Technical Review (12/01) by Michael Murray
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of

Nuclear Emissions During Acoustic Cavitation
by
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At the request of Dr. Taleyarkhan, I have reviewed the subject draft paper with a special focus on tritium production and measurement techniques. My expertise in tritium measurement is based on 20+ years of experience in nuclear counting laboratories and research in collecting and monitoring for tritium. While having used various methods for measuring tritium, most of my work involves using liquid scintillation counting which is the generally accepted method for measuring tritium in trace amounts. The Beckman 6500 liquid scintillation counter Dr. Taleyarkhan used for results reported in the manuscript is operated by the Life Sciences Division at Y-12 and represents the state-of-the-art in liquid scintillation counting apparatus; he also currently has for his work in his own laboratory the Beckman 5000 counter which was recently donated from my laboratory at the Dosimetry Applications Research (DOSAR) facility.

When collaborating on a different matter Dr. Taleyarkhan and the DOSAR staff recognized a common interest in nuclear measurements especially tritium. Tritium decays by beta emission of maximum energy 0.018 MeV. Given this low energy in a liquid matrix and at low concentration, liquid scintillation is the only practical measurement technique. The Beckman 5000liquid scintillation counter, although a good, reliable counter at DOSAR had been set aside and was only being used as a backup for a newer model (which has more interface-type capabilities). Drs. Taleyarkhan and Cho expressed an interest in acquiring the counter provided its performance satisfied their research needs. The counter was moved to building 9204-1 and a demonstration and a performance test was performed by me. These counters, when used with an appropriate cocktail (Ecolite) in borosilicate glass vials and operating procedures is capable of tritium analysis in the desired concentration ranges encountered by the research under review.

Previous to this review Dr. Taleyarkhan gave a tour of the laboratory where work described in the paper is being performed. The tour provided some insight and familiarity to the work, making this review more productive. The following comments and follow up actions are given for consideration.

1) Beginning on page 9 and in general -- Using units of "cpm" can lead to confusion and misinterpretations. Units of "cpm" are justified provided all other parameters are constant, i.e., sample volume, analysis volume, efficiency, instrument

settings, quenching, energy windows . . . Units of "dpm" or "dpm/g" are generally preferred. However, subsequent conversation and review revealed a concerted effort to only vary one parameter at a time and sufficient checks and balances are in place to monitor variances that may occur. Therefore, the use of cpm for relative change assessment is justified in this case.

2) Aliquots for tritium assay are collected using a syringe in the amount of one cc. A concern was initially raised by me about the potential error introduced when using a syringe to dispense acetone (a volatile liquid) in quantitative amounts. This practice could also potentially introduce confusion later if the normal assumption of one gram per cc is used in calculations (perhaps by an analytical laboratory) since the density for acetone is ~0.8 g/cc. When this issue was first raised, a quality control experiment was performed by the same staff dispensing the aliquots to show that any error introduced would be less than 1 percent, and well within one standard deviation of the data. This amount of error is certainly reasonable and can be used if necessary in an over all uncertainty analysis.

3) Page 8. 3rd para "65000" should be A6500"; minor typographical mistake of no significance to data or conclusions.

4) Page 9. middle of page --- I couldn't find the volume of the irradiated sample. This may not be important except to estimate the order of magnitude of neutrons produced by D-D reaction as mentioned in the last paragraph of page 9. Again, here it's important to know the tritium concentration in dpm/g and mass of the irradiated sample to validate the estimate of neutrons per second. To remedy this, the ~10^2 cc volume of the irradiated sample which was later communicated to me should be included in the next version.

The experimental procedure to detect tritium, monitor its production and draw conclusions from its presence have been well thought out and reasonable. The multiple tests and precautions taken are consistent with other research involving tritium. It appears obvious that many unstated details (such as independent verification on different machines, use of fresh syringes, changing one parameter at a time) were carried out as a matter of good laboratory practices. The analytical measurements for tritium reported in this paper were performed at laboratories outside of the experimental laboratory and with the availability of the liquid scintillation counter under the control of Drs. Taleyarkhan and Cho, more timely and consistent tritium measurements are possible.

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