Date: April 16, 1980

Project Title: "Evaluate Molecular Heating Concept and Principles of Operation"

Project No: G-41-605

Project Director: Dr. William Harter

Sponsor: Tennessee Valley Authority

Agreement Period: From November 15, 1979 Until December 31, 1979

Type Agreement: Contract No. TV-50547A

Amount: $921

Reports Required: Final Report

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Defense Priority Rating: N/A

Assigned to: Physics (School: EES)

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Date: 10/14/80

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Project No: G-41-605

Project Director: Dr. William Harter

Sponsor: Tennessee Valley Authority

Effective Termination Date: 12/31/79

Clearance of Accounting Charges: 12/31/79

Grant/Contract Closeout Actions Remaining:

- [X] Final Invoice
- Final Fiscal Report
- Final Report of Inventions
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CA-4 (1/79)
Review of Molecular Heater Presentation for Tennessee Valley Authority

1. Introduction

The presentation of the Molecular Heater contains a schematic diagram in Section I, a seven page description of theory in Section II, fifteen or so pages of test results in Sections III and IV, and a number of advertising circulars, testimonials, tests, and clippings from newspapers and Readers' Digest. Finally, there is a copy of two pages, presumably from an encyclopedia discussion of the Peltier, Seeback, and Thomson thermoelectric effects. The energy source for the heater consists of four 375 watt infrared heater lamps. The presentation claims that this heater is better than other 1500 watt devices. While they do not mention it, a comparison could be made with a national brand sold at K-Mart for under $20.00.

There are five claims made on pages 1-3 of the presentation. (1) The heater "holds the heat near the floor". (2) It does not force moisture "to move through the walls and ceiling" since it "is not a forced air system". (3) It "destroys common household irritants such as cigarette smoke and foul odors". (4) It "can do the job of heating with substantial savings on our rising fuel bills" and "can heat 400-800 square feet of living area while using 1.6 Kw of electricity". (5) "Finally, the system is portable."

Obviously, claim (4) is the important one, and so this review will attempt to deal with it first. The last part of the claim about heating 400-800 square feet actually has no meaning by itself. If one is allowed an arbitrary amount and quality of insulation it would be possible to heat that area comfortably with a 40 watt light bulb on a cold day. Obviously, nothing would be needed to heat any area on a warm day. The part of the claim about "substantial savings" is the key issue. How these savings will be obtained
is important. On page 1 the following warning is written.

"This heating system is unlike any other on the market today. Before we get started, it is fundamentally important that we forget anything we know about other systems. Any attempt to use old concepts related to Forced Air systems will lead to confusion. This is a new system that utilizes new and somewhat difficult concepts. An open mind is essential for a good working knowledge of our product."

On page 3 the warning continues.

"This is the portion that demands your patient attention. This is not a heater! It is an energizer. The sole purpose of the unit is to energizer (sic) Oxygen molecules."

The presentation implies that if 1500 or 1600 Watts are put into the molecular heater some extra benefits in the form of warmth or energy will come out above and beyond that which emerges from comparable heaters. Furthermore, an "open mind" which has forgotten "anything we know" is required to understand "new and somewhat difficult concepts."

However, forgetting principles or "anything we know about other systems" is usually a mistake. One should have an open mind as long as it does not mean an empty mind. The history of science and technology shows that new principles and inventions have usually come from people who learned more than anyone else about their systems, whereupon they discover more precise statements of principles. Physics principles undergo an evolution; seldom if ever do they experience a revolution.

Therefore one should expect the theory in this proposal to contain more detailed and accurate information about molecular energetics than anywhere else. One should expect clever and skillful application of new or existing hardware. What this reviewer found is discussed in what follows.
II. Discussion of Molecular Heater Theory

The molecular theory begins on (unnumbered) p. 4 with the following. "Before going ahead a little talk about the oxygen molecule is necessary. First, 1 molecule of oxygen contains 8 electrons in its normal state. Normally 8 electrons assume orbits around the center or nuculus (sic) of the molecule. Each electron assumes an orbit further and further away from the nuculus (sic)."

The first scientific claim in this proposal is totally wrong. Also, "nucleus" is misspelled. The oxygen (O\textsubscript{2}) molecule has two atoms, two nuclei, and total of sixteen electrons. It should be also pointed out that the atmosphere in a room contains about 78\% (by volume) nitrogen (N\textsubscript{2}) but only 21\% oxygen (O\textsubscript{2}). It also has 0.9\% argon (Ar), .03\% carbon dioxide (CO\textsubscript{2}), small variable amounts of water (H\textsubscript{2}O), and trace quantities of CH\textsubscript{4}, N\textsubscript{2}O, CO, H\textsubscript{2}, NO\textsubscript{2}, and rare gases.\textsuperscript{1} (This does not account for any "smoke and foul odors" alluded to in claim (3).)

The next step involves the interaction of the oxygen molecules with some "projectiles" in the molecular heater. "The 288 projectiles now take over. The temperature difference between the plate and the tip of the projectiles creates a potential difference. The result is a flow of electrons, negative charges...through the projectiles. The fan...keeps oxygen molecules flowing by the front on the plate where the negatively charged projectiles are ready."

An examination of our molecular heater revealed that the "projectiles" were common crating nails. About 300 nails have been driven through a vertical sheet metal plate to make something that resembles an Indian Fakirs' bed.

The key to operation of this heating device is a supposed potential difference along the crating nails. They do not mention the Seebeck Effect. However, one presumes this pertains to an included copy of pages from an encyclopedia. The copy reads: "If one end of a conductor is heated...an
electric current... (will) flow along the conductor. This is called the Seebeck Effect." However, they apparently did not understand the rest of the description: "In order to observe current...or voltage...it is necessary to have a circuit..." A single crating nail in a metal plate with its head facing a heat lamp does not make a Seebeck thermocouple circuit. Furthermore, a better encyclopedia will give the values of the Seebeck coefficients. It is not mentioned in the proposal whether the designers checked to see if the sign of the crating nail-sheet metal coefficient was (+) or (-). It doesn't really matter. The magnitudes of the metal-metal coefficients are tiny, typical a few micro-volts per degree. Given that several thousand volts are needed to create appreciable amounts of $O_2^-$ negative ions, one concludes the best possible arrangement would miss doing this by a significant factor.

For the sake of argument let us assume with the authors of this proposal that $O_2^-$ negative ions are produced in abundance. The consequences of this assumption should be pursued now since there are ways they could make ions.

The effect of the electrons is described on p. 4.

"...every electron added increases the size of the molecule. In...

oxygen adding a 9th electron would increase its size 4 times. ...when this is done we are adding a little bit of energy to the molecule."

It should be observed that the reaction

$$O_2(3_{1g}) + e^- \rightarrow O_2^- (2_{1g})$$

yields an $O_2^-$ molecule in a slightly lower, not higher, energy state (see Fig. 1) with only about a 10% increase in inter-nuclear distance and small adjustment of the outermost orbitals. Nevertheless, the proposal continues:

"If a molecule now moves in front of the plate a reaction occurs. ... The (-) charges on the projectiles attract the protons ... the end result is that the molecule has all its (+) charges on the side near
Figure 1. From Molecules and Radiation

Figure 3.10 Potential energy diagram for O₂ compiled by F. R. Gilmore (Reference 7).
[Reproduced with permission of F. R. Gilmore, The Rand Corporation.]
the plate and all the (-) charges ... away from the plate.

Because the charges ... have been separated, a similar reaction occurs in other molecules across the room. In a short time all the oxygen molecules become alligned such that each one has its charges separated."

This is a grossly exaggerated description of polarization which could never occur in a gas. Such alignment of molecules is only possible in polar liquids or solids with large electric fields.

Nevertheless, the authors of the proposal continue and get themselves in deeper on p. 5.

"Soon excess electrons are attracted off the projectiles ... by the oxygen molecules. The result is that ... the molecule increases in size by 400%. Remember the 9th electron represents a little bit of energy. The same process is repeated ... until there are many oxygen molecules becoming energized. This process is called ionization."

Now it appears that the device would not be a heater but a \textit{cooler}. All those \textit{O}_2 molecules out in the room have less energy than their healthy neutral \textit{O}_2 cousins. They are just liable to take it all back and reduce the room temperature.

However, the authors have tried to leave a way out on p. 5.

"Although ionization is one way to energize oxygen there are two other factors that are probably aiding in the heating process. First, oxygen can be energized by direct absorption of infra red energy. When this absorption occurs one of the 8 electrons is excited such that it jumps to an orbit further away from the nucleus. From this point it produces heat as an ionized molecule would. Second, water vapor is a very efficient absorber of infra-red."

The first allowed electronic transitions in \textit{O}_2 which may be caused by radiation are the (\textit{^3}\Sigma^- \rightarrow \textit{^3}\Pi_u) bands. All lower transitions are forbidden.

In Fig. 1 we see that \textit{^3}\Sigma_u^− \ lies about 6 eV = 48,360 \text{ cm}^{-1} \ above the ground state \textit{^3}\Sigma^-_g. \ Unfortunately, infrared radiation falls in the 500 \text{ cm}^{-1} \ to 14,000 \text{ cm}^{-1}
region of the spectrum. Visible light goes from 14,000 cm \(^{-1}\) (red) to about 30,000 cm \(^{-1}\) (violet). The allowed excitation of \(\text{O}_2\) requires so-called vacuum ultraviolet radiation which is not supplied by the heat lamps in this heater.

Possibly one should emphasize that forbidden electronic infrared transitions in oxygen are not absolute. However, their probability is very low. It is difficult to impress upon oneself just how low this is.

The report continues by showing what consequences are claimed for the non-existent electronic infrared transitions.

"It has completed its assignment .... (and) energized oxygen molecules in the room. ... The molecules being bigger must collide ... more frequently. ... the excited electron releases its extra energy in the form of heat due to friction ... The walls ... gain heat. The reason why the temperature is uniform is because energized molecules are heavier. Why are they heavier? It is because they are not super heated .... Because they are not super heated they do not rise to the ceiling. ..."

The mass increase of even the electronically excited (6 eV) oxygen molecule is quite small. The famous \(E = mc^2\) formula gives

\[
m = \frac{E}{c^2} = \frac{(6 \text{ eV}) (1.6 \times 10^{-12} \text{ ergs/eV})/(3 \times 10^{10} \text{ cm/sec})^2}{1.1 \times 10^{-32} \text{ gm}}
\]

which is only about one over five billion times the mass (\(m_{\text{O}_2} = 5.3 \times 10^{-23} \text{ gm}\)) of oxygen. This excess weight doesn't affect its distribution. In fact oxygen weighs a full 10\% more than nitrogen, yet we do not find that the distribution of oxygen to be noticeably different from the nitrogen in our atmosphere.

At this point the balance of the claims for the Molecular Heater is less scientific.
"It is easy to see why cigarette smoke is destroyed. It is simply being beat to death. You have to admit that this is a nice side benefit to the system."

This does not correspond to any known theory of molecular physics. The average rms speed of N₂ and O₂ molecules is many hundreds of meters per second even in very cold air. A trained physicist should be aware of what sort of "beating" is going on naturally. Small amounts of beating affect this very little.

The concluding paragraph of the presentation is the following.

"Finally, many people will say there is no way to create so much heating using so little electricity."

However, their supportive conclusions repeat the same incorrect claims.

"The answer is that we are not using the bulbs to create heat. We are using them to create electrons to change the structure of oxygen molecules. The oxygen molecules then do their thing."

Included in the presentation was a Xerox copy of a Readers' Digest reprint of an article from the Rotarian magazine. The article discusses the benefits of negative ions. Given what has transpired it is hard to lend this much relevance. If the desire is to make ions then uv-lamps should replace the infrared bulbs. However, the result would be an even worse heater. It would put out ozone O₃, and various O₂, O₃, NO, NO₂ ions and radicals. These would proceed to rot and bleach the furniture and do unknown damage to humans, plants, and animals.

One must conclude that the infrared heat lamps excite the normal infrared molecular transitions to rotational and vibrational levels in both N₂ and O₂ in the same way that a resistance heater would do. The only difference is that a heat lamp puts more energy into the near infrared and visible regions of the spectrum. This energy may not all show up as useful heat, and this would mean that the molecular heater would actually be less efficient than the electric
resistance heaters.

In conclusion, there are no reasons given by the molecular heater theory which support the idea that their device is better than other heaters that consume the same energy.
III. Brief Consumer Evaluation of the Heater

Before studying the Molecular Heater presentation this reviewer tried the device in his home on several sub-30° evenings. On each occasion the furnace was turned off and the Molecular heater was turned on in a ~350 square foot area of a small dining and living room. On each occasion the temperature dropped from 68° to about 65°. However, it dropped faster with the Molecular Heater than it did with the comparable resistance heater.

Indeed, it does not appear that the Molecular Heater works even as well as the resistance heater. However, it weighs more (about 30 lbs.) and costs more (over $400.00, with cabinet), and it is built like a tank.
IV. Comments on Energy Tests

Any heater works by exciting rotational and vibrational transitions mostly in the infrared region of spectrum. If the heater is matched to a properly insulated enclosure a comfortable steady state temperature range should be reached before the output capability of the heater is less than the heat loss through the walls. Ideally the distribution of energy amongst the radiation and molecular activity should be as close to equilibrium as possible, so that temperature gradients, net radiation flux and air currents are minimized.

Engineers have detailed procedures for testing various parameters. Some tests by Energy Dynamics Corp. are attached to the presentation of the Molecular Heater. However, they are quite incomplete. No data about the insulation or thermal surroundings of the room are given. No indication is given about how close the recorded distributions are to a steady state. While the Molecular Heater seems to be a couple of degrees better than the "forced air electric heater", neither one was allowed to raise the temperature above 65°. A difference of a few degrees could easily disappear when more experiments are averaged or run longer. Also one must question the integrity of the experiments after reading the theory. This reviewer refuses to comment on the testimonials.

If the theoretical presentation of the molecular heater was not such a ludicrous sham, it might be worthwhile to run tests at the National Bureau of Standards. However, it appears that this company has already gone to far in the wrong direction.
V. Conclusion

This reviewer has concluded this proposal does not contain a single shred of scientific truth, and as such, can only serve to mislead consumers ignorant of physics. It is recommended that all claims concerning this heater be rejected until the authors can write a reasonable scientific report. Their very first claims made about the nature of the oxygen molecule should be recognized as errors by a good science student in the fifth grade. What follows is a collection of claims that are non-sequitur and untrue.

VI. References