

# Experimental Measurement of Excess Thermal Energy Released from a Cell Loaded with a Mixture of Nickel Powder and Lithium Aluminum Hydride

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**Abstract** - This paper describes the experimental setup, and methodology for assessing the energy in a small volume heat cell, that was loaded with a mixture of nickel powder and lithium aluminum hydride. This paper confirms the results obtained previously by Andrea Rossi and AG Parkhomov - that under certain conditions the cell makes excess energy; I.E. in the amount of heat released exceeding the input.

## I. INTRODUCTION

In recent years, interest has significantly increased in the study of low-energy nuclear reactions (LENR); especially after the publication of the test results from Andrea Rossi's high-temperature heat source, which operates on a mixture of nickel and lithium aluminum hydride [1]; and the successful experiments A. G. Parkhomov [2], [3]. It became clear that full-scale research was necessary, both theoretical and experimental in certain patterns of the reaction, to identify the optimal mode of operation; and in particular, to clarify the conditions for a self-sustaining reaction. However, initial experiments showed that the reaction is unstable; occurring in a narrow temperature range (in practice, it is outside the melting temperature of the fuel materials). In this paper we describe the design of the heat generator, the calorimetric method for measuring the amount of heat energy, and the first results. In the future, we plan to perform a series of installations for systematic research.

## II. DESIGN OF THE THERMAL REACTOR

Schematically, the design of the experimental heat generator is shown in Fig. 1.

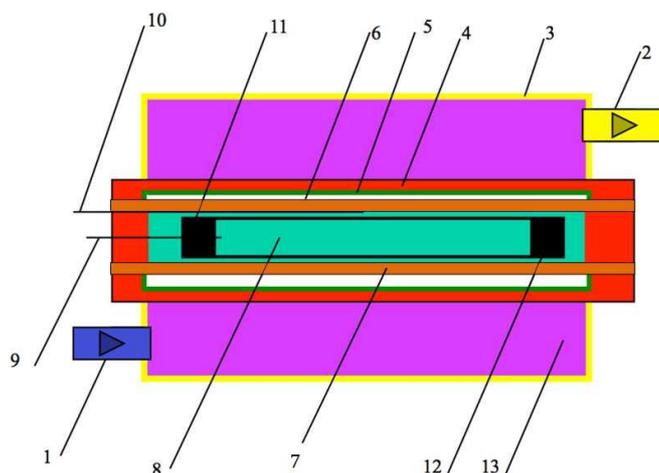


Figure 1. Schematic of the Thermal Generator. 1-Inlet fitting for connection to the thermocouple of the calorimeter water cooling line; 2-outlet fitting with a thermocouple for the open water discharge; 3-Outer casing of the calorimeter; 4-Copper pipe as inner calorimeter body; 5-Electrically insulating layer; 6-Heater; 7-Ceramic body heater; 8-Heated cell with fuel; 9,10-Thermocouples; 11,12-Test cell plugs; 13-Running coolant water

The main element of the thermal generator is a heat cell, 8, which is a cylindrical tube, the inner volume of which filled with fuel. Initial fuel consisted of a mixture of uniform mixture of Ni powder weighing 0.9g and lithium aluminum hydride ( $\text{Li}[\text{AlH}_4]$ ) - 0.1g. The nickel powder used was PNE-1 (GOST 9722-97).

The geometrical dimensions of these cells are as follows: length 160 mm, inner diameter 4 mm, and outer diameter 6 mm. The cell was constructed using high temperature materials such as stainless steel and ceramics 12X18H10T based on  $\text{Al}_2\text{O}_3$ .

One end of the tube is hermetically sealed using heat resistant cement (12); and at the other end (11), the thermocouple (9) was mounted using the same cement. On the outside of the heat cell a second thermocouple (10) was mounted in the center laterally. Thus, during the experiment, the temperature was recorded at the same time in two different points on the cell, allowing not only measurement at the beginning of the reaction, but also to trace the development of temperature.

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The same type of chromel – alumel (k-type) thermocouples were used for measurement of both the cell body heat and the temperature of the water. A photo of the completely assembled thermal cell in operating condition is shown in Figure 2.

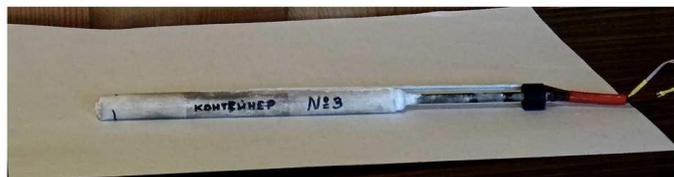


Figure 2: Photo of the assembled thermal cell

Next, the heat cell (see Figure 1) is installed inside the cylindrical heater (6) – a ceramic tube wound on the outer surface with 0.56 mm fehrlevaya wire [a Fe-Cr-Al wire like Kanthal, about 23 AWG] with a total winding resistance of 21 ohms, and protected with insulating layer (5) to prevent electrical contact with the calorimeter.

Figure 3 shows the heater with the thermal cell installed inside and prepared for installation into the calorimeter with the connections to the power supply and measurement system on the right.



Figure 3: Photo of the heater with the thermal cell installed inside

### III. METHOD FOR DETERMINING THE HEAT GENERATED

A well known and approved method was used to measure the heat generated. The calorimeter is a cylindrical coaxial design with flowing water. The outer cylinder is made from stainless steel and the inner pipe is copper. The volume between the inner and outer cylinders is filled with tap water, and the water flow was measured using an AQUARIUS P flow meter. A damping tank was added to smooth the flow rate of the water against variation in supply pressure. The damping tank is shown in Figure 4.

The water temperature at the inlet and outlet of the calorimeter was measured with thermocouples as described above [k-type], connected to a TRM202 meter/controller (manufactured by ARIES, Russia). Using commercially available devices of this brand, it was possible to use common software on a PC to combine the measurement and control of the system over time.



Figure 4: Water flow rate damping tank

The amount of heat generated was determined by temperature difference between the water inlet and outlet. The typical water temperature at the inlet was 16°C, and the maximum temperature at the water outlet during excess heat production was 50°C.

The primary power for the heater was from a single phase auto-transformer (TDGC2-2A). To measure the voltage on the heater, the current through it, and the power being delivered, an LCD network monitor was used (CMC-F1).

The entire heat cell and heater assembly was installed coaxially inside the calorimeter. The outer wall of the calorimeter and its ends were covered in heat insulation. The general view of thermal reactor in the calorimeter is shown in Figure 5, and Figure 6 shows the system ready for experiment.



Figure 5: Overall view of the reactor in the calorimeter

### IV. EXPERIMENTAL RESULTS

Between February and June 2015 we conducted five series of experiments to measure excess energy release in this system. In all experiments, excess heat was detected; however, in some experiments the thermocouple was destroyed and the test cell melted, which naturally required the manufacturing of new elements. This catastrophic scenario occurred when attempting to enter the operating temperature in 1.5-2 hours. To prevent the undesired consequences, the heat-up mode was slowed to 8-9 hours. This slow ramp

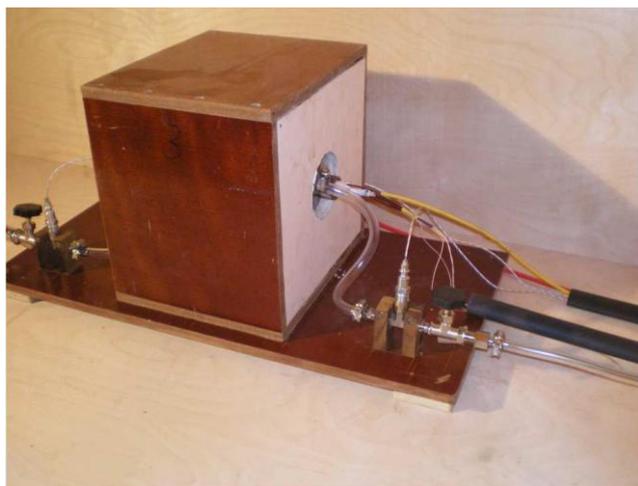


Figure 6: Fully assembled portable installation

was used in [3].

Below are graphs of temperature segments from the experiments.

Initially the temperatures inside the cell and on its surface are equal. After switching on the heater, the surface temperature of the test cell begins to rise faster than the cell interior. Over time, the difference in these temperatures decreased; and after 9000 seconds after the start of the experiment, the temperatures were practically equal (see Figure 7a).

With further increase to the heater input power, and when the temperature reached 1030°C, the temperature inside the cell began to grow and became higher than the temperature on the cell surface. Ultimately, the difference between these temperatures reached 100°C (Figure 7b). The temperature rise inside the cell with respect to the cell's surface signals a change in heat balance and the emergence of excess heat. At this stage a significant change was observed in the water temperature at the outlet of the calorimeter. The water temperature at the calorimeter outlet increased by  $\Delta T = +34^\circ\text{C}$  at an average temperature inside the reactor cell of 1100°C. The corresponding heat generated was 2100 watts with a constant water flow rate in the calorimeter of 1.0 liter/minute and a constant input electrical power to the heater of 850 watts. The resulting COP is approximately 2.47. The generated excess heat is 1250 watts, which corresponds to a specific power per unit fuel weight ratio of 1.25 MW/kg. During the period of this excess heat mode (4000s until the machine was switched off), 1g of fuel produced in excess of 5MJ of energy, which is much higher specific heat than known chemical reactions.

For purely organizational reasons we could not leave the system enabled for even a whole day. The total duration of the experiment was approximately 12 hours which was long enough to perform calorimetric measurement.

Measurement of x-rays from the calorimeter was also attempted. To do this, five flat cassettes with x-ray film (RF-3) were placed on the outer insulation of the calorimeter along its axis. The duration of exposure was almost 12 hours. After developing the film, no trace of exposure to the photoemulsion was found.

In addition, we consider it necessary to draw note the following important observation. In the graph (Figure 7b) there is a "quasi-periodic" fluctuation. Similar phenomena took place in all of our experiments. We cannot explain this phenomena. However, the working fuel mixture of nickel and lithium aluminum hydride in the cell has multiple phase changes during heating. Changes in composition and thermal properties, particularly conductivity, are the likely cause of this effect.

#### IV. ASSESSMENT OF RELEASED HEAT FROM THE CHEMICAL REACTION

At a sufficiently slow rate of heating, as carried out in the experiment, the decomposition of lithium aluminum hydride should proceed according as follows [4]:



That is, from the decomposition of one mole of  $\text{Li}[\text{AlH}_4]$  one obtains 2 moles of hydrogen gas to diffuse towards the reactor wall to be oxidized in air:



The fuel added to the test cell contained 0.1g of  $\text{Li}[\text{AlH}_4]$ , and from the complete oxidation of its contained hydrogen, a maximum heating of 2.6 kJ would be realized - much less than the 5 MJ measured in the experiment (in fact, the fuel probably has an order of magnitude greater service life [1]). Thus, this reactor has released an amount of heat energy that could not have been of purely chemical nature. A reaction mechanism must be present that is still to be understood.

#### VI. CONCLUSIONS

1. A heat generator system was constructed to conduct experiments to study the process producing excess energy in a sealed cylindrical thermal cell filled with a mixture of nickel powder and lithium aluminum hydride.
2. The results demonstrate excess heat during heating the powder mixture of nickel and lithium aluminum hydride to temperatures ranging from 1030-1140°C, consistent with the results of [1], [2], [3].
3. The generator did not expose an x-ray photographic emulsion (film RF 3).
4. The excess heat measurements and chemical analysis indicate the reaction on the inside of the

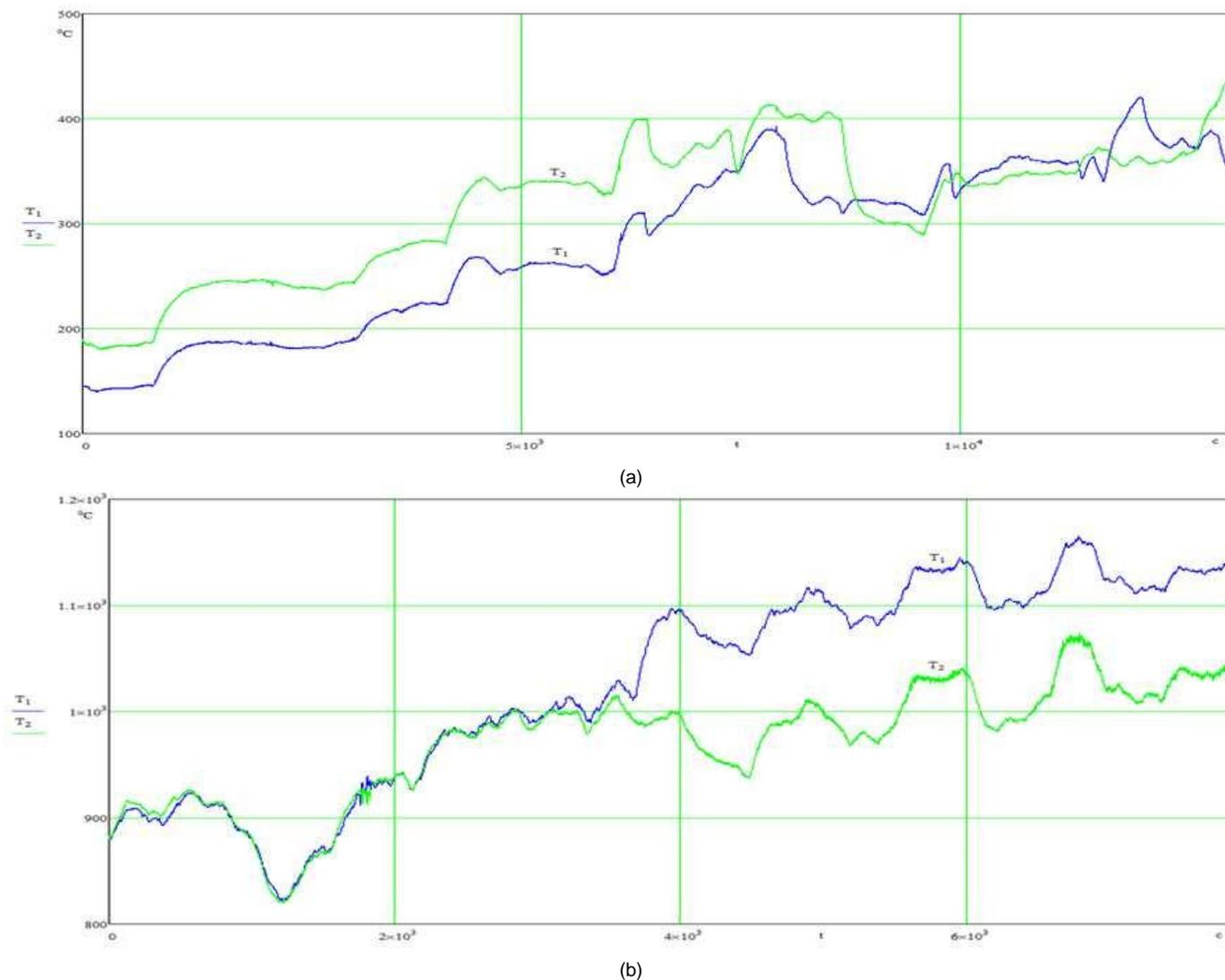


Figure 7: Temperature Vs. Time inside the thermal cell, T1, and T2 on its surface. Graph a) initial stage, and Graph b) excess heat release stage

thermal generator could be a source of power much greater than chemical reactions. To determine the nature of this reaction, including confirmation that it is a kind of nuclear reaction, it is necessary to analyze the isotopic composition of the source fuel and the spent fuel after prolonged operation [5].

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