

Slow Burn Simplicity

There is a parallel between how one burns carbonaceous fuel and how cold fusion "burns" deuterium. In burning carbonaceous fuels there is a contrast between the slow combustion of charcoal and the flaming fire that consumes wood logs. When one burns charcoal in the backyard grill, one first prepares the charcoal by soaking it with igniter fluid and igniting the fluid vapors so as to get local portions of the charcoal red hot, or one heats the charcoal with a propane flame until portions of the charcoal are red hot. Once red hot, the charcoal is quietly consumed, producing enough heat by its combustion (exothermic reaction with air) to keep itself at reaction temperature. In the log fire, one ignites newspaper under some kindling which has been strategically placed within or under the log pile. The burning newspaper raises the local temperature of the kindling wood to a point where gaseous flammable vapors are distilled from the kindling wood. These gaseous hydrocarbon-rich vapors burn, heating some of the logs, distilling off more gases from the logs. The burning of the decomposition gases when combined with desorption of new decomposition gases is a self-stimulating process. We call it fire. The fire continues until the wood runs out of enough decomposable material to maintain the flaming fire. Residual charcoal is left. Combustion ends when the slow burning residual charcoal is insufficient to keep the remaining charcoal at combustion temperature.

At the ICCF13 conference in Russia, a paper by the author was presented that calculated the heat produced by a slow burn process in a previously published cold fusion experiment. The earlier experiment was a 2004 A-Z gas loading study using zirconium-palladium ONC.

The Caucasus mountains extend from the Caspian Sea to the Black Sea and along the northern coast of the Black Sea almost to the Crimea peninsula. A railroad hugs this north coast, passing through tunnels on its way to the present, somewhat disputed boundary between Russia and Georgia. Close to this boundary is the airport of the bustling Russian city of Sochi. On the western side of Sochi is the resort and conference facility of Dagomys, which has been the host site of several Former Soviet Union (FSU) conferences on cold fusion and related subjects. Last year (2007) Dagomys was the host site for the ICCF13 conference on Low Energy Nuclear Physics (LENR). Your author has attended two conferences at Dagomys, and one at a Moscow State University conference site a few miles west. This year he prepared a presentation for ICCF13 titled "Cold Fusion Heaters". He was unable to attend, but was honored to have his talk presented by Michael McKubre of SRI. He wrote a paper for the conference

which will be published in the *Proceedings of ICCF13*. Figure 2.7,1 is taken from this Proceedings.

In 2004, Arata and Zhang were able to work together for less than 2 months. During this time they developed plans for a gas loading study using ZrO₂ + nanoPd composite material, built the test equipment, and carried out the first laboratory tests on this material, together with comparison studies using Pd-black. This period included 17 days of test time. Despite this severe time limitation they obtained pioneering data that was presented at ICCF12. They showed for the first time that cold fusion reactions could be made to occur in palladium material through the use of gas loading of a nanometal at elevated temperature. Their ICCF12 Proceedings paper provided information that was not presented in conference talk. This added information enables one to estimate the amount of cold fusion power that was liberated during the study. This analysis is part of the author's *Proceeding of ICCF13* paper, and is the basis of this discussion on slow-burn fusion. For more detail the reader is directed to Supplement 3.

We have already discussed the 2002 A-Z production of cold fusion heat using electrolysis onto a DS-cathode. Steady heat was produced at a 10-Watt level for 3 weeks. Basically the same geometry was used in the A-Z 2004 lab studies. Instead of calling the inner cylinder with Pd wall a DS-cathode, A-Z called it an "inner vessel". The inner vessel was surrounded by an "outer vessel" made of stainless steel. Both inner and outer vessels were vacuum tight, and were independently evacuated before lab tests were started. The outer vessel, which surrounded the inner vessel, was connected to pressure tight tubing through which deuterium gas could be fed by opening a needle valve during the test. The outer vessel was surrounded by a cylindrical electrical heater element, which in turn was within a cylinder of insulation. Both outer and inner vessels were instrumented to provide continuous recording of temperature and pressure.

The A-Z 2004 study operated the new test facility so as to compare behavior under 4 conditions. In all 4 runs the previously evacuated assembly was first heated to a steady 140 °C using the cylindrical heater. The heater was first operated at a relatively high power to quickly heat the assembly, and then the heater power was gradually reduced to a low maintenance power level as the 140 °C temperature was approached. After vessel temperatures were stabilized, deuterium gas was flowed into the outer vessel at a controlled rate, with flow stopped when the interior pressure reached about 100 bar (atmospheres). In one run H₂ was used instead of D₂. The results were as follows:

In Run 1 the assembly was studied with the inner vessel containing no test powder and using D₂ gas. The inner vessel, being further from the cylindrical heater, approached steady state with the inner vessel temperature being and remaining lower than the outer cylinder temperature.

In Run 2 the assembly was studied with the inner vessel filled with previously evacuated Pd-black test powder and using H₂ gas inflow. Again, the inner vessel, being further from the cylindrical heater, approached steady state with the inner vessel temperature being and remaining lower than the outer cylinder temperature. There was no indication of fusion energy release.

In Run 3 the inner vessel was filled with evacuated Pd-black and the input gas flow was D₂ gas. In the third run there was the same transient rise in temperature during gas inflow, but as steady state was approached, the inner vessel temperature became and remained higher than the outer vessel temperature. This reverse in steady state temperature difference indicated that cold fusion heat was being generated within the inner vessel.

In Run 4 the inner vessel was filled with evacuated ZrO₂ + nanoPd composite and the input gas flow was D₂ gas. In the third run the inner vessel temperature approached steady state with the inner vessel temperature being and remaining higher than the outer vessel temperature. But this time the steady state temperature difference was about 6 times that shown in Run 3. Also the temperature of the whole assembly rose from about its initial steady value of 140 °C to a steady value about 183 °C. The increase in temperature difference suggests that the ZrO₂-nanoPd composite was about 6 times more effective in catalyzing cold fusion than the Pd-black.

The author's ICCF13 paper used the observed rise in inner and outer vessel temperatures to estimate the amount of cold fusion power being liberated in Run 4. Figure 2.7,1 shows the basis of the calculation. The estimated heat output was 0.6 Watt, which is quite a bit less than the 10 Watts observed during the A-Z 2000 electrolysis run. This lower fusion rate indicates an important difference between "slow burn" and a "self-stimulated burn" behaviors. On the other hand, the 0.6 Watts suggests that a small increase in fusion heat relative to the electric energy that powered the heater could result in the continuous production of cold fusion heat with the electrical heater turned off. The reactor assembly would subsequently be kept hot solely by cold fusion generated heat. Demonstrations of continuous heat with no input power would make it difficult for skeptics to deny the reality of the cold fusion process.

Quantifying Excess Heat in Arata and Zhang ICCF12

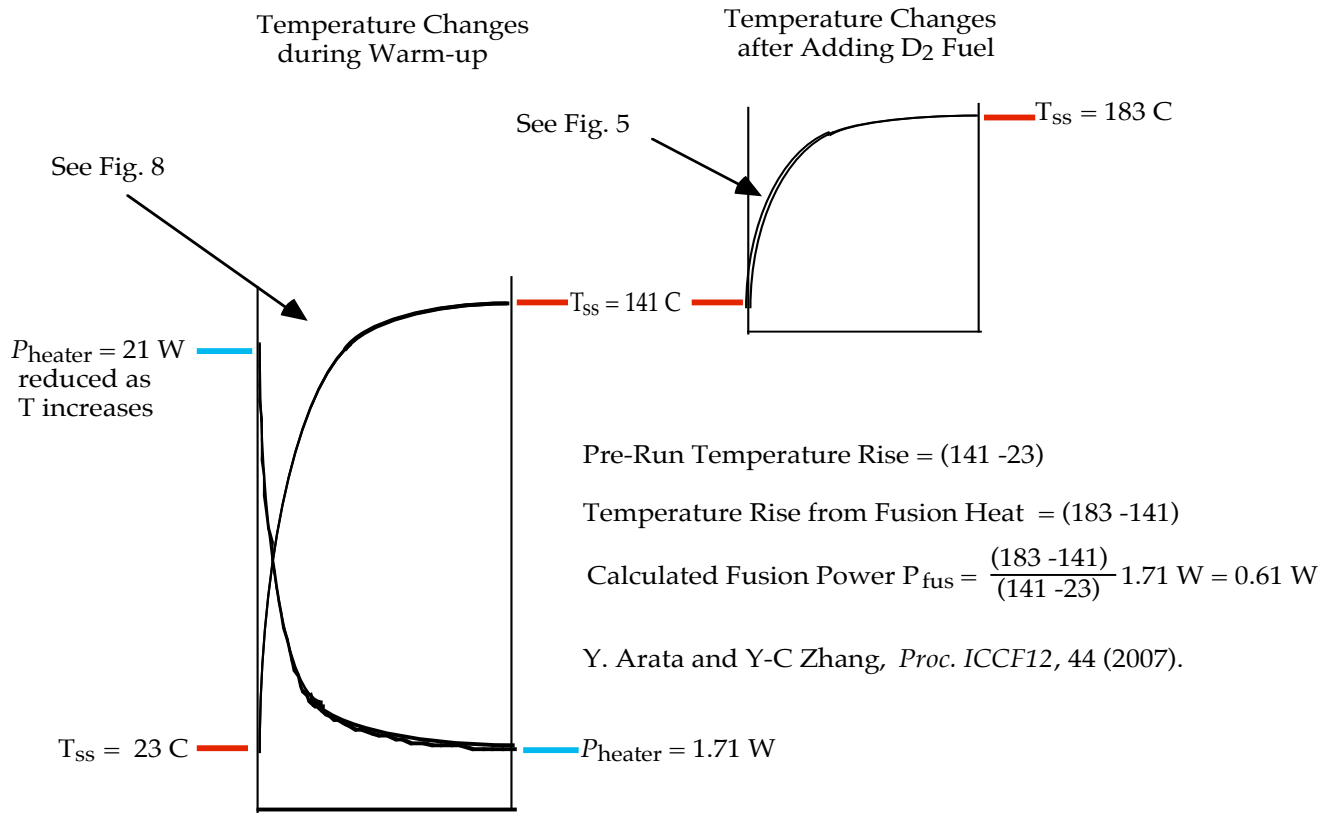


Figure 2.7,1. Temperature and heater power history used in calculating cold fusion power produced by gas loading of ZrO₂, nanoPd composite. Data for the lower left plot were taken from Figure 8 of the A-Z *Proc. ICCF12* paper. Data for the upper right plot were taken from Figure 5. The calculated fusion power assumes that fusion power and heater power affect the temperature of the outer ss vessel equally. The heater power at temperature stabilization was 1.7 W. Fusion power that resulted from the inflow of 100-bar D₂ raised the temperature of the apparatus a further 42 °C, which means that 0.6 W was added to the constant heater power of 1.7 W.

