F R E E   R A D I C A L S

A Weekend Trip to Mars

Nuclear Fusion: Energy for the Future?

by Wilson Greatbatch

By the year 2050 AD, we will have run out of all the economically recoverable fossil fuels. Our natural gas will be exhausted. Our oil will be exhausted. We will still have about 100 years supply of coal left if we are willing to put up with the "greenhouse gases" that result from using it.

We will still have available alternate sources of energy, among them water power, geo-thermal power from the heat deep in the earth, wood power from burning biomass fuels, tidal power from the movement of the tides in the northern latitudes, and solar energy from the sun, which is good for another few billion years. We will have wind power, which is now being utilized more and more, even in the western New York state area.

We will still have uranium and plutonium to fuel our nuclear fission reactors; however, even today we are suffering from the gradual creation of a backlog of our radioactive waste from our nuclear reactors. West Valley doesn't want them. Nevada doesn't want them. Nobody wants them. France develops 90% of their power from nuclear fission energy. They have never had a nuclear accident. But all of their reactors are identical. They are run by nuclear engineers rather than technicians. Indeed, their example of a successful nuclear fission program has been very impressive.

But France has the same problem that we do in disposing of the toxic nuclear residues from their reactors. Nuclear fission energy is undoubtedly a viable alternative for an interim period following the exhaustion of our natural fuels. But it is not a permanent answer and it is quite clear that we need a new source of energy.

I believe that that source of energy will be nuclear fusion.

As we look at the atomic series and the energy content of the elements therein, we see that the elements toward the center of the atomic series have much lower energy than those on the ends. As we get up to the very heavy elements like uranium and plutonium, the energy becomes quite extensive. This is how our atom bombs work and as we convert the heavy elements of plutonium or uranium into the lighter elements toward the center of the atomic series a very large amount of energy is released. Our engineers and physicists have succeeded in taming this energy (which is that derived from the atom bomb) to the point where we have useful electricity. As I pointed out above, France derives most of their useful power from that source. As we progress down through the atomic series to the lighter elements we pass through the center of the atomic series where the energy is quite low, but as we approach the very light elements, like helium and hydrogen, the energy becomes tremendously high, much higher than at the heavy end of the atomic series. This is the area of nuclear fusion whereby fusing elements like hydrogen and certain isotopes of helium we can achieve the energy, which is released in the H-bomb. We have never succeeded in taming this reaction to the point of obtaining useful electricity from it.

Fusion reactions have been predicted for several chemistries. The combination of two atoms of an isotope of helium, ^3He, shows great promise to achieve nuclear fusion energy. However, this has never been achieved in sufficient quantities to produce useful energy. In another words, we have never achieved "breakeven" with our helium reactors. Most of the work on ^3He is being done at the University of Wisconsin in Madison at their Fusion Technology Institute headed by Dr. Gerald Kulcinski and his collaborators.

^3He, although it presents an attractive alternative to nuclear fission energy, presents a triple problem, which must be solved before we can take it into space.

First, we must achieve breakeven with the ^3He reaction. The Fusion Technology Institute at the University of Wisconsin is working on this challenge. The second one to be solved is direct electrical conversion, the conversion of a stream of protons into electrical energy. This challenge is being worked on in the Greatbatch Enterprise laboratories in Clarence, New York. According to the lab's consultant from Columbia University, Alexander Klein, direct electrical conversion has been achieved.

The third part of the project is colonizing the moon. At Greatbatch Enterprise, we believe that when the need becomes pressing we will go to the expense and the risk of colonizing the moon to recover the ^3He from the ilmenite ore, which is readily available up there. We visualize having facilities, a factory so to speak, to refine the ilmenite ore, extract the ^3He, liquefy it and utilize it to power our space ships, which we believe will fly from the Moon rather than from the presently planned space station. We anticipate that it will take at least twenty years to achieve a reasonable reaction rate with ^3He. Within the fifty years we have allotted to us (before our natural fuels run out) we will be able to achieve interplanetary space travel and utilize the facilities on the Moon for ^3He and anticipate travel to Mars, also a non-magnetic planet and which has even more copious quantities of ^3He. It has been calculated that there is enough ^3He on the Moon to supply all the requirements on Earth for a 1,000 years. But we engineers like to look ahead. What will we do after that 1,000 years has gone by? The answer is that we will have to find another source for ^3He and that source is Mars. So, we anticipate travel to Mars within the next fifty years, which will require nuclear power and a new concept of space travel, which this article is designed to present.

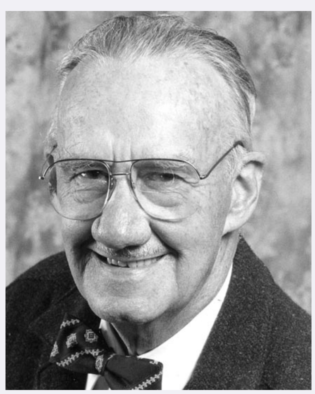
^3He is not the only reaction that will produce nuclear fusion energy. An alternative source, which is attractive to us, is a reaction of hydrogen versus boron. The boron would be the eleventh isotope, 11-B, which has 11 heavy particles in the boron. This reaction has the advantage that the fuel is much more readily available than ^3He on the Moon. The oceans are two-thirds hydrogen; our deserts are largely "20 Mule Team" borax or boron. Thus, the source of fuel is readily available in our country and is much easier to obtain than ^3He from the Moon. However, the reaction is a more difficult one and to date no one has achieved this reaction. We have engaged a consultant who believes that the boron reaction is probably the way to go and we will shortly be undertaking an attempt to prove his work. It will begin about two years from now. At the present time, all this work in ^3He or in P11B and has been done with private funding without any government support of any kind.

We are working on several new concepts. One is that if space travel is to be made safe it will be necessary to design our space ships to travel with a one-G acceleration, possibly a little more; perhaps two Gs if we take off from Earth, although one G would be plenty adequate to take off from the Moon. The history of the United States space exploration has shown that exit and re-entry of space vehicles through the upper atmosphere using fossil fuels to exit the atmosphere, and the high velocity space travel needed to re-enter the atmosphere, are really accidents waiting to happen. You cannot exit and re-enter the atmosphere at 10,000 miles an hour without great risk. Those accidents have happened twice within recent times with two of the space shuttles. We maintain that space travel should be done at not much more than one G. This means that we would be exiting the Earth's atmosphere at little more than 200 miles per hour. For re-entry, as we approach the Earth, we would circle the Earth and slowly decrease orbital speed until we were rotating at the same speed as the Earth, roughly a 1,000 miles an hour, and simply drop straight through the atmosphere with a fraction of the generated heat that our vehicles are seeing now.

The other concept is that at one-G acceleration we can travel halfway to Mars, at the closest approach from Earth, in a little over one day. At one-G acceleration for one day, we would be traveling about 2 million miles an hour. We would turn the rockets off, reverse the space ship and fire the rockets again, and decelerate for a day to get the rest of the way to Mars. We would arrive at Mars with essentially zero velocity. We call this "To Mars in a Weekend." We have presented a number of talks to local engineering societies on the concept. With a couple of simple calculations, it is quite clear that we cannot achieve this kind of space performance with fossil fuels. It will be quite necessary to have nuclear fusion energy before we can do it—this energy source becomes a key part of our space travel.

It is my personal opinion (admittedly highly biased) that we should no longer send people into space until we can assure them the safety, the efficiency, and the comfort of nuclear fusion energy. I think that some sort of progress in this direction is inevitable. It will take time, it will take money, it will take effort. It would take the complete effort of a lot of people who are convinced that this is where our future lies. ■

About the Author



WILSON GREATBATCH is the inventor of the first successful implantable pacemaker. He is a graduate of the Cornell School of Engineering and holds a MSEE from SUNY at Buffalo. He is inventor or co-inventor on more than 300 U.S. and/or foreign patents. He has been inducted into five halls of fame, and has been elected to fellow grade in nine international professional societies. He holds adjunct professorships in five colleges and universities and has been given five honorary doctorates. He is presently an engineering executive and has developed an MRI-safe photonic cardiac pacemaker. His latest research has led him to design a hybrid battery, which should revolutionize the ICD industry. Mr. Greatbatch also has an ongoing research project relating to nuclear fusion of helium-3 as an alternate power source to replace fossil fuels. In 2004 he has started his doctoral thesis titled, "Nuclear Fusion Energy versus War, An Alternative to U.S. Foreign Policy."