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Research Article

Fundamental Experimental Tests toward Future Cold Fusion Engine Based on Point-compression due to Supermulti-jets Colliding with Pulse (Fusine)

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Abstract

Our previous reports based on theoretical considerations and supercomputer simulation showed the possibility that super multi-air jets of gases such as air or deuterium colliding with pulse (K. Naitoh, patent: 2012-519298 (2010)) lead to self-compression over 60 MPa and 2000 K at single point around the reacted center, at maximum. This may bring about a more stable occurrence of cold fusion. This approach due to supermulti-jets will also cause an insulation effect because of encasing, which will result in less heat loss from the reactor walls. Based on this, we developed three types of prototype engine reactors using the supermulti-jets colliding with pulse. In the present report, we show some fundamental experimental data for one of the three prototype engine reactors, derived now, before we plan to begin testing for cold fusion.

Keywords: Experiment, Pulse, Reactor, Simulation, Supermulti-jets colliding, Theory

1. Introduction

A very impressive and mysterious phenomenon called cold fusion has been reported over 20 years [1–4]. Among many studies, it was found that the use of nano-particles is an effective means of stabilizing the reaction [5].

Further studies were conducted, which also indicated stability of the reaction [6–8]. However, the level of production energy is still small.

Our thermo-fluid dynamic theory [9,10] clarified the inevitability of sizes of various particles generated in phenomena from subatomic to macroscopic levels, which include atoms produced by cold fusion and liquid fossil fuel droplets atomized in combustion engines. The theory indicates the possibility that strong impact due to instantaneous pulse of pressure and temperature on particles including nano-particles for cold fusion may produce stable excess heat release in far greater amounts than combustion can produce.

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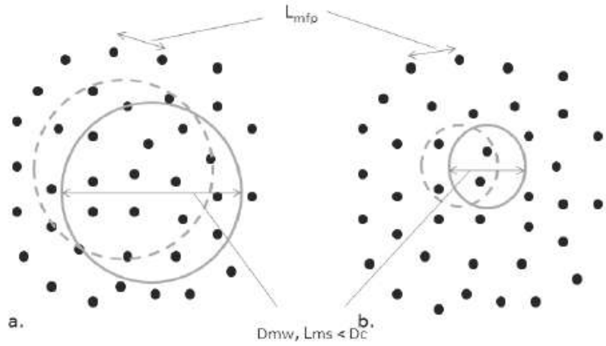


Figure 1. Stochasticity and indeterminacy generated by a mesoscopic window size smaller than that of continuum mechanics. a: weak stochasticity in density averaged in a larger window; b: stronger stochasticity in density averaged in a smaller window (Mean free path: Lmfp; Mesoscopic window size for averaging (MW): Dmw; Minimum scale dominating the phenomenon: Lms; Continuum assumption window: Dc).

2. Weakly Stochastic Field Theory based on Fluid Dynamics

While statistical mechanics usually uses a probability density function defined and averaged in the space of molecular speeds, the Boltzmann equation is also based on averaging a large volume in Euclid space because of the continuum assumption, which leads to the form of a deterministic partial differential equation for a stochastic field [11].

Here, the basic idea is that physical quantities such as velocity and density are intentionally averaged in a spatial window on a scale smaller than that for continuum mechanics (mesoscopic window: MW), in order to resolve the minimum scale (Lms) dominating the phenomenon between molecules and the continuum, which is also mesoscopic window size for averaging (Dmw). When the smaller spatial window for averaging, including a small number of molecules, moves right and left, the number of molecules inside the window varies and also the physical quantities are a little vague or indeterminant (Fig. 1).

As a result, a mesoscopic equation in the form of a stochastic partial differential equation for the field is obtained with stochastic fluctuations, in which stochasticity comes from the discontinuity of molecules in space.

The traditional macroscopic governing equation in continuum mechanics for the physical quantity $f(t, x_i)$ such as density, fluid velocities, and temperature defined in four-dimensional space of time t and space x_i is generally written in the form of

$$L\, f(t, x_i) = Q(t, x_i) \tag{1}$$

with a partial difference operator L on time and Euclid space and a source term Q.

The mesoscopic equation averaged in a smaller averaging window (mesoscopic window size: Dmw) can be written as

$$L\, \bar{f}(t, x_i) = \bar{Q}(t, x_i) + \varepsilon(t, x_i), \tag{2}$$

where $\bar{f}$, $\bar{Q}$, and ε denote the physical quantities averaged on the minimum scale dominating the phenomenon for f and Q and a stochastic fluctuation, respectively.

Weak vagueness of $\bar{f}$ also has the advantage that a smaller averaging window resolves the smaller scale of physical fluctuations and shows the possible ranges of the natural phenomena. Vagueness brings a solution, albeit a little vague because of $\bar{f}$ that includes indeterminacy. This vague solution is welcome, because the deterministic macroscopic governing equation averaged on the traditional scale for the continuum, which is too large to resolve the minimum scale dominating the phenomenon, cannot show any solutions. The important point is that the indeterminacy of $\bar{f}$ reveals another advantage in the form of the level of instability in the phenomenon and the range of the solution, which is important for scientific and engineering applications. It is stressed that complete random motion differs from that of the vague solution with weak indeterminacy [16,17].

The quantum mechanics of the Schrodinger and Klein–Gordon equations is based on an indeterminacy principle [12]. The presence of electrons is given in a certain area, not at a deterministic point. This vague viewpoint with indeterminacy shows an outline of a possible solution. We can obtain vague solutions in exchange for abandoning determinant ones.

Thus, this new approach to solving several problems with weakly stochastic partial differential equations can be said to be at the triple point of the indeterminacy principle in the Schrodinger equation, the stochasticity principle in the Langevin equation [11], and deterministic field theory in the Boltzmann equation [11]. In short, it represents the fusion of indeterminacy, determinism, and stochasticity.

In nature, discrete molecules in space are essentially discontinuous, which leads to stochasticity, while phenomena are relatively continuous in time. Thus, averaging for time can be regarded as being consistent with the observation window for spatial averaging.

3. Nano-particles Explained by the Weakly Stochastic Theory

An important momentum equation (Eq. (3)) [9,10,15]

$$\frac{\mathrm{d}^2}{\mathrm{d}t^2}X(t) = -A(t)\left[\frac{\mathrm{d}}{\mathrm{d}t}X(t)\right]^2 - B(t)\ X(t) + \varepsilon(t) + \xi(t) + Q_2(t) \tag{3}$$

with initial deformation speed of $\mathrm{d}X(t)/\mathrm{d}t_{t=0} = Uo$

describes the deformation rate $X(t)$ of a particle (a nano-particle or a cluster) consisting of atoms like palladium for time t,while $A(t), B(t), \varepsilon(t), \xi(t),$ and $Q_2(t)$ denote nonlinear function of $X(t)$ for convection inside the particle, nonlinear function of $X(t)$ for contact surface force, stochastic term related to the small number of sub-particles

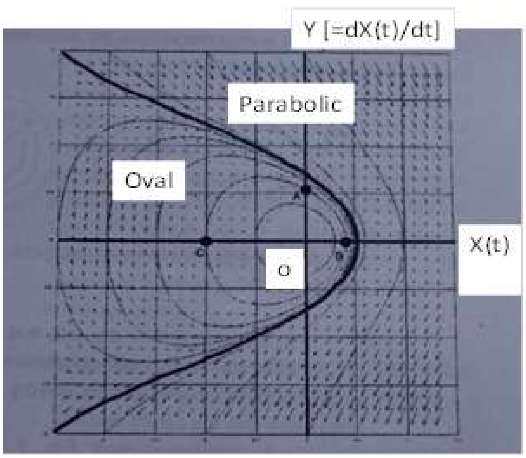


Figure 2. Trajectories of the solution for Eq. (3) ($Y = \mathrm{d}X/\mathrm{d}t$ plotted against X).

(atoms) explained Section 2, random force due to collisions of the other type of particles such as hydrogen (H) or deuterium (D), and another particle (another nano-particle or a cluster) consisting of atoms like palladium connecting just before breakup or just after collision, respectively.

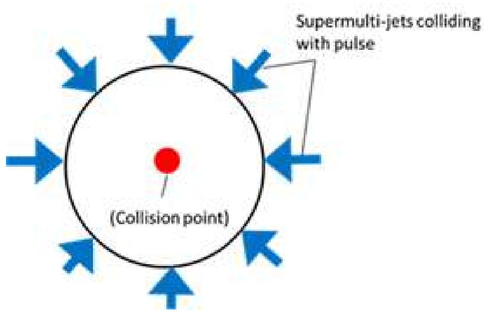
Next, $A(t)$ and $B(t)$ in Eq. (3) can be set as fixed constants, because cold fusion will occur in a very short time. Then, $\varepsilon(t), \xi(t),$ and $Q_2(t)$are eliminated. Equation (3) is still nonlinear because of the first term on the left-hand side. The analytical solution of Eq. (3), which we fortunately found, shows that increasing input energy causes a drastic transition from oval-type of oscillation implying small deformation of $X(t)$ to parabolic divergence implying breakup of particle due to infinitely large deformation (Fig. 2).

Equation (4) then shows the critical condition of initial deformation speed Uo (minimum input energy at the initial stage), after which the breakup of the particle occurs.

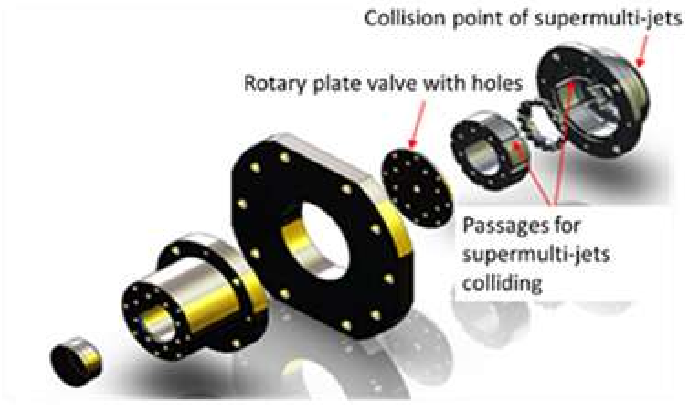
$$Uo^2 > \frac{B}{2A^2}. \tag{4}$$

The theory based on Eqs. (3) and (4) brings two important sources of knowledge.

First, the present theory can clarify the reason why decreasing sizes of particles such as palladium will result in a little more stable occurrence of cold fusion, as proposed by Prof. Yoshiaki Arata. When the input energy is smaller



(a)



(b)

Figure 3. Point compression due to supermulti-jets colliding with pulse. (a) Principle of the point compression due to supermulti-jets colliding with pulse. (b) Actual system of supermulti-jets colliding with rotary valve for generating pulse.

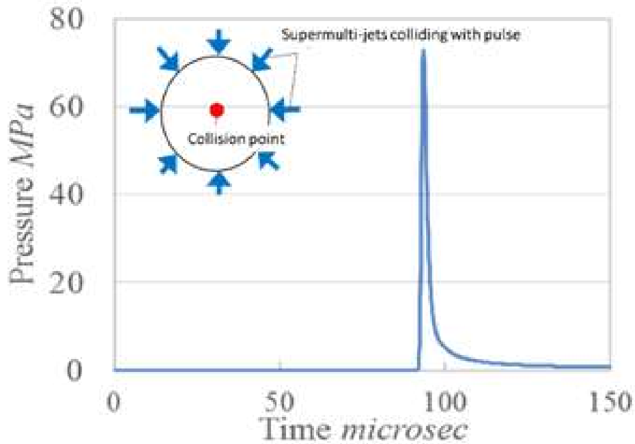
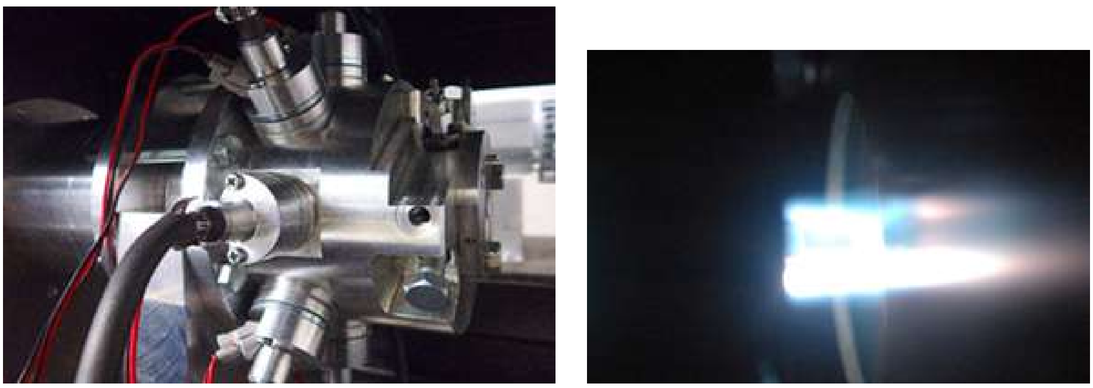


Figure 4. Pressure history computed for supermulti-jets colliding with pulse.

than that for breakup, the stochastic term $\varepsilon(t)$ due to small number of sub-particles, which appears for nano-particles, often gives an effect surpassing the critical condition of breakup.

4. An Approach toward Higher Energy Generation Based on the Supermulti-jets Colliding with Pulsation

Second, the above theoretical consideration and numerical simulation on a supercomputer shows a concrete methodology for making the cold fusion phenomenon more stable. An important point of the methodology is supermti-jets of gases such as deuterium with pulse, which collides at the center of reactor (Fig. 3). This is because point-compression due to this supermulti-jets colliding with pulse gives particles larger deformations in the form of an increase of the initial force Uo shown in Eqs. (3) and (4) or $\xi(t)$, which will lead to a stable cold fusion reaction.



(a) **(b)**

Figure 5. Prototype engine reactor with 14 nozzles for supermulti-jets (*Left*: reactor. *Right:* Chemical reaction occurrence in the prototype engine reactor).

The super multi-air jets of gases such as air or deuterium colliding with pulse, i.e., collision of jets of transonic- or supersonic- speeds, lead to self-compression over 60 MPa and 2000 K at a single point around reacted center, at maximum (Fig. 4). This compression level will be larger than that in traditional cold fusion systems, whereas it wil be much less than for high temperature fusion systems. This may bring about more stable and frequent occurrences of cold fusion. This approach due to supermulti-jets will also cause an insulation effect because of encasing, which will result in less heat loss from the reactor walls.

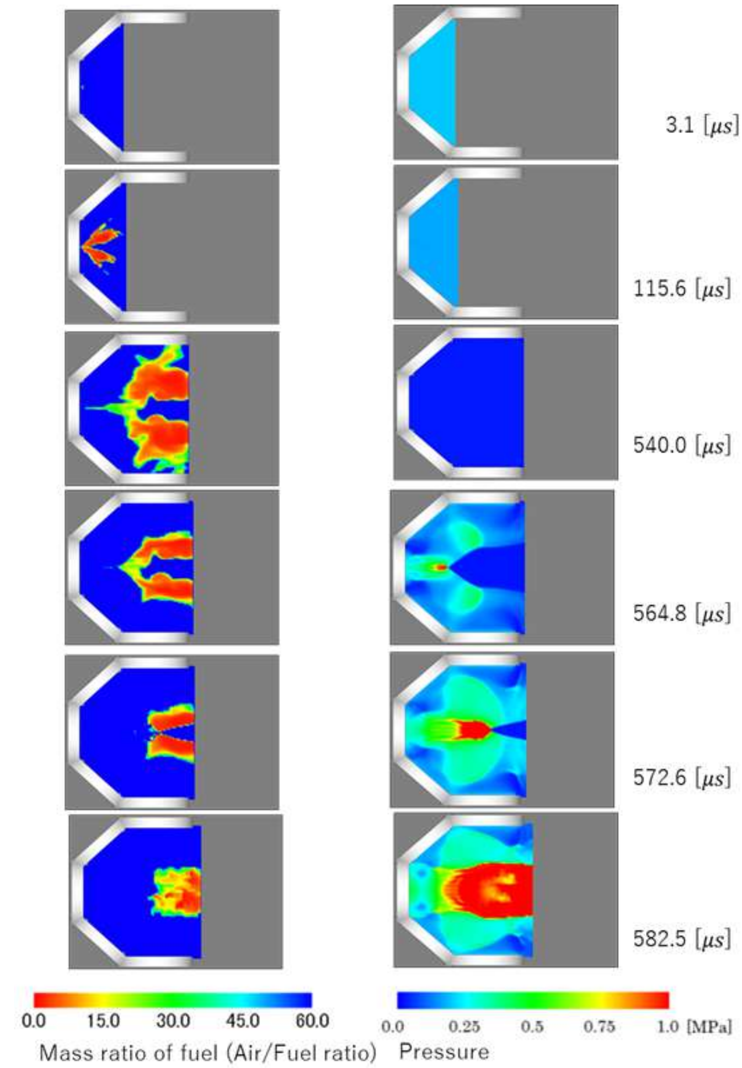


Figure 6. Unsteady three-dimensional computation of the supermulti-jets and fuel supplied into the Fusine. Injection cone angle is 70°. Injection speed of fuel is 135 m/s. Piston diameter is 39 mm. Piston stroke is 40.5 mm, Piston speed is 12,500 rpm. Intake pressure due to turbo-/super-charged system is 3.0 bar. Computational grid: 150× 120× 120 points.

We developed three types of prototype engine reactors using the supermulti-jets colliding with pulses. One of them is shown in Fig. 5. In the present report, we show some fundamental experimental data collected before testing cold fusion with one of the three prototype engine reactors. First, we measured the compression level due to supermulti-jets colliding in the case of atmospheric air. From the data, we got evidence that self-compression is possible. Second, we added a hydrocarbon fuel around the reactor center, i.e., around the compression point, which resulted in a chemical reaction with large increases of pressure and temperature (see the right-hand side of the figure in Fig. 5 as an example) [13,14]. High thermal efficiencies and nearly complete air insulation effect were obtained from the combustion experiments [13,14,19,20].

5. Concrete Design of the Fusine System

The engine reactor system must be extended to trigger cold fusion in a future cold fusion engine (a "Fusine"), because solid particles such as palladium are necessary. Figure 6 shows unsteady three-dimensional computational results for the supermulti-jets colliding having 17 nozzles with pulsation around the reactor center and also fuel injected from the left position of the reactor [18]. Injection of fuel starts at microsecond zero, while the supermulti-jets of the other vapor reactant enter into the reactor about 550 μs later. A high pressure region over 1 MPa can be observed around the reactor center after 564.8 μs, while fuel is also compressed into the reactor center due to the supermulti-jets after 564.8 μs. Thus, by using the present numerical model [18], we can find optimum conditions including injection timings of H_2/D_2 gases and nanoparticles such as palladium, injection pressure, and injection cone angle (width of fuel injected). A special injection system of solid particles designed by using the numerical model [18] can be developed with durability.

6. Conclusion

Most of the studies on cold fusion have been done with closed reactors until now. Thus, the open reactor systems shown in Figs. 3 and 5 will be important for the actual implementation of cold fusion phenomenon. We have started to make a concrete reactor system including one with nanoparticles, and we will also perform fundamental experiments. In the near future, we will report the results.

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