Report of Excess Heat and Neutrons from Russian Experiments

Sergei Tcvetkov Work in Nurnberg Shows Encouraging Results with Titanium and Deuterium

Marianne Macy*

Sergei Alekseevich Tcvetkov is a molecular physicist with two specialties, along with many research interests that include his work using cold fusion for transmutation of nuclear waste products. His specialties are the physics of nuclear power reactors and the separation of isotopes. His other research includes tests of material of biological protection for nuclear power reactor installations on gas evolution, along with system engineering of the analysis of micro impurities for a system of clearing high temperature helium gas reactors. He has done analysis of micro impurities in hydrogen and inert gases in clean rooms.

Tcvetkov has long concentrated on the loading of titanium and palladium by deuterium from a gas phase along with initiation of cold fusion by laser radiation. An in-depth analysis of all his work on titanium from 1989 to 2011 is available in a 2012 *Journal of Condensed Matter Nuclear Science* paper ("Initiation of the Cold Fusion Reactions by Air Components," Vol. 8, pp. 23-28). This paper shows the development of his experimentation and ideas.

Sergei Tcvetkov and Natalya Famina, Italy 2015

"The principal difference between my experimentation and that of other people is involved with the gas loading," Tcvetkov says. "This is the principal difference between my work and Fleischmann and Pons and Michael McKubre. It is different from Andrea Rossi and Francesco Piantelli. Their system is hydrogen and nickel. I have deuterium and titanium. If you analyze our patent application we have submitted in the European patent office in Germany, the difference of the two directions of research is described in detail." (See: http://www.google.com/patents/EP2701157A2?cl=en&hl=ru)

In July 2015, Tcvetkov, assisted by Natalya Famina, whose long and dedicated service in translation has facilitated the communications of scientists from Russia, spoke to Marianne Macy and Michael Melich about Tcvetkov's recent work. Tcvetkov believes he is at a stage where he is ready to seek additional large-scale funding to make a low-energy nuclear reactor plant based on his system. Tcvetkov says, "We have determined that as a result of the interaction of titanium with deuterium, a huge amount of excess heat is produced. And some neutrons are registered, which proves the nuclear character of all these processes. Based on this data we are now starting the actual design of the set-up and the actual design of a heating device, to produce electricity based on the reactions described. It goes without saying that this work requires large financial backing and that is what I am looking for. We are now negotiating with some investors who want to invest in this project. These negotiations are still going on."

A prolific experimenter and author, Sergei Tcvetkov has edited two books and authored 22 papers in journals and conferences. Most recently, he has been working on developing a LENR reactor technology using titanium and deuterium, working for a private company in Germany. He agreed to describe his recent work for *Infinite Energy*.

How did Tcvetkov decide to work with the metal titanium? He explained the antecedents of the research: "At the time Fleischmann and Pons declared their experimentation, it happened that we were engaged in experimenting with titanium, to use it for material for biological shielding from nuclear radiation. I was working with an experimental nuclear reactor. This work was done near Ekaterinburg, Russian Federation (Sverdlovsk, USSR at the time) at the Beloyarsk Nuclear Power Plant. The work was considered dangerous and as a result I was entitled to early retirement."

Today, Sergei Tcvetkov, supported by a small company in Germany, has managed to construct the experimental device and done more than 60 runs on the installation. He claims to have excess heat and neutrons in each experiment that is reliable and reproducible.

Michael Melich, a professor of physics at the Naval Postgraduate School in Monterey, California, has worked with many Russians on research projects and has learned how to clarify points left ambiguous by language differences. Melich assisted with scientific translation while Natalya Famina supplied the English-Russian translation of the conversation with Sergei Tcvetkov. That conversation follows and is reproduced in transcript form to serve the dual purpose of reporting Tcvetkov's work and illustrating the complexities of scientists coming to understand what their colleagues are working on.

Tcvetkov: Right now with my protocol I can give you exact figures. Here are the results of my measurements. This protocol reflects the latest experimental results. The figures reflected are the most recent. The excess heat, the calculated excess heat, is deuterated titanium at 573 degrees, the sum of COP is 1.789 Joules, or 1 degree per gram…131 Kj…For the time of 190 seconds this amounts to 695 Watts. The extended power for the heating of the sample is calculated at 153 W. That means that the excess power coefficient is 224. This is the data coming from one of the experiments.

Melich: Let me go back with you and review what was just said. You have 2 grams of titanium deuteride…

Tcvetkov: The sample is 3 g per one cubic centimeter. The additional mass is 6.9 g. The sample is about 7 g.

Melich: So, the sample of 7 g is loaded with deuterium…

Tcvetkov: Yes.

Melich: And the temperature rises to 600°C…560…

Tcvetkov: This is the initial temperature.

Melich: The titanium sample is heated to 580 or 560°C.

Tcvetkov: 573°C.

Melich: Okay the sample is heated to 573°C, with 153 watts of input power.

Tcvetkov: That is the temperature expended to gain the temperature of 573°C.

Melich: Then deuterium is added. And the temperature rises.

Tcvetkov: Up to 1022°C.

Melich: It stays at that level? It stays at that temperature of 1022°C?

Tcvetkov: No, this is the highest point and after that temperature starts to go down.

Melich: So it gets to that temperature within 30 minutes?

Tcvetkov: Within 190 seconds. A bit more than three minutes.

Melich: And then it hits 1022°C…

Famina: After it is saturated with deuterium Sergei switches off the current.

Melich: He turns the heater off. After three minutes that heater is off.

Tcvetkov: No, it is switched off before the saturation starts. When the input of the deuterium starts. In three minutes when the temperature gains 570°C, the heater is turned on again.

Melich: Okay. The temperature is at 570°C. You turn the deuterium on..

Tcvetkov: I turn on the heater when the temperature is 570°C.

Melich: Then let's start at the beginning. The time is zero. Starting the experiment, we turn on the heater. We raise the temperature to 570°C. What time is it? How many minutes have gone by?

Tcvetkov: About 20 minutes.

Melich: And the temperature is 570°C. At time equal to 21 minutes the heater is turned off. And the deuterium is fed to the device.

Tcvetkov: The deuterium is input into the installation.

Melich: In 20 minutes the device T is 570°C and there is no heat and deuterium is flowing. When it is 570°, deuterium is added and the heater is turned off.

Tcvetkov: We first turn off the heater and only then add deuterium.

Melich: Good. Now the heater is turned off. The deuterium is being added. And then in approximately 23 minutes, the temperature equals 1022°C.

Tcvetkov: It raises to 1022°C within four seconds.

Melich: Okay. So when you add the deuterium, the heater is off. The temperature equals 573°C.

Tcvetkov: And the temperature within four seconds goes up to 1022°C.

Melich: So now what happens is at time equal to 21 minutes +4 seconds...

Tcvetkov: The temperature within the three minutes that follows goes down to the point of 573°C.

Melich: Okay. The sample is cooling, which weighs 6 g.

Tcvetkov: About 7 g.

Melich: Okay, the cooling occurs in three minutes but the temperature rise occurs in four seconds.

Tcvetkov: Yes, that is so.

Melich: So you know the heat capacity of the sample.

Tcvetkov: Yes. I do.

Melich: And you use the heat capacity and the temperature change.

Tcvetkov: Yes, in calculation of the total amount of heat produced.

Melich: So you are integrating the temperature, delta T, over the heat capacity and the temperature in that period. I am trying to make sure I understand how you estimate. Let me tell you what I want to do. We know how much material is present. We know that adding deuterium provides an increase in temperature. And we know that it cools off back to the original temperature in a certain time. So we can compute the amount of energy required to raise to a certain temperature.

Tcvetkov: To get the excess heat.

Melich: And that is what you have done.

Tcvetkov: Yes.

Melich: In joules, that number, you say is essentially 1 megajoule.

Famina: He said 100 kJ, that is .1 megajoules.

Tcvetkov: I divided by 190 seconds and I arrived at 695 watts of the energy generated.

Melich: Got it. I understand your calculations. So there is no input power to the experiment after you turn off the heater power?

Tcvetkov: No, of course not.

Melich: And there is nothing in the experiment that could be used as a source of 131 kJ, other than the deuterium in some way interacting with the titanium?

Tcvetkov: That is why I calculate I have expended energy only for the heating of the sample. And no more.

Melich: I am beginning to understand how you get the numbers you get. I believe the calculation of the COP…I have to think a little bit about whether this is a good way to explain what you have. But I am thinking is if you were to imagine that you had some fuel, say gasoline, and then you lit it on fire and therefore ended up burning it, and got a certain amount of energy out…Would you think of the process of burning that fuel in your reactor as needing a COP? Is COP a good way to think about it? Because I am thinking that is what is interesting about the experiment.

Tcvetkov: You are saying COP, coefficient of power?

Melich: What I am thinking is, Sergei, is it more interesting if you ask the question, "How much energy would I have if I burned the amount of deuterium to make it D_2O, deuterium water?" And I say that is the amount of energy I would get just to burn deuterium in oxygen. And then I compare it to the amount of energy you get by burning deuterium with the titanium.

Tcvetkov: The latter one is a chemical reaction. The chemical reaction results in no more than 4 electron volts for a pair for the system of oxygen and deuterium.

Michael McKubre and Sergei Tcvetkov, Italy 2015

Melich: What I'm trying to suggest is that your result is better understood by making comparisons between a chemical reaction with your ingredients as compared to a nuclear reaction with your ingredients.

Tcvetkov: The chemical reaction doesn't result in more than two atoms. If you have deuterium with oxygen then the diffusion reaction results in mega-electron volts. And it is clear that it is one million times more in a chemical reaction.

Melich: Correct. And what I am suggesting is that the device, your reactor, has on a chemical basis only produced a few kilojoules from deuterium fuel. It was chemical. You are getting 131 kJ with the same amount of deuterium fuel.

Tcvetkov: The excess heat that I get in the experiments corresponds to the amount of mega-electron volts for two atoms of deuterium.

Melich: I understand. Yes. What I am suggesting is that in terms of explaining what you have, there are two different terms which are used in the cold fusion world. One is called excess power and the other is called excess energy. Now, when people use the word excess, it means something above something else. It is comparing something to something. When I look at your description of the experiment, what you do is explain that you bring a container with 7 g of titanium in it to 573°. Now you add fuel, deuterium. It looks as if you burn the fuel and raise the temperature to 1022°. And in three minutes it comes back down to 573°. In order for the temperature to rise from 573° to 1022°, you needed to add some energy to the system. The energy added to the system is deuterium interacting with the titanium. When you do that, you have added a certain amount of energy by some way burning the deuterium with the titanium. Now let me stop right there.

Famina: Sergei does not burn it. It interacts.

Melich: Yes, the language is difficult. If I say I have a fuel and I burn it, I don't say whether or not it is nuclear burning or chemical burning. So what I'm trying to do is I am trying to get to the notion of what constitutes excess. So the thing is, if I say I take Sergei's experiment and I do chemical burning, I will get one number for the amount of energy that will be consumed by doing chemical burning. If I say I am not doing chemical burning but I am doing nuclear burning, then what I can say is the difference I get from the energy of nuclear burning compared to the energy I get from chemical burning, I can say his nuclear burning has much more energy in comparison to chemical burning. The word we use—"excess"—means the amount of energy in excess of chemical. So the point that Sergei has made is that nuclear energy in excess of the chemical energy is produced by the device.

Tcvetkov: Are you saying this is applicable to chemical and nuclear burning?

Melich: I am saying we need to know what we are comparing. The term "burning" and how it is used.

Tcvetkov: Chemical burning and nuclear burning.

Melich: Correct. Then we can use the term "excess"…If I do chemical burning, like 1 kJ of energy is produced. If I do nuclear burning I get 131 kJ. So nuclear burning produces a lot more in excess of chemical. The reason we're going through this is that here we are trying to describe your experimental results. What we will be able to report is that your machine, your reactor, will be able to burn the deuterium fuel both chemically and as a nuclear fuel.

Tcvetkov: The chemical reaction exists but it is rather negligible in comparison to the nuclear reaction.

Melich: That is the important message.

Famina: Sergei says this is just one of the many phenomena that is observed during the experimentation.

Macy: We have talked about the heat; now let us talk about the neutrons.

Tcvetkov: I register neutrons.

Melich: How many neutrons do you register?

Tcvetkov: We register neutron bursts.

Melich: Are these thermal neutrons that are registered?

Tcvetkov: High energy neutrons with the energy of the order of MeV. But the thermal neutrons are also registered but those neutrons are already cooled.

Melich: How many MeV do you think your neutrons have?

Tcvetkov: The energy produced divided by number of neutrons obtained is 13 million electron volts.

Melich: So that is the average energy of the neutron bursts. Do you consider this to be hazardous?

Tcvetkov: Hazardous meaning irregular? It is just a burst.

Melich: Is the production of these neutrons at 13 MeV sufficiently large enough to create a health hazard? I want to know if people are going to get hurt when you run the reactor.

Macy: He means to say, is it dangerous?

Tcvetkov: Same as a fission reactor. We have sealed ourselves with fission reactors and we can do the same with these fusion reactors.

Melich: The question will be asked whether or not it will require a health certification by the nuclear authorities?

Tcvetkov: There is a probability of neutron bursts…to 13th power per second. That is the probability of the bursts.

Melich: 10^{13} per second?

Tcvetkov: Per second. Such neutrons do not influence too much...Centimeters will be enough.

Melich: How are you measuring the neutrons?

Tcvetkov: Helium-3 detectors.

Melich: Okay, good. Does the time when the deuterium is added to the titanium…When do the neutron bursts occur?

Tcvetkov: Not at once.

Macy: How long?

Tcvetkov: Several seconds have passed before it starts.

Melich: Okay, the temperature is 1022°. Have you seen any neutrons when the temperature is at 1022?

Tcvetkov: Not for such a short time period.

Melich: So you do not see neutrons when the major amount of heat is being produced by the deuterium titanium?

Tcvetkov: We can claim that there is a correlation between this...The system…calculation is separate. It is placed outside the installation so it wouldn't be heated. So it would be safe from the heat. Safe from the system, which consists of all these calculators, the gauges.

Melich: The detectors, yes.

Tcvetkov: So those neutrons should be decelerated, and the decelerator would be affected. A special decelerator. And when they are decelerated to the heat thermal energy they go to those detectors and only after that, they are registered. That is why we cannot talk about the correlation. We can just say there is a correlation between the burst of energy and the neutron bursts.

Melich: When you have the device at 573° and the neutron detector, the helium-3 neutron detector, is sitting outside the reactor, what is the background count of neutrons?

Tcvetkov: It is one pulse per second. That is the count for the background. One pulse per second. The system is devised, or designed, so that it reacts and gives out the signal when the excess of the background attains a value of 4 sigma. The registered bursts may be as big as 10 to 12 bursts—neutron pulses per second.

Melich: Do you have some of the neutron spectra that you could send me?

Tcvetkov: Not yet. Right now I am in negotiations with Alexey Roussetski (from the P.N. Lebedev's Physics Institute, Russian Academy of Sciences, Moscow). Roussetski will work on measurements of the neutrons using his own detectors.

Melich: Very good. Where will that be done? In Germany?

Tcvetkov: Yes, we plan to make it in Germany.

Melich: When will that happen?

Tcvetkov: When we get the amount of funding needed we will proceed with his measurements for the registration in our lab.

Melich: If you were to demonstrate that you could produce these neutrons and also the amount of excess heat you have produced, when will you be able to show it to someone in your laboratory?

Famina: At the moment Roussetski is waiting for his visa to go to Germany. There are some problems with the visa. They will give him the visa no earlier than September. Right now there is a problem with the German visa. It is a nuisance. He has delays.

Melich: Let us just talk about neutrons for the moment. I have one pulse per second background count. I bring the temperature of the reactor to 573°. Now I turn off the heater. And the neutron detector is still the 1 neutron pulse per second?

Tcvetkov: Yes it works permanently, counts permanently.

Melich: You now add the deuterium. The temperature rises to 1022° and three minutes later it is back down to 573°. Has the neutron counter during that three-minute period showed any additional pulses?

Tcvetkov: The experiment proceeds within two hours. The background in neutrons increases by 10%. After I switch off the power supply and deuterium, then the background gets back to the original figure. Besides this, I have gamma detectors. It shows that after the intense situation background increases by 12%. The gamma background increases by 10%. For three months after the experiment finishes, this background decreases exponentially. We suggest that the materials of the installation are activated by the neutrons and that causes the increase of the gamma background.

Melich: Do you have the gamma spectrum?

Tcvetkov: Not yet.

Melich: So you don't know whether or not...what materials have been activated?

Tcvetkov: I can only guess right now. I have the shield around the installation that is polyethylene with 3% boron. The experts told me, physicists, that boron is activated by the neutrons. And the gamma emission is triggered by the boron, activated by neutrons.

Melich: I think the headline is that Sergei has a reliable experiment which demonstrates the production of excess heat and neutrons. Now one more question for Sergei. What is the difference between this experiment and those you have been working on for the last 20 years?

Tcvetkov: My neutron counts and excess heat counts have increased by several times with my latest results. I would say, very cautiously, that I am trying to understand the processes that are going on during my experiments. Very cautiously!

Sergei Tcvetkov and Natalya Famina bid us farewell and said they will keep us informed about the results of forthcoming experiments.

Thank you to Michael Melich for technical and scientific assistance.

*Marianne Macy has been doing oral histories relating to the cold fusion since 2007. She is writing a book on cold fusion's start to the present day. She reports on new energy, integrative medicine and social/business issues.