Introduction to Cavitation Experiments

The Preface described four methods for loading isotopes of hydrogen into materials. They are electrochemical loading from a liquid, gas loading, plasma loading and beam loading. Over the years, there has been a steady stream of results reporting cavitation loading of solids in LENR experiments. So, how does cavitation loading work? Does it fit into one of the four classes of loading?

Cavitation is the process where pressure within water or another liquid is quickly reduced, so that the liquid rapidly vaporizes and forms bubbles even at ordinary temperatures. The bubbles then collapse, which results in a self-collision in the center of the bubble. That generates both high temperatures and high pressures. If the bubble is in the liquid and away from any solids, the collapse is symmetric in all three dimensions. The radius of a cavitation bubble varies from about 4 micrometers to 40 nanometers during its lifetime of about 100 nanoseconds. It collapses at a speed of about Mach 4 and produces a million-fold increase in density over the initial vapor density. Light generated at the center of a collapsed cavitation bubble is called sonoluminescence. The collapse of cavitation bubbles also induces chemical reactions.

For LENR cavitation experiments, a thin solid foil is placed into heavy water. An ultrasound transducer produces intense sound in the water, leading to formation of transient bubbles. If the bubbles are on the surface of the metal foil, the collapse is cylindrically symmetrical around an axis normal to the foil surface. As a cavitation bubble on a solid surface collapses, a jet of material impacts the surface. This phenomenon is responsible for cavitation erosion of the surfaces of materials, such as the propellers of ships, and also for acoustic emissions. However, in LENR experiments, the collapse of cavitation bubbles on the surface of a solid effectively injects nuclei of the vapor into the foil. These include protons in the case of light water and deuterons in the case of heavy water. The chemical state of the vapor, that is, molecules, atoms or ions, is an important consideration for understanding the advantages of cavitation loading and its energetic efficiency.

Returning to the questions about the types of loading due to cavitation bubble collapse, we have a mixed situation. The collapsing bubble contains gas (the vapor) for most of its motion, and then a plasma of increasing temperature, when it is near fully collapsed. And, the jet of material is like a beam impacting the surface of the foil. So, cavitation loading spans at least two of the major classes of loading, plasma and beam, both of which involve higher energies per particle than electrochemical or ordinary gas loading. But, however complex is cavitation loading, it is effective.

The use of cavitation to load materials with H or D in LENR experiments is sometimes called sonofusion. That is a correct term only if fusion is the sole resulting nuclear reaction. This terminology also has one other disadvantage. In the past several years, another line of experiments involving insonification, cavitation and fusion has arisen, and received a lot of attention. It is best called “bubble fusion”. Such fusion is not LENR because no solid lattice is involved. In the case of bubble fusion, sound is used to produce cavitation in a liquid with a nearby source of neutrons. The hot plasma produced by the cavitation bubble collapse in heavy water is postulated to cause hot fusion. The experimental measurement of such plasmas is challenging because of their small size and very transient lifetimes. And, there is a wide range of opinions on the reality as well as the characteristics of bubble fusion. However, the field of bubble fusion is of no concern to LENR.

There were two papers on cavitation induced effects presented at ICCF-14. The first was by Stringham, who has worked on sonofusion for many years and presented some remarkable results at earlier conferences in this series. This time, his paper was a useful review of the basics of sonofusion, and a summary of some results. Some of his excess heat data is at Stringham's web site: http://sonofusionjets.com. There he shows excess power data to almost 40 W.

The second paper on bubble cavitation was qualitatively different from most experimental papers at the conference. There was no lattice involved in these experiments. In this paper, Kornilova and her associates reported the production of x-rays, as well as light, from cavitation bubbles produced when light oil was forced through an orifice at pressures up to 80 to 90 atmospheres. First, very soft x-rays (1-2 keV) were measured, a remarkable result given the very short ranges of such radiation in condensed matter. Then, fine copper powder was placed on the exterior of the experiment, and x-rays peaking at 3 keV and extending to 5 keV were recorded. These unusual results challenge explanations.

In general, the work on cavitation fusion has produced enticing results, but has not been adequately replicated in other laboratories. Such work is on the very long list of LENR and related experiments that should be done.