Confirmation of Neutron Production During Self-Nucleated Acoustic Cavitation

Edward R. Forringer, David Robbins, Jonathan Martin

LeTourneau University, 2100 S. Mobberly Ave., Longview, TX 75602. tedforringer@letu.edu

INTRODUCTION

Evidence for acoustic inertial confinement nuclear fusion has been presented[1,2,3]. The authors of the present summary visited the meta-stable fluids research lab at Purdue University in order to independently test whether or not the previous results could be replicated. The test liquid used in the data presented here is a mixture of deuterated acetone (C3D6O), deuterated benzine (C6D6), tetrachloro-ethene (C2Cl4) and uranyl nitrate (UN).

EXPERIMENTAL SETUP

The setup for our experiments, shown in figure 1, is essentially the same as what has been used in successful demonstrations of self-nucleated acoustic inertial confinement nuclear fusion[1]. Notably, there is no external neutron source used as cavitation is triggered by alpha decay of the uranium nuclei. The test liquid was placed in a cylindrical glass vessel and driven with a sinusoidal frequency using a cylindrical lead-zirconate-titanate (PZT) piezoelectric crystal attached to the outside of the vessel.

Two types of detectors were used to identify neutrons. First, a fast rise time, NE-213 type, liquid scintillation (LS) detector was located 17 cm from the center of the vessel. Second, three CR-39™ plastic fast neutron detectors, which are insensitive to gamma rays, were used. Two plastic detectors were mounted on opposite sides of the vessel and a third was placed 70 cm away to measure background neutrons.

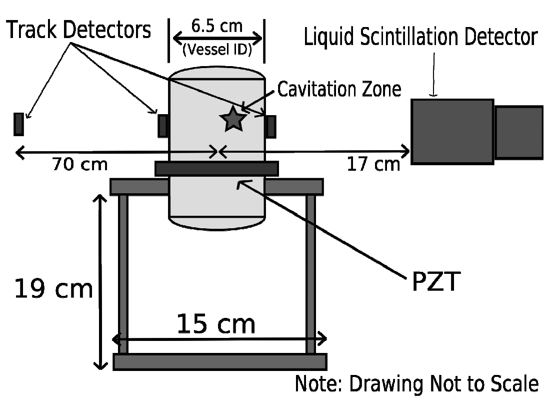

Fig. 1. Schematic representation of experimental setup

The PZT crystal was driven at the resonant frequency of the fluid in the vessel (between 18 and 19 kHz) as determined by maximizing the response received from a microphone attached to the vessel. When conditions were correct, cavitation of the fluid was observed as a pulse of sound whose amplitude was noticeably larger than the typical sound response from the system along with an audible "pop". These cavitation events occurred typically 3 to 9 times per second when the system was tuned properly.

RESULTS

Liquid Scintillation Detector

The LS detector was used with pulse shape discrimination (rejecting 93% of the gamma events while retaining the majority of fast neutrons). Table 1 shows the number of counts for cavitation on and off with deuterated and control (non-deuterated) liquids. For the deuterated case, counts measured with cavitation on were eight standard deviations above the background (no cavitation) level. For the control case (non-deuterated liquid), counts measured were within one standard deviation of the background level.

Table 1: Liquid Scintillation Detector Results

	Cavitation On	Cavitation Off	Difference
Deuterated Liquid	379	186	193±24
Control Liquid	131	146	-15±17

Figure 2 shows the pulse height spectrum (cavitation on minus cavitation off) of the events detected in the LS detector for deuterated and non-deuterated fluids. Calibration of the LS detector with gamma sources (Cs-137 and Co-60) showed that the 2.45 MeV proton recoil edge occurred at approximately channel 100. While most of the counts are consistent with neutrons below 2.45 MeV as expected from deuterium-deuterium fusion, some counts appear above channel 100. It is possible that these events represent gammas which were not rejected by the pulse shape discrimination.

It has been suggested[4] that the pulse height spectrum from acoustic inertial confinement nuclear fusion resembles the spectrum from a Californium-252 source (shown in figure 3 using the same LS detector). The authors of this report, being aware of this suggestion, were very careful to ensure that there were no sources present that could compromise our data. While the statistics from the data presented here are not sufficient to distinguish the neutron spectrum from the test apparatus from a Cf-252 spectrum there is an apparent difference. The Cf-252 spectrum is monotonically decreasing from channels 20 through 60 while the spectrum from the test apparatus appears fairly constant in that region. This region of the spectrum is important because it represents the energy range where the bulk of neutrons are expected from deuterium-deuterium fusion.

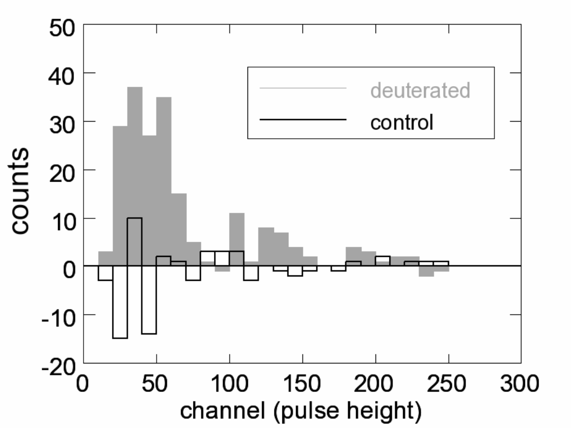

Fig. 2. LS detector pulse height spectrum for cavitation on minus cavitation off for deuterated and non-deuterated (control) liquids.

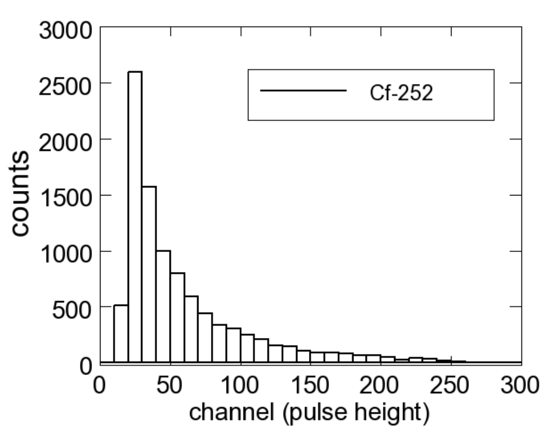

Fig. 3. LS detector pulse height spectrum for a Cf-252 neutron source.

Plastic Detectors

Table 2 shows the number of neutron tracks counted from plastic detectors used in two experiments, one using deuterated liquid and one using non-deuterated (control) liquid. The signal is the average number of neutron tracks for the two detectors mounted on the vessel. For the deuterated case, neutron production was 3.8 standard deviations above background. For the non-deuterated case (control) neutron production was within one standard deviation of background.

Table 2: Plastic Detector Results			
	Signal	Background	Difference
Deuterated Liquid	81.5	40	41.5±11
Control Liquid	30.5	30	0.5±7.7

SUMMARY

Neutron production during self-nucleated acoustic cavitation of a mixture of deuterated acetone and benzine has been verified with two independent neutron detectors. No neutron production is observed for the deuterated liquid when cavitation is not present, and neutrons are not produced with or without cavitation for the non-deuterated liquid. These observations support previous results indicating deuteron-deuteron fusion during self-nucleated acoustic cavitation of a mixture of deuterated acetone and benzine.

REFERENCES

1. R. P. Taleyarkhan, C. D. West, J. R. T. Lahey, R. I. Nigmatulin, R. C. Block, and Y. Xu, Phys. Rev. Let. 96 (2006).

2. R. P. Taleyarkhan, C. D. West, J. S. Cho, J. R. T. Lahey, R. I. Nigmatulin, and R. C. Block, Science 295, 1865 (2002).

3. Y. Xu and A. Butt, Nucl. Eng. Des. 235-3 (2005).

4. Science. 2006 Mar 17;311(5767):1532-3.