A comment on the nuclear emissions accompanying acoustic cavitation in deuterated liquids

In March, 8 issue of Science R. Taleyarkhan and colleagues report nuclear emissions (neutrons and tritium) during acoustic cavitation in dielectric deuterated liquid (D-acetone) [1]. Although this work appears to be controversial in terms of the detailed neutron [2] and tritium detection (the increase of T^3 in D-acetone after cavitation was only 1.7 times the background solution tritium content), it claims the first observation of nuclear effects in cavitation experiment with a deuterated liquid. However, in 1990 researchers of Institute of Physical Chemistry The Russian Academy of Sciences (including myself) published an article titled "Observation of neutrons under cavitation effect on deuterium containing media" in Russian Technical Physics Letters [3]. In a later article [4] we also reported tritium production under conditions of cavitation in a D_2O-based electrolyte. The experiments on tritium detection in the deuterated solution after cavitation treatment (performed similarly to R. Taleyarkhan et. al), showed an increase in T^3 beta-activity of 4 times that for the control solution (before cavitation treatment). In these papers acoustic multi-bubble cavitation was created by a titanium vibrator, operating with frequency 20 kHz in a glass vessel containing D_2O. We also reported a weak, but statistically significant fast neutron emission (0.5-1.0 n/s).

In contrast to R Taleyarkhan et al's explanation of this observation, we did not assume super-high temperature (10^7 K [1]) for the bubble implosion. Instead we proposed that reaction occur when deuterons accelerated by the electric field generated during the bubble's breakdown bombarded the surface of the deuterated Ti-vibrator and/or surrounding heavy water. Taking into account that measured temperature of single-bubble implosions in the Sonoluminescence (SL) never exceeds 10^5 K [5] and the fact that R. Taleyarkhan et al had no direct time correlation measurement of the individual SL burst (duration ~ 10^{-10} s [5]) with neutron pulses, a similar accelerating mechanism could possibly applied to their study.

Indeed, the electric charge separation in a pure cooled (dielectric) acetone (structured in the acoustic field) should take place during rupture of the liquid continuity and cavity formation [3]. Thus, the typical electric field intensity at the bubble wall could be easy reach at least E ~ 10^5 –10^6 V/cm. Then, during the bubble growth stage (maximum radius R_m ~ 10^{-2}-10^{-1} cm [1]) when a minimal pressure is achieved, the electric breakdown (discharge) inside the bubble could accelerate deuterons to ~5-10 keV. These deuterons bombarding the D_6- acetone molecules in the bubble walls could generate neutrons with the rate 10^2-10^6 n/s (depending on deuterium concentration in the bubble, number of bubbles, time and frequency of their oscillation and so on). At room temperature acetone has a higher conductivity and lower viscosity than at T=0°C, so leakage currents would prevent build-up an electric charge at the bubble's wall surface at higher temperatures. Thus, the nuclear effects cannot be observed at T=22 °C consistent with results reported [1].

Finally, I would like to emphasize that regardless of actual mechanism of nuclear product generation in SL experiments, the first observation of neutrons and tritium during acoustic cavitation in deuterated liquids was produced in [3,4]. It is truly sad that R. Taleyarkhan et al. did not cite such prior studies of nuclear effects during acoustic cavitation..

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