Anomalous Effects in Deuterated Systems
Melvin Miles
The Correlation of Excess Heat and Helium

Movie Transcript

NARRATOR

Dr. Melvin Miles is an electro-chemist now retired from the United States Navy where he spent a career in battery research.

In 1989, he successfully reproduced the Fleischmann-Pons Excess Heat Effect, a controversial form of fusion-sized heat energy generated by electrolyzed bits of metal and water in a test-tube. Martin Fleischmann and Stanley Pons had found a way to generate nuclear power from water, without the deadly radiation.

Critics claimed it was impossible and held fast to their belief that atomic fusion could only occur in extreme environments, like the interior of stars. These "hot fusion" reactions produce nuclear products harmful to life.

Researchers had reported nuclear products from cold fusion cells, but always in amounts millions of times less than hot fusion theorized, and their production could not account for the amount of excess heat generated.

In a series of three electro-chemical experiments beginning in 1990, Melvin Miles and his colleagues found a nuclear product that matched the heat energy generated in the cell.

The work confirmed the nuclear nature of an as-yet-unknown atomic mechanism and provided a major clue to the origins of a next-generation nuclear power.

TITLE

ANOMALOUS EFFECTS
in DEUTERATED SYSTEMS
MELVIN MILES
THE CORRELATION OF EXCESS HEAT AND HELIUM

NAVY LENR RESEARCH SERIES

MELVIN MILES

I was always a skeptic; you have to be a skeptic. I was surprised that we were getting results.

We had evidence for a nuclear product. Everybody was saying, if there's a fusion reaction, there has to be a nuclear product.

Later that fall, I had heard that Julian Schwinger was proposing that because no one was finding any neutrons or gamma rays that it could be a D plus H reaction - deuterium plus hydrogen going to

helium-3; that does not give neutrons or gammas. So I thought well that might be the nuclear product.

So based on what Julian Schwinger had said, I decided that would be interesting to try to find helium-3 because there's not very much in the atmosphere and that would be quite decisive if it were produced in an experiment.

The cell itself was a small test tube, it was filled with about 18 milliliters of electrolyte, not a lot it was rather small. It was inserted into another glass tube that was bigger and in between the two, we filled it with water. So we measured the temperature in the second liquid, so the cell acted just as a heater.

Surrounding that was insulation in a plastic container, and that was our calorimeter put in a constant water bath.

Palladium was at the center of the test-tube, the counter electrode was a platinum-rhodium counter-electrode. I used the same electrodes three or four different times, and each time they gave excess heat. So I knew that we could probably get excess heat. We just needed to collect the gas samples coming off for Helium analysis.

The gasses coming off did not go into the atmosphere, they went through a flask where we collected the gas in what we call an Erlenmeyer flask, 500 milliliter. It went in and it came out. The exit was through an oil bubbler, so it comes out as a bubbling oil, and it bubbles to the atmosphere. The atmosphere cannot flow back through the oil; there's no way that air could flow in. It's closed in the sense that its bubbled through oil.

Also its under positive pressure. Because of the oil bubbler, we had a little higher pressure inside than was outside, so the tendency would be for something to flow out, not flow in, if it found a place where it could do that.

When we first put the flask in position to start with, then we would pass this boil off nitrogen through the whole system for maybe thirty minutes or so, just to flush everything out, because when you put a new flask on, it probably has air and a little bit of helium-4 in it, so would spend thirty minutes flushing before you're even worried about doing any measurement. But you would leave the flask in place often for a week or more, at least several days, before you disconnect it.

And when we have a good excess heat effect, and decided to collect the gas, we would just close the inlet valve on the flask and close the outlet valve on the gas and trap it inside, and remove it from the line.

Overnight it would be shipped to Texas. The university had a person dedicated to mass spectrometry so Ben worked with him.

But Ben had some good ideas about how to pass it over activated charcoal at liquid nitrogen temperatures, so the D2 would be slowed down, and the helium-3 or helium-4 would not absorb in the activated charcoal at liquid nitrogen temperature, and it would go on into the mass spec first. They don't go in at the same time, so we didn't have to worry too much about contamination and problems with D2 which also has a mass 4 because it would be slowed down, it would be separated.

NARRATOR

A search for helium-3 required extra precaution to prevent contamination of helium-4 from the atmosphere. The entire system was self-flushing and under positive pressure.

While Navy labs were generally well-equipped, the flasks were then taped shipped by express mail to post-doc Benjamin Bush at University of Texas Austin where a sensitive mass spectrometer would measure the helium in each flask.

To eliminate any bias by Bush, the flasks were coded with the birthdays of Miles' friends and family.

MELVIN MILES

So he never knew which flask had excess heat and which one didn't. And sometimes we had large excess heat and sometimes small. And it turned out in analysis, when we had large excess heat, we found more helium.

We couldn't put a number on it cause we didn't have it quantized, but the ones with more heat gave more helium, and the ones with less heat gave less helium. We found that as a correlation also.

And early on there was no heat, and that sample had no helium. So when there's no heat, there's no helium. When there's large heat, there's large helium. When there's smaller heat, there's smaller amounts of helium, though we didn't have the accuracy to put a number on it. We guessed at the accuracy, but we were off by a factor of ten.

We first ran controls in January 1991, we ran water, and those did not produce any excess heat and those did not produce any helium-4 six controls that we ran.

NARRATOR

Cells that made excess heat, all made measurable helium. Without knowing exact numbers, the amount of helium followed the amount of excess heat generated. Higher excess power, generated higher helium; when there was no excess power, there was no helium.

But it wasn't helium-3. It was helium-4. Since the atmosphere contains a small portion of helium-4, how could we be sure no helium from the atmosphere contaminated the flasks?

MELVIN MILES

If any air leaked in, the mass spectrometer would have gone of-scale for helium-4. If it did develop a leak, you would be way off because we were measuring parts per billion and the helium in the air is parts per million.

The only way helium could get in is it could diffuse in, but that's very slow. We later learned that was not fast enough to effect our results.

NARRATOR

Diffusion of helium through the glass flask or rubber tubing was the only way helium from the atmosphere could enter the system. Later experiments would show that this diffusion is too small to effect the results that pointed to a possible reaction pathway.

MELVIN MILES

When you do the calculation with the amount of heat that we were getting, if you're are getting 100 milliwatts of excess heat, just by the calculation of the D+D fusion reaction, you'd expect in the flask over that time period it would take to fill the flask, you'd expect about 5 parts per billion and that's about what we were getting. We were getting the right amount based on the amount of excess heat that was measured.

You have to have products to prove a reaction. In a nuclear reaction, you have to have some nuclear product, and nobody knew what that was. It was not neutrons, though everybody was looking for neutrons.

And it was not helium-3, because we did not find helium-3.

So it was helium-4.

This is not the only explanation, but the most likely one I think is D + D fusion going to helium-4 and energy that was captured inside the cell - not a gamma - because if it was a gamma, it would be a 23.8 MeV gamma, and that would go through the cell, out the cell, through the walls of the building, into the next building and it could go a long ways away before it could be detected. So a gamma could take all that energy away you would not necessarily be measuring excess heat.

But somehow that energy in a cold fusion experiment gets converted to heat in the cell.

NARRATOR

There are several fusion reaction pathways that take deuterium to helium, each making a different amount of energy. The number of helium atoms that Miles and Bush were counting and the excess heat measured matched closest to the energy corresponding to simple deuterium fusion to helium-4. But unlike hot fusion, there was no gamma photon. The cold fusion reaction made heat instead.

MELVIN MILES

I was hoping Schwinger was right. I was hoping it was D + H going to helium-3; no neutrons, no gamma rays. That's what I hoped for, but that's not what we found.

Shortly after that, we started getting visitors that wanted to come check on us. Brian Oliver, who was working down near LA for Rockwell International, and he was the foremost helium expert in the United States. And he came and talked to us, and he saw what we did, and he did not have much criticism.

But he wanted to do his own studies, and that was our second series of experiments, was to get samples and send them to him. The trouble was, the electrodes that had worked so well we had ran the controls

in regular water, so they were contaminated by then with regular hydrogen - so we tried new electrodes and we could not get the excess heat, so we went almost the rest of that year 1991 trying to get an excess heat effect to send to Brian Oliver.

But it took us to almost the end of the year before we got an electrode - we got another Johnson Matthey wire it was 1 mm diameter smaller, and I finally got an excess heat effect with that - not a large effect, not as large as I wanted, but one sample we collected at 100 mW, another sample we collected at 50 mW excess power, and the third sample was 20 mW of excess power, which is borderline based on my calorimetry.

What he did, he would measure the helium diffusion into the flask each day for over forty days, he got a straight line. It diffuses in and gives a straight line, and he extrapolated back to when we disconnected the flask, and that would be the amount that was in there when we disconnected the flask.

The one with 100 mW gave the highest results, the one with 50 mW gave the middle results, the one with 20 mW gave the low results.

We did not tell him which flask was which. We reported it to Dr. Lagowski at University of Texas. And Brian Oliver did not tell us what he had measured. This was reported back to Dr. Lagowski at University of Texas, so it was double-blind. I did not know his results, and he didn't know my results.

But it fit exactly what we had measured. When we got more heat, we got more helium. And he was measuring to 0.1 parts per billion accurately - 0.1 parts per billion.

There's a little bit of helium that comes through this thick rubber tubing, so there's a little bit of background, and I later found out what that was, so a couple years later I subtracted the background, and all three came very close to the expected value of 2.6 x 10^11 helium atoms per second per watt. I came very close to what you would expect for the D+D reaction.

EDMUND STORMS

Quite a number of efforts were made to find helium, and they did in fact find helium, but here's two that made a correlation between the amount of energy and the amount of helium.

This is the amount of helium that should be detected, that is, the helium to watt-sec, or the amount of helium to the amount of energy based on the mass change going from two deuterons to helium, and this is the data.

These are two different data sets. The open circle points were made first, they have a somewhat larger scatter. That was done with an isoperibolic calorimeter. Later, somewhat better work was done with a Seebeck calorimeter, a little less air, but you'll notice, they are all in basic agreement.

MELVIN MILES

That was the most accurate measurements that I had ever done. The top expert in the United States Brian Oliver measuring the helium content at the time zero when it was disconnected and within 0.1 parts per billion, and there was at least ten sigma difference between the different experiments.

The first set we had large excess heat effects, some of the largest I had ever seen, but the helium

measurements were not as accurate as the second set.

The second set, we had smaller excess heat effects. The second set was much more accurate helium-4 measurements, the most accurate I ever had done. He was able to measure to +/- 0.1 parts per billion.

NARRATOR

The tiny amount of excess heat in the second experiment made an extraordinarily small amount of helium. Still, an expert in helium measurement confirmed the earlier results. To within one-tenth of one part per billion, the amount of helium followed the amount of excess heat generated from the cell. But critics weren't listening.

MELVIN MILES

Well, because that was always the criticism, was that helium could get in - helium can diffuse through glass, that's their argument. Even though we showed the rate is so slow, that it could not have affected any of the results that we had.

In fact, Brian Oliver took account of that when he measured the helium increase over a 40-day period, he was measuring the diffusion and extrapolating to zero time when no diffusion could have taken place.

But this was a year or two later, and nobody was paying much attention anymore to cold fusion that's the problem, you didn't get a lot of attention except in the conference publications.

But to dispel any question of helium diffusing in, Ben Bush, he was with me working at China Lake, and I wanted to do an all metal system, and so we designed these flasks, and Ben Bush did a lot of the work on that. But it had a metal to metal seal - even the seal did not use anything other than metal against metal - so there's no way that helium could get in, because metal doesn't allow that.

And then Ben Bush left before we did the measurements, so the next year when I was getting excess heat, I was collecting samples in the metal flasks and shipping those off to Amarillo, Texas.

And they could measure accurate enough that even when there was no heat, they could measure background. The background was maybe 2-3 parts per billion, and then when I had excess heat I would get up around maybe 9-10-11 parts per billion, and their error was +/- 1 parts per billion.

And that was the background that I used to subtract off the second set of experiments,

I subtracted the background and when I did that I got very close to the 2.6 x 10^11 helium atoms per second per watt, if you want to put it terms of a rate. That's what everybody tried to prove, that it is close to that number predicted by theory.

NARRATOR

Deuterium fusion to helium-4 is accompanied by 23.8 Million electron-Volts of energy for each helium produced. There should be 260 billion (2.6 x 10^11) Helium atoms generated each second for every watt of power generated. But these three experiments showed slightly less than that amount of helium. Why wasn't the amount of helium found exactly matching the excess heat measured?

MELVIN MILES

One reason is the excess heat is not exact.

The second reason is, measuring the helium is not exact, so you're going to have experimental error in both of those.

And the third reason is not all the helium escapes from the palladium, some can remain trapped in the palladium. So you have those three possibilities.

I'm surprised it came as close as it did, though critics claim because it didn't come closer it may not be correct.

EDMUND STORMS

They are in basic agreement, but they are all lower than what's expected. They're all lower on average by a factor of two, and that fits with how we understand the process to work.

The process takes place on the surface of the cathode. The helium made there has two choices, it can diffuse inward, and not be detected, or it can diffuse outward towards the surface, where it will go off as a gas, and then be detected by the later analysis, and, there's a 50-50 chance of it going in either direction.

MELVIN MILES

I think it came as close as you could expect based on the experimental error of both excess heat measurement, excess power, and the helium measurements, and the fact not all of the helium can escape necessarily.

So you don't get an exact number. I'm not surprised at that at all.

A fourth reason that I left out, is that we are assuming everything is due to D+D fusion, but there might be a side reaction forming tritium, for example, and that would change the value of energy you would get. So you will not get an exact value.

You'll get the exact value if you have 100% of the reaction being D+ D fusion, you have no error in the helium measurement, you have no error in the excess heat measurement, and all the helium gets out. Then you might get an exact number. But if there's some other reaction going on as well, then it will be different.

NARRATOR

While error occurs in all types of experiments, the correlation between the excess heat and helium in palladium-deuterium systems have been reproduced many times since.

MELVIN MILES

There were other people, I think another name is Gozzi in Italy later reported helium-4, Bockris found

helium-4 in the palladium based on Brian Oliver's work; Brian Oliver did the measurements. Another person is Arata in Japan. De Ninno and other people in Italy also found helium-4 and they did a very good job. This is quite a few years later.

I think the best evidence that I was correct comes from Mike McKubre and the experiments he did at SRI. They had a closed calorimetric system, where they recombined the D2 and O2 so that the gasses never escape, so they can keep collecting the gas and the helium can keep increasing over time.

So he can show how the helium increases over time because it doesn't flow out of the cell; it keeps building up. It even gets higher than the room concentration of helium-4; it gets above the 5.2 parts per million helium-4 in the room, so how can it diffuse in when it's higher inside the cell than outside? I would say that is the most substantial proof that what I did was correct.

The first set of experiments measured by the University of Texas, the second set of experiments measured by Brian Oliver at Rockwell International, top expert in the country for measuring helium-4, and the third set, ran in metal flasks, where Helium could not have diffused in, because it was an all metal system, and that was measured by the Department of Interior in Amarillo Texas.

And all those experiments agree, there's helium-4 measured when there is excess heat, and with no excess heat, you don't see helium.

An exact calculation can be done mathematically, it's complicated, but it comes out, to get the right results 30 out of 33 times, the chance of that happening, just by random, is 1 in 750,000.

A simple way to think of that statistic is that if you were flipping a coin, and you want to predict heads or tails and you could do that correctly 30 out of 33 times, that would be similar to the results I had, and it would be rare that you'd ever get that by chance.

NARRATOR

Experimental evidence shows excess heat is commensurate with the amount of helium produced in palladium-deuterium systems. While there is yet no definitive theory that describes the reaction, most of today's leading theoretical models predict helium, though sometimes corresponding to different pathways.

MELVIN MILES

Preparata ahead of my experiments predicted helium-4 would be the major product; Scott Chubb and Talbot Chubb came out with a prediction of helium-4 prior to my experiments, again I didn't know about it until later. There's Takahashi's process with four deuterons coming together, Kim at Purdue, his theory predicts helium-4; Peter Hagelstein explains production of helium-4; and you could add Ed Storms, he predicts helium-4 as well.

I think the only product it could have been, in retrospect, because it was so hard to find, would be helium-4 or helium-3. No other product could escape detection for so long as did helium-3 or helium-4 because those are very difficult to detect. The amount is very small, you have to have very accurate mass spectrometry done, you have to be able to measure down to parts per billion, or 0.1 parts per billion, and unless somebody has real expertise to do that, you had to go somewhere - I had to go somewhere that expertise existed, they couldn't do the experiments in their own lab.

NARRATOR

The China Lake research program closed in 1995 after losing funding. Once recognized for his outstanding work, Dr. Miles was told to report each morning to the stockroom clerk for inventory. He chose instead to go to a new lab in Japan where he again re-produced the excess heat effect using the co-deposition method.

Today, further re-production of these experiments hopes to convince the broad mainstream of science to once again look at this work and help to uncover a new phenomenon of nature and a green solution to our global energy needs.

MELVIN MILES

If you work in this field, and you see the effects, and you know its real, and you know its very important, and anything else is much less important in your mind, and in truth really, in reality; it's much more important than battery research.

And so, that's what you want to do, you want to do something as important as possible, and that was cold fusion. That's why I wanted to do it.

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Melvin Miles The Correlation of Excess Heat and Helium

with Melvin Miles

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