Progress in Development of an LENR Power Cell for Space

George H Miley[1, 2a], Kyu-Jung Kim[1], Erik Ziehm[1], Tapan Patel[1] and Bert Stunkard[1]

[1a]Department of Nuclear, Plasma and Radiological Engineering, U of Illinois, 216 Talbot Lab, 104 S Wright St., Urbana, IL 61801
[2]Lenuo LLC , 912 .West .Armory Ave, Champaign, IL 61821
217-3333772; ghmiley@illinois.edu

Abstract. Since originally reported at NETS 2013, considerable progress has been achieved in development of a revolutionary new nuclear power unit using Low Energy Nuclear Reactions (LENRs). Test units now produce power densities equivalent to fission power plants, but work still needs to be done to insure the long lifetimes required for space applications. If successful, LENR reactors will allow small power units that could provide a vital new power supply for both space station power and propulsion. Due to the low energy of reactants, the compound nucleus formed in LENRs has little excess energy, thus the resulting breakout products are mainly channeled into stable or near-stable products, avoiding significant radioactivity or nuclear waste problems. Such a power source enables a tremendous advantage in energy density, lifetime, and tolerance to wide differences in environmental conditions (temperature, pressure).

During the past decade, extensive experimental and theoretical work worldwide has been done to study the basic LENR phenomena and to understand the underlying physics. At the most recent international meeting on the subject at the University of Missouri, several companies announced progress on gas loaded nickel nano-particle units designed for MW size plants. Others, including Lenuco LLC in collaboration with the NPRE department at the U of Illinois., are working on development of small 10's of kW units. Physically these power units are very simple. Special Ni alloy nano-particles are placed in a pressure vessel which is then pressurized to 60-100 psi with hydrogen to initiate the reaction. With pressure control, these units are expected to run for several years, before replacement of the nano-particles is required due to buildup of transmutation products. Replacement is simply done by substitution of a new cylinder containing fresh particles while the used particles are recycled for use in fresh nano-particles. Our results in terms of energy gain from the pressurized nano-particles are among the best reported in the field to date.

The main obstacle to development of a practical unit is preventing the hot nanoparticles from overheating and sintering together, limiting unit run time. Thus present work is focused on overcoming that problem. Two approaches are under test. One is to provide thicker oxide coating and somewhat larger nanoparticle. The other is to use plasma surface bombardment to create nanostructures on Ni wire mesh. Both approaches use a gas loading system using with a cylinder or vessel to hold the nickel based alloy nano-particles or nickel alloy mess wire. A large output of heat is then released when pressurized to 60~100 psi with hydrogen (alternately deuterium gas using a Pd rich version of the metal alloy can be used).The discovery at the University of Illinois of the existence of Ultra-High-Density clusters inside the host material is a break-through development that provides a reproducible approach to loading and subsequent heat production. Both experimental and theoretical studies have demonstrated that the hydrogen atoms in these clusters (almost metallic hydrogen) are close enough together that diffusion of another atom into the cluster transfers sufficient momentum to create a nuclear transmutation reaction with the hydrogen and host nickel atoms. Incorporating these clusters into the material has resulted in excess heat experiments that reproducibly produces orders of magnitude more heat energy out than energy in. Since the chemical heat release is limited to the initial pressurization, the energy "gain" for long run is extremely large.

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