# Cavitation Chemistry

*Acknowledging text by K.S.Suslick*

As described in section (Nhc), cavitation (either acoustic or hydrodynamic) creates extremely localized hot spots of very high temperature and pressure (see, for example, Suslick *et al.* 2018). These hot spots can cause chemical reactions, both energy-producing, exothermic (for certain reactants) and energy-absorbing, endothermic (more commonly), but the energy efficiency of cavitation induced chemistry is extremely low. Production of hydroxyl or hydroperoxyl (in presence of $O_2$) or hydrogen peroxide is extremely energy inefficient and extremely slow. At intensities of $100W/cm^2$, acoustic cavitation from high intensity ultrasound generates never more than $mM/min$ (i.e., a few ppm per minute) concentrations of peroxide, and hydrodynamic cavitation is 100 times less efficient.

In liquids other than water (for example, hydrocarbons), if there is also an oxidant present (oxygen from air, added hydrogen peroxide, bleach, etc.), then cavitation may initiate exothermic reactions that could cause heating of the liquid. In such circumstances, chemical energy (the exothermic reaction of a fuel and an oxidant) is being converted into heat.

In water, there are no possible exothermic reactions that could result in heating of the water: all reactions of water lead to higher energy products (e.g., hydrogen peroxide, hydrogen, hydroxyl radicals) and cannot generate contribute heat.

Perhaps the first demonstration of a chemical reaction driven by hydrodynamic cavitation was described by Suslick *et al.* (1997). A more recent review by Arrojo *et al.* (2007) confirms that hydrodynamic cavitation is much less energy efficient in this regard than acoustic cavitation. The inefficiency lies in the coupling of the acoustic pressure oscillations or turbulent flow into efficient cavitation. That coupling to productive cavitation and the formation of intense local heating in hot spots during bubble collapse is an inherently energy inefficient process (less than 0.01% for hydrogen peroxide production from acoustic cavitation in water), and it is even less efficient with hydrodynamic cavitation than with acoustic cavitation.

We remark in passing that a number of published but widely discredited papers claim that excess neutrons and radiation are produced by the high temperatures and pressures occurring during cavitation, either hydrodynamic or ultrasonic production. Those publications usually quote neutron detection but such measurements are notoriously error-prone because of the scattering of the very low levels of background neutrons from many sources as well as by the position of the detectors.