machine output.
- (2) The controlled D-acetone irradiation alone test results show a net negative CPM and DPM changes with large Poisson and Gaussian errors.
- (3) The three controlled N-acetone with irradiation and cavitation show one positive (0.2 CPM, 1.025 DPM) change with large Poisson (0.78) and Gaussian (1.49) errors, and two negative CPM and DPM changes. The average results for the control N-acetone irradiation and cavitation tests show a net negative change in counts.
- (4) All the five D-Acetone irradiation and cavitation tests with 1 Ci source show a net positive change in CPM and DPM. The CPM changes are 3.8 SD and DPM changes are 4.5 SD.
- (5) In the D-Acetone irradiation and cavitation tests with 10 Ci source, three out of 5 tests show a net positive DPM changes and four out of 5 net positive CPM changes.
- (6) The aggregate results of all D-Acetone irradiation and cavitation tests show that 8 out of 10 test show a net positive DPM change. The CPM change is 2.83 SD and the DPM change is 3.4 SD Gaussian.
- (7) *The overall conclusion is that the tests results of D-Acetone irradiation and cavitation give a convincing evidence of net positive DPM change with about 4 SD Gaussian, whereas the N-Acetone irradiation and cavitation tests give a negative DPM change.*