

Hyperbaric Oxygen

Moreover, it is of value to consider ways in which the nuclei population might be controlled so as to modify the cavitation characteristics of a procedure or a device. The author was recently involved with a project in which bubble nucleation suppression was remarkably successful (Brennen (2002), Creech *et al.* (2002)). The context is a system designed to inject a highly supersaturated aqueous solution of oxygen into the bloodstream in order to minimize tissue damage caused by oxygen deprivation in the aftermath of a heart attack or stroke. The aqueous solution of oxygen is prepared at very high pressure (hundreds of atmospheres) and then is injected through very small capillaries (hundreds of micrometers) at high speed (m/s). The trick is to accomplish mixing with the receiving fluid without nucleation, that is without the formation of gaseous oxygen bubbles; this was achieved as follows.

Because of the high speed and high pressure gradient within the capillary, only a short length close to the exit has a pressure below the saturation level. Consequently only nucleation sites within this short length have the potential to produce bubbles. Observations (Brennen (2002), Creech *et al.* (2002)) showed that there were typically only of the order of 10 such sites in the drawn silica capillaries. Moreover these sites could be deactivated by the simple expedient of flushing ethanol through the capillary while it was underwater. Apparently, the ethanol preferentially wets the interior surface of the site and removes the buried nucleation bubble. The ethanol may also help dissolve the gas in the nuclei since the solubility in ethanol is about an order of magnitude larger than the solubility in water. This process of *ethanolization* of the surface was remarkably successful in suppressing nucleation. Moreover, it was made compatible with medical injection by preparing the capillary with an interior coating of benzalkonium heparin laid down in ethanol. This remarkably successful example of nucleation control suggests that similar strategies might be successfully employed in other contexts.