HYDROGENATION OF NICKEL AS A FACTOR IN LENR/ EXCESS HEAT. Hank Mills.

The following thorough review of published information on (in particular) the pre-treatment of Nickel in the many forms in which it has been used by LENR researchers has been submitted to Lookingforheat by Hank Mills, to whom we must accord the (very small) distinction of being the first 'outside' contributor to our 'Research Notes' section.

Enjoy!

To increase the probability of exothermic nuclear reactions taking place in nickel-hydrogen based LENR or "Cold Fusion" systems, such Andrea Rossi's E-Cat (Energy Catalyzer), it is likely a number of fuel preparation steps may need to be undertaken. Although some or all of these processes may take place in an active reactor, pre-processing, de-oxidizing, and hydrogenating the nickel beforehand may ensure the "fuel" or "catalyst" (depending on the definition you wish to use) is ready to be "triggered" into producing excess heat. Due to the large number of variables involved in these processes and the huge characteristic differences in different samples of nickel, replicators will need to experiment until they find the protocols that produce results for them.

Nickel bar, rod, wire, plate, and powder have all been used with hydrogen in cold fusion experiments -- resulting in excess heat being detected. Using nickel in the form of a powder seems to be ideal. The massively increased surface area and highly textured surface features of micron sized carbonyl nickel powder allows for a faster and greater overall quantity of hydrogenation.

The first step in preparing the nickel is removal of water inherently trapped inside of the particles and the "reduction" or elimination of oxides that have formed. The papers of Sergio Focardi, the patents of Brillouin, and other references indicate an initial heating of the nickel sample to a temperature of 625C as a starting point in the process of removal of impurities from the nickel surface. To further clean the nickel and reduce oxides, or if a vacuum pump is not available for the first step, the nickel in the heated vessel may be flushed with hydrogen at a temperature range between 300 and 425C at 1 bar of pressure. Three cycles at this temperature and pressure may remove approximately 90% of oxides. These thermal processes may also change the surface features of the nickel powder. Andrea Rossi's "Fluid Heater" patent states that by baking the nickel steam explosions may produce micro-cavities on the surface and create additional particles of even smaller size. He claims these micro-cavities (tubules in previous statements) are where the nuclear reactions take place and where resulting emissions (gamma or alpha particles) may be thermalized into heat.

The second step in preparing the nickel is the hydrogenation of the fuel material. This can happen in one or both of two different processes -- adsorption or absorption. When hydrogen has only entered or bonded with the very top surface layer(s) of nickel atoms, adsorption has taken place. If hydrogen has penetrated deeper into the lattice of the nickel, absorption has taken place: allowing a greater degree of hydrogenation to take place. This is a simplification of these two concepts. The result of either of these processes is that molecular hydrogen H2 is disassociated into atomic hydrogen (single hydrogen atoms) and take positions inside of the nickel lattice.

To start the hydrogenation process, the nickel powder should be placed in a heated pressurized vessel filled with hydrogen gas. The pressures and temperatures that can be used for hydrogenation are varied and far ranging. A study of multiple papers seems to show that a starting pressure of 1 bar of hydrogen and a temperature of between 150C and 300C may be suitable for preparing nickel for exothermic reactions. However, in non-LENR studies of the dynamics of nickel hydrides, very high levels of hydrogen loading have taken place at temperatures of around 100C or less. A study of the literature will help you select a starting temperature and pressure that you are comfortable with.

Multiple cycles of loading are required to adequately hydrogenate nickel powder. Ed Storms, a well-known LENR researcher, has explained that the surface of untextured nickel (for example thermally or chemically unprocessed bar or rod) resists the penetration of hydrogen, so only a low level of surface adsoprtion takes places. He indicates repeated cycles may create cracks, fractures, and other openings that allow for the migration of hydrogen deeper into the lattice (absorption). Sergio Focardi, in his tests with nickel rod and wire, utilized multiple cycles. He would allow hydrogen to enter the heated vessel, watch the pressure drop over a period of hours, and then add hydrogen to restore the initial pressure. Eventually, after several cycles, the pressure would no longer drop significantly -- indicating the fuel was ready for "triggering" by a sudden drop and increase of heat and/or pressure.

Once this level of hydrogenation is achieved, the concentration of hydrogen in the nickel can be driven up even further if even higher hydrogen pressures are applied. This is because there are two different phases of nickel hydride that may be formed: a-phase and b-phase. At the beginning stages of hydrogen absorption into the lattice, primarily a-phase nickel hydride is formed. Later on, after absorption has passed beyond a certain point, the existing a-phase nickel hydride is converted to b-phase. Phase diagrams are available that show how b-phase loading of hydrogen can then increase dramatically under certain conditions. This b-phase loading of the nickel is driven primarily by hydrogen pressure regardless of the temperature utilized in the vessel. The a-phase and b-phase nickel hydride have different properties. There is speculation and conjecture that the hydrogen atoms in b-phase nickel hydride may be more energetic and succeptible to influence by external stimulation (perhaps heat, electromagnetics, or accoustics).

Andrea Rossi describes very high pressures inside micro-cavities being used to "hammer" hydrogen into the nickel to produce nuclear reactions. If such high pressures exist inside the micro-cavities, they might be locations where a greater ratio of b-phase nickel hydride has formed. Inside of an active E-Cat fueled with LiAlH4 and possibly some quantity of elemental lithium, the nickel may under go cleaning, hydrogenation, and surface modification at various temperatures and pressures. But by cleaning and loading the fuel ourselves, before it's placed inside of the reactor for a run, much more of the loading and micro-cavity forming process might be controlled. Also, with lithium and aluminum present in the reactor, there are far more variables and chemical processes to be considered. For example, the creation of lithium hydride, which has the potential to transport hydrogen into micro-cavities, and the binding of free oxygen and reduction of nickel oxide by aluminum at high temperatures.

A primary focus must be to design, engineer, build, and test systems until massive excess heat can be produced. Precise control of these processes may not be required to prove and validate the "Rossi Effect." But if someone is properly "tooled up" with precise measurement equipment they may consider carefully and precisely pre-processing their fuel before use -- making sure proper cleaning and hydrogenation protocols have been followed.

SOURCE DOCUMENTS.

A Students Guide to Cold Fusion by Edmund Storms http://lenr-canr.org/acrobat/StormsEastudentsg.pdf

Large Excess Heat Production in NiH Systems http://www.lenr-canr.org/acrobat/FocardiSlargeexces.pdf

Thermodynamics of Metal Hydrides: Tailoring Reaction Enthalpies of Hydrogen Storage Materials http://cdn.intechweb.org/pdfs/21876.pdf

Fluid Heater http://www.google.com/patents/US9115913

Control of Low Energy Nuclear Reactions in Hydrides, and Autonomously Controlled Heat Generation Module

https://patentscope.wipo.int/search/en/detail.jsf?docId=US154011431&recNum=2&maxRec=7&office=&prevFilter=&sortOption=Pub+Date+Desc&queryString=FP%3A%28brillouin+and+robert+godes%29&tab=PCTDescription

Overview of H-Ni Systems: Old Experiments and New Setup.

http://newenergytimes.com/v2/library/2004/2004CampariEGoverviewOfH-NiSystems.pdf