Neutron Isotope Theory of LENR Processes

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1. The Theory

Constraints

- Quantum mechanics.
- Coulomb barrier.
- Neutral reactants required.
- Neutrons? Too few seen.
- Neutron isotopes? The only possibility.

Neutron Isotopes

- Bound neutron clusters $^{A}\mathbf{n}$.
- Catalysts for LENR reactions.
- A ≥ 6, no upper limit.
- Permutation-symmetric wave function.
- Unchanged by permutation of neutrons.
- Indicated by **bold** print.

Charged Symmetric Isotopes

- Bound neutron and proton clusters $^{A}\mathbf{H}$, $^{A}\mathbf{He}$, …
- Permutation-symmetric wave functions, A ≥ 6.
- Unchanged by permutation of nucleons n and p.

2. Catalytic LENR Reactions

Neutron isotope growth examples

Powered by deuterium

Rates influenced by environment

$$^{2}H + {}^{A}\mathbf{n} \rightarrow {}^{A+1}\mathbf{n} + {}^{1}H$$
$$^{2}H + {}^{A+1}\mathbf{n} \rightarrow {}^{A+2}\mathbf{n} + {}^{1}H$$
$$^{2}H + {}^{A+2}\mathbf{n} \rightarrow {}^{A+3}\mathbf{n} + {}^{1}H$$
$$^{2}H + {}^{A+3}\mathbf{n} \rightarrow {}^{A+4}\mathbf{n} + {}^{1}H$$

Symmetric isotope beta decay examples

Rates not influenced by environment

$$^{A}\mathbf{n} \rightarrow {}^{A}\mathbf{H}$$
$$^{A}\mathbf{H} \rightarrow {}^{A}\mathbf{He}$$
$$^{A}\mathbf{He} \rightarrow {}^{A}\mathbf{Li}$$

Symmetric isotope alpha decay examples

Rates not influenced by environment

$$^{A}\mathbf{He} \rightarrow {}^{A-4}\mathbf{n} + {}^{4}He$$
$$^{A}\mathbf{Li} \rightarrow {}^{A-4}\mathbf{H} + {}^{4}He$$

3. Neutron Isotope Fission

Growth and decay reactions conserve symmetric isotope number.

Number can decrease by escape of $^{A}\mathbf{n}$ from reactor.

Neutron fission is essential to build up and maintain $^{A}\mathbf{n}$ population:

$$^{(A+B+C)}\mathbf{n} + {}^{D}Z \rightarrow {}^{A}\mathbf{n} + {}^{B}\mathbf{n} + {}^{C+D}Z.$$

Net loss of C nucleons from symmetric isotopes.

Loss must be less than gain from growth reaction.

Hence concentration of catalyst precursor ^{D}Z must be small.

4. Hegelstein Criterion

The criterion: Kinetic energies of LENR products are negligible.

The theory: Every LENR reaction has a symmetric isotope product.

- Symmetric isotopes are weakly bound.
- Their vibrations have low energy levels and are closely spaced.
- Their excitations can be understood as nuclear phonons.
- They absorb reaction energy and become hot.
- Kinetic energies of reaction products are negligible.

Conclusion: The Hegelstein criterion is met.

5. Heat and Helium

Four growth reactions: $^{A}\mathbf{n} + 4(^{2}H) \rightarrow {}^{A+4}\mathbf{n} + 4(^{1}H)$

Two beta decays: $^{A+4}\mathbf{n} \rightarrow {}^{A+4}\mathbf{He}$

One alpha decay and $^{A}\mathbf{n}$ catalyst restored: $^{A+4}\mathbf{He} \rightarrow {}^{A}\mathbf{n} + {}^{4}He$

Overall: $4(^{2}H) \rightarrow 4(^{1}H) + {}^{4}He + 21$ MeV

21 MeV per ^{4}He (agrees with experiment).

$4(^{1}H)$ per ^{4}He (predicted ratio not yet measured).

6. Transmutation

Neutron transfer reactions lead to transmutation. As an example:

$$^{A}\mathbf{n} + {}^{23}Na \rightarrow {}^{27}Na(300ms) + {}^{A-4}\mathbf{n} + 10 \text{ MeV thermal energy}$$
$$^{27}Na \rightarrow {}^{27}Mg(9.5min) + 9 \text{ MeV kinetic energy}$$
$$^{27}Mg \rightarrow {}^{27}Al(stable) + 2.5 \text{ MeV kinetic energy}$$

(^{27}Mg and ^{27}Al are ionized and electrons carry kinetic energy.)

Overall: $^{A}\mathbf{n} + {}^{23}Na \rightarrow {}^{A-4}\mathbf{n} + {}^{27}Al + (10+12)$ MeV.

$^{23}Na \rightarrow {}^{27}Al$ (agrees with Iwamura).

7. Role of Fluid Shear

1. Fleischmann-Pons reactor produces D in solution at cathode.
   Solution becomes supersaturated with D.
2. Bubbles of D are nucleated at cathode irregularities.
   Rapid bubble growth drives high shear rate in electrolyte.
3. Shear deformation brings potential reactants together.
   Much faster than diffusion.
4. Neutron isotope growth rate is dramatically increased.
5. Temperature of electrolyte rises rapidly.
   Causes a flash of radiant heat.
   Enough to melt palladium cathode surface.
   A micro-explosion.
6. Bubble nucleation site is blown clear of electrolyte.
   Electrolysis is interrupted at that site.
   The site cools down, electrolyte returns, electrolysis resumes.
7. Another LENR cycle produces another reaction flash.
   Sparkling thermal energy flashes cover the cathode surface.

8. Heat after Death

Pons and Fleischmann	Mizuno
Electrolytic D/Pd reactor Boils dry (death)	Electrolytic D/Pd reactor Turns off power (death)
No fluid shear No growth reaction	Fluid shear continues Growth reaction continues
Beta and alpha decays continue **n** concentration drops to zero Reaction stops	Beta and alpha decays continue **n** concentration stabilizes Reaction continues
Heat after death lifetime about 3 hours	Heat after death lifetime more than 5 days

Mizuno fluid shear makes the difference.

Convection? Boiling hot spot?
Research opportunity.

9. What Is Known and Projected About Electrolytic Reactors

1. D in D_2O with Pd cathode, supports LENR.
2. Reaction occurs at cathode surface. D fuel, ^{4}He ash.
3. Need fluid shear for neutron isotope growth.
4. Need trace of transmutation for isotope fission.
5. LENR occurs in micro-explosions.
6. Hot enough to melt Pd.
7. Visible as heat radiation flashes.
8. Dry heat after death lasts a few hours. (No shear, no growth.)
9. Wet heat after death lasts for days. (Shear at boiling hot spot?)
10. D in natural H_2O with Ni cathode, also supports LENR.

Path to optimize power generation:

Natural water. High pressure steam.

Thick as kerosene, red hot, speed of pistol bullet, into turbine.

Path to optimize explosives:

Synchronize micro-explosions at cathode? Throughout electrolyte?

Probably no potential, but we should know.

10. Frequently Asked Questions

What is the evidence for neutron isotopes?

The LENR phenomena.

Through the history of physics every particle has demonstrated its existence by the phenomena it explains.

Why is it necessary to load a Pd cathode?

To prevent loss of D into Pd.

Here's why:

Electrolysis generates deuterium at the electrolyte-palladium interface.

Deuterium is soluble in a palladium cathode and diffuses into it.

Deuterium concentration in the electrolyte remains low. Bubble formation and growth are inhibited and there is little fluid shear.

LENR is suppressed.

Only after the palladium is saturated does deuterium remain in the electrolyte and support the bubble growth and fluid shear required for LENR.

How do you explain H + Ni reaction?

The reaction is not nuclear.

(See next panel.)

11. Published H+Ni Data

Data: From Fig. 5 of Focardi, Habel, and Piantelli (1994).

Equipment

A gas-tight oven containing (1) hydrogen gas, (2) a nickel rod surrounded by an electric heater, and (3) a thermocouple for measuring rod temperature.

The equipment is not a calorimeter.

Procedure

A stable relationship is established between input heater power and rod temperature, for temperatures up to about 400°C.

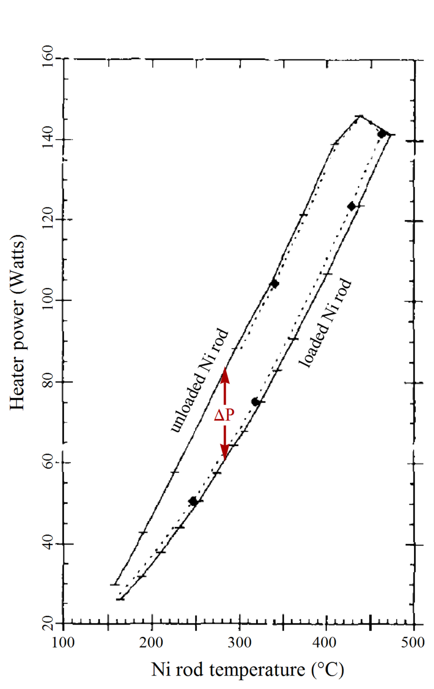
(see "unloaded Ni rod" in figure)

The temperature is raised above 400°C for a period of time, during which hydrogen is absorbed by the nickel rod.

The high-temperature treatment produces irreversible change.

A new stable relationship between heater power and temperature has been established for the hydrogen-loaded rod.

(see "loaded Ni rod" in figure)



Result

Less heater power is required to heat the loaded rod than was required to heat the unloaded rod (at any temperature up to 400°C).

Excess power required for the unloaded rod is denoted ΔP.

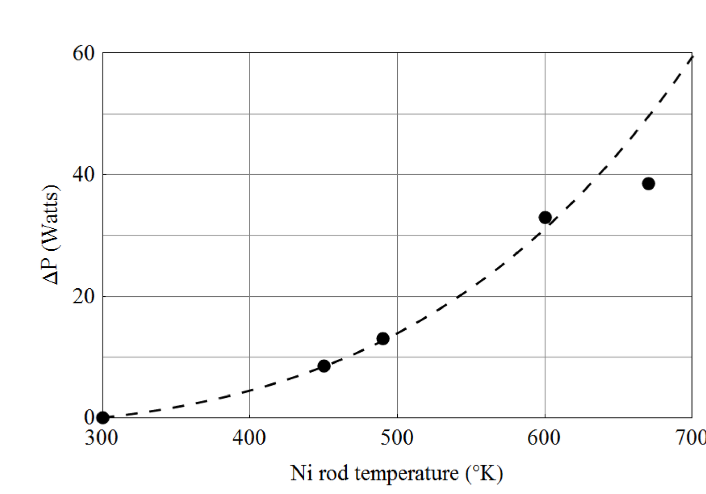
Interpretations

ΔP > 0 can indicate an increment of nuclear power.

Or it can indicate a change in thermal insulation.

12. Derived H+Ni Data

The following diagram plots the power difference ΔP as a function of temperature.



Heat flow interpretation

The hydrogen loading process permanently alters the oven.

When heated, the altered oven reduces the loss of radiant energy and decreases oven output power by ΔP.

Nuclear interpretation

The hydrogen loading process permanently alters the Ni rod.

When heated, the altered rod generates nuclear power and increases oven input power by ΔP.

Which interpretation is correct?

This question can be answered by measuring both the input power to the oven and the output power from the oven.

In the heat flow interpretation they will be equal.

13. Additional Considerations

Data: The diagram in section 12 shows that ΔP is proportional to $T^4 - T_o^4$ where T_o is room temperature. (In this experiment T_o = 300K.)

Heat flow interpretation

Power transmitted by radiation is proportional to T^4.

Action of hot H and chemicals emitted from the heater and the rod during the loading process can bleach and whiten interior oven surfaces and decrease the rate of radiant energy flow.

The difference is proportional to T^4.

Nuclear interpretation

Suggested new type of nuclear power.

No explanation offered for dependence of power on temperature.

Data: Sometimes the power difference is negative (ΔP < 0).

Many variations of the H+Ni experiment have been performed, some with trace additions of materials to alter the nature of the nickel loading procedure.

Heat flow interpretation

Same idea as for ΔP > 0.

In some experiments the action of hot H and chemicals from rod, heater, and trace additions increase the rate of radiant heat transfer instead of decreasing it, changing the sign of ΔP.

Nuclear interpretation

Requires negative energy release from spontaneous nuclear reaction, sometimes called endotherm:

"Endotherm … means that when a large amount of outside heat is put into the system, a substantial fraction of that heat seems to physically disappear, as if there was a magical internal heat sink—far surpassing any chemical explanation. Celini, Technova, Ahern and others have seen this physical feature—but have not pursued it."

Jones Beene, Infinite Energy 18, No. 108. (2013) p29.

Poster design by M. E. Fisher and J. D. Fisher