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# Recent Results from Gas Loaded Nanoparticle-Type Cluster Power Units

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## 1. Introduction and Experimental Setup

This research was done is support of the development of modular 5 kW co-generation power cells by LENUCO LLC. The aim of this research was to determine the dependence of particle composition and initial temperature on peak power and total heat output. Three particle compositions, composing of various amounts of nickel, palladium and zirconium, have been studied. The effects of initial temperature are also discussed. Excess heat generation is seen and is theorized to be attributed to Low Energy Nuclear Reactions(LENR).

The following steps were used to conduct the experiments:

- Following a pre-treatment stage, the particles were loaded into a 30 cc stainless steel reaction chamber.
- The particles were heated at 300 C for 24 hours under a vacuum to ensure any residual oxygen was removed
- Depending on the experiment, the chamber was then heated to an initial temperature using a heating coil under vacuum.
- The particles were then pressurized with either deuterium or hydrogen at pressures up to 100 psi
- Three thermocouples were used to measure the temperature rise in the reaction chamber.

Figure 1 shows a schematic of the chamber used. Insulation was wrapped around the chamber (not shown).

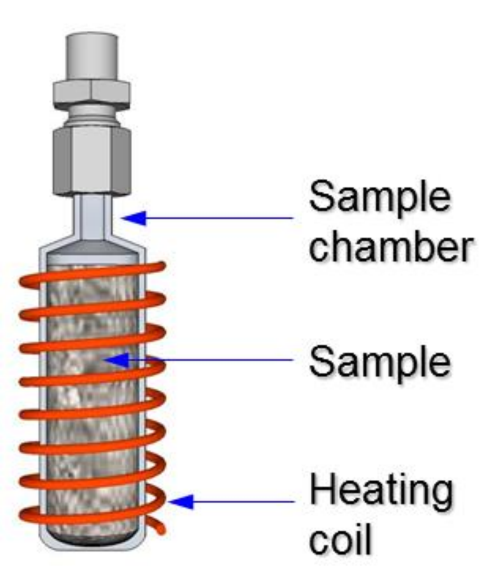



Figure 1. Schematic of reaction chamber.

## 2. Initial results from pressurization

Figure 2 shows a typical temperature versus time graph of the chamber upon pressurization. In the graph, thermocouples 204, 205 and 206 represent the temperature at the bottom, middle and top of the chamber.

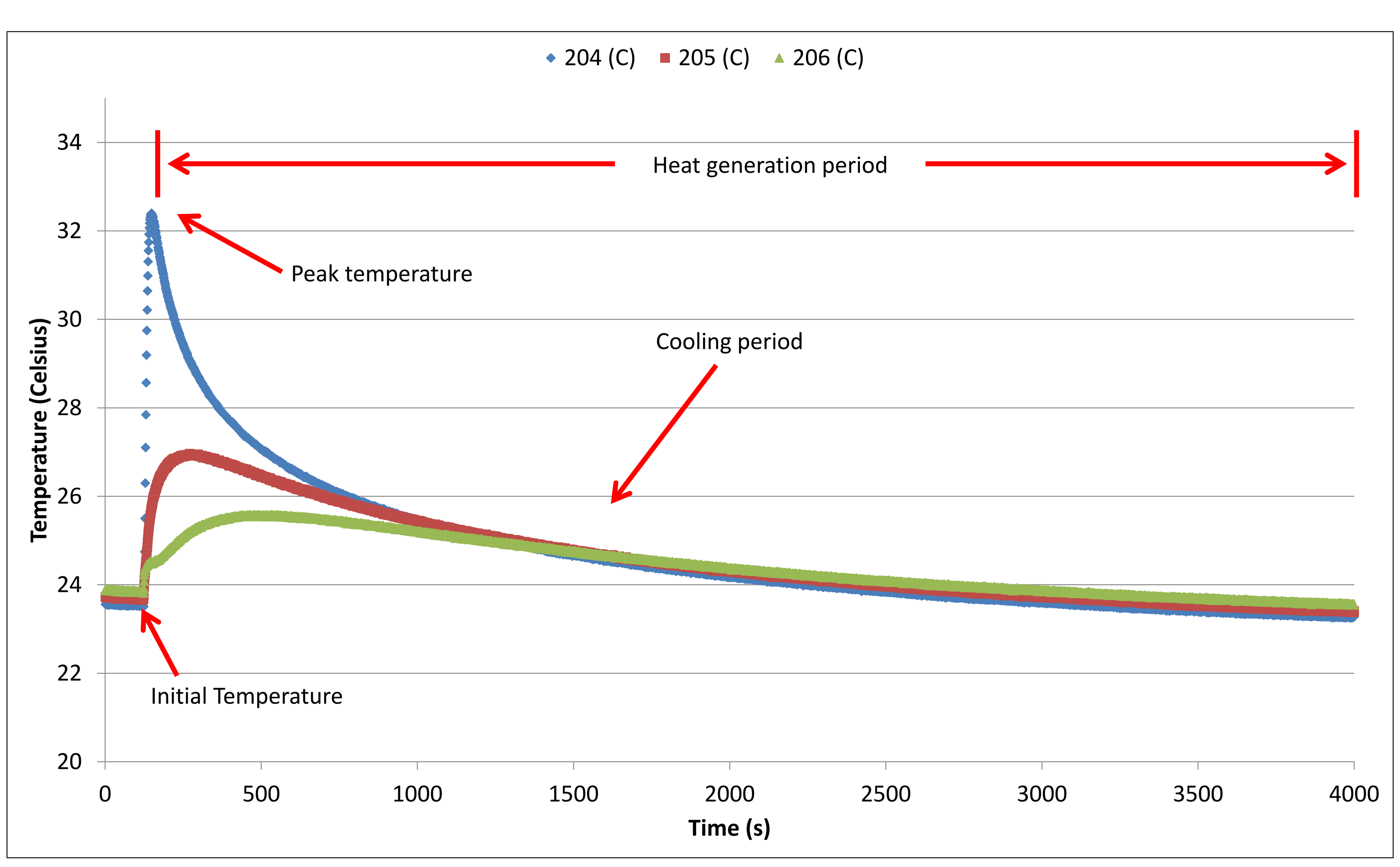



Figure 2. Typical temperature vs. time graph during pressurization.

As seen in the graph, the bottom thermocouple (204) experiences the highest temperature rise. Thermocouples 205 and 206 experience a less modest rise in temperature. Eventually, all three thermocouples reach the same temperature and cool back down to room temperature.

The power generation from each pressurization was calculated using the initial temperature and the peak temperature. These runs are generally considered adiabatic due to the relatively quick increase in temperature. COMSOL heat transfer simulation (discussed later) will be used to determine if there is any excess heat being generated after the peak temperature. This is labeled as "heat generation period" in Figure 2. The COMSOL model will use a baseline cooling reference to calculate the heat generation from these pressuziations.

## 3. Temperature effects on peak power

Two types of particles, A and B were studied further based upon initial experiments and results of peak power density. Table 1, below, summarizes the composition of each particle type.

| Particle Type | Particle Composition |
|---|---|
| A | Pd-Zr |
| B | Pd-Zr-Ni (High Ni, Pd) |

Table 1. Summary of particle composition

Each type of particle was tested under various initial temperature conditions. A 2 g sample of particle type A was pressurized repeatedly at 5 different initial temperatures. Each temperature was tested twice for a total of 10 "runs" totaling over 40 hours of pressurization. Between each "run", the particles were regenerated by heating them at 250 C for two hours.

Results of these pressurizations for both Particle A and B are presented in Table 2. The total heat output and peak power per gram are presented. Run 1 represents the first set of 5 initial loading temperatures with Run 2 representing the second pressurizations at each of those temperatures. Results from 2 runs are omitted due to incomplete data.

| | | | Particle A | Particle B |
|---|---|---|---|---|
| # | Average starting temp ( C ) | Run | Peak Power (W/g) | Peak Power (W/g) |
| 1 | 23 | 1 | 2.76 | 2.40 |
| 2 | 100 | 1 | N/A | 14.20 |
| 3 | 150 | 1 | 1.56 | 14.41 |
| 4 | 150 | 2 | N/A | 3.65 |
| 5 | 200 | 1 | 2.93 | 14.18 |
| 6 | 200 | 2 | 0.79 | 14.62 |
| 7 | 250 | 1 | 7.05 | 2.94 |
| 8 | 250 | 2 | 0.56 | 14.92 |
| 9 | 300 | 1 | 2.25 | 12.84 |
| 10 | 300 | 2 | 0.56 | 11.85 |

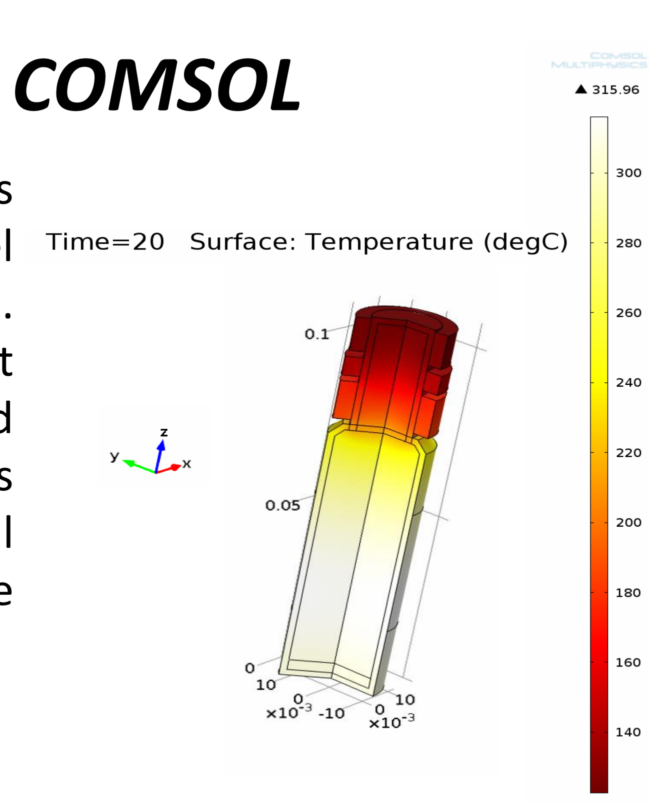
Table 2. Summary of heat output from pressurization of Particle A & B under various initial temperatures

Results from these pressurizations show some correlation with temperature for Particle A. In general, a higher initial temperature results in lower peak power generation. For particle B, there does not seem to be a correlation between peak power and temperature. In fact, the peak power appears to remain similar for all temperatures above room temperature. The peak power from Particle B is significantly higher than the peak power from Particle A for nearly all temperatures.

For each temperature, each subsequent run, in general, shows a decrease in peak power. Visual inspection of the powder shows occurrence of clumping/coalescence of the particles. This would lead to decreased surface area and the reduced power may be attributed to this phenomena. Currently it is unclear which mechanism is causing this issue. A second poster (titled "Study of Composition of Nanoparticles during Gas Loaded LENR Power Cell Operation") describes the effect of these loadings and their relation to the structure of the nano-particles.

## 4. Heat transfer simulations using COMSOL

In our experimental set up, only exterior wall temperatures are measured. To calculate the total heat output, a model of the chamber has been create using COMSOL software. The model is being calibrated to determine accurate heat transfer coefficients based on the actual geometry and setup of the chamber. Once the calibration process is completed, COMSOL can be used to determine several other output including: internal temperature field, or more accurate values for energy and power generation.




## 6. Conclusions

Preliminary results show that Particle B – hydrogen pressurization combination provides the greatest peak power. The particles appear to suffer from clumping/coalescence which diminished peak power output from each subsequent run. Ongoing experiments and modeling will provide additional thermodynamic information of the system as well as more accurate peak power and heat generation values.

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