Dual Fluid Reactor: Inherently Safe Nuclear Power Till Fusion Comes Online

by Marco Hebestadt

Many people are afraid of nuclear energy, but know virtually nothing about it. The media likes to report extensively about nuclear accidents, but generally ignores the fact that billions of people are suffering and dying because they have inadequate access to energy. There is a clear connection between child mortality and mortality rates in general, and per-capita energy supply. In the land of "German Angst," meanwhile, people are proud to have pioneered the phase-out of nuclear energy. That makes us a laughing stock, because the world is counting on nuclear energy in the fight against poverty.

Not without reason! The great importance of nuclear power lies in its high energy density. The same amount of energy could be generated either by 2 million tons of coal, by 1.3 million tons of oil, by 30 tons of uranium (nuclear fission), or by 0.5 tons of deuterium (nuclear fusion). The wear and tear on roads and the environment, as well as the total energy required to put the energy obtained to productive use, are millions of times greater from fossil fuels than from nuclear energy.

Renewable energies are not free, by the way, because the steel production for wind turbines and the silicon crystal production for solar panels consume a great deal of energy. There is only a limited amount of wind and sunlight per square kilometer available to us on this Earth. Finally, the maintenance of energy infrastructure that consisted only of wind and solar plants, would completely devour the energy they themselves produce. With fusion power, however, we could generate almost unlimited energy from seawater (i.e., the deuterium contained in it).

Why Nuclear Fission?

In this article, however, we shall discuss nuclear fission. It has the potential to liberate many people in Africa and other underdeveloped regions from misery, even before nuclear fusion is adequately researched and commercially available. Nature is not so cruel as to allow only a few people a decent standard of living! Nuclear fission has been thoroughly studied, but many useful technological innovations have not been implemented for the sole reason that the British monarchy and its stooges—such as Hans Joachim Schellnhuber[1]—want population reduction and not progress.

People who live in squalor and have to struggle every day just to survive are all that much easier to dominate. Therefore, their Lordships prefer to talk of overpopulation rather than of underdevelopment. The BRICS countries, however, have a daunting task to overcome if they want to end the poverty and underdevelopment of their populations, and therefore prefer to be guided by reason and not by the babbling of so-called environmentalists.

The establishment of the BRICS New Development Bank, which is intended to serve the public interest, was an important step in this direction. Therefore, the age of fossil fuels is now effectively over. The Chinese even want to bring helium-3 from the Moon to the Earth, because that is the best way technically to achieve controlled nuclear fusion. There are still many problems to solve before this can be done, but we need energy now to improve the deplorable living conditions of so many people. The conversion of "nuclear waste" into energy and valuable raw materials could already be a reality today, but cheap oil and greenie opposition have so far prevented it.

There Is No Nuclear Waste!

I will introduce you to a very interesting new reactor concept from Germany and explain a few basics. But, first, you need to know that there is no such thing as nuclear waste. Nuclear waste is full of energy and raw materials, which are as precious as gold (such as the

1. Hans Joachim Schellnhuber is chairman of the Scientific Advisory Board of the German Federal Government for global environmental change. In 2004, Queen Elisabeth II awarded him the title "Commander of the Most Excellent Order of the British Empire" (CBE), and he has been pushing the deindustrialization of Germany for years.

rare metals palladium, rhodium, and ruthenium).

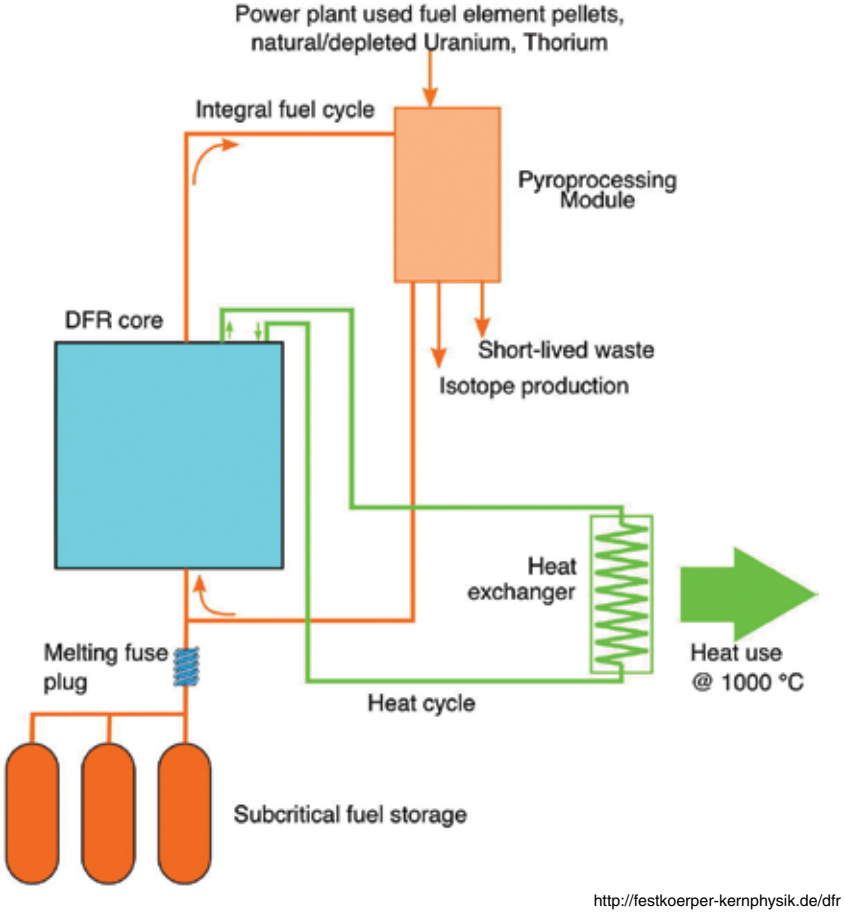
Allow me to explain briefly. It is a bit complicated, but once you understand it, you will know quite a bit about nuclear technology.

The fuel in the reactor core consists of two different types of uranium, uranium-235 and uranium-238. Natural uranium ore is only about 0.7% uranium-235 and 99.3% uranium-238.

That is because uranium-235 has a shorter half-life than uranium-235 and therefore, since the Earth was formed, almost all of it was split in a natural way. Uranium-238 has a very long half-life, however, which also means that it is barely radioactive at all. You can hold it in your hand without any problem. In any case, nuclear power plants currently can only split uranium-235. That means that only 7 kg out of 1,000 kg of natural uranium ore is directly usable.

The reason is that uranium-235 is only split by relatively slow neutrons (referring to the speed of the neutrons in the reactor core; the term thermal neutrons is usually used instead of slow neutrons), whereas uranium-238 is not. With fast neutrons, even uranium-238 can be split. Then it is no longer just 0.7% of the uranium ore that can be used, and the problem of nuclear waste is solved, because the waste consists of 95% of uranium-238. The remaining 5% contains very long-lived radionuclides, which have hitherto required permanent waste disposal. With fast neutrons these can also be rendered harmless (the technical term for this is transmutation). Fast neutrons have also long been used for energy generation (e.g., the Russians' first BN-350 in 1973, then the BN-600 and BN-800[2]). So this is not "just theory"!

FIGURE 1
Dual Fluid Reactor Physical Control Loops



http://festkoerper-kernphysik.de/dfr

The two loops are the fuel loop (red) and the coolant loop (green). The liquid lead coolant leaves the reactor core at a high temperature and moves into the heat exchanger, where it transfers the heat to another medium for commercial use. Now at a cooler temperature, it returns to the reactor. The molten-salt fuel moves through the reactor, where its chemical composition changes by transmutation, fission, or breeding.

The Dual Fluid Reactor

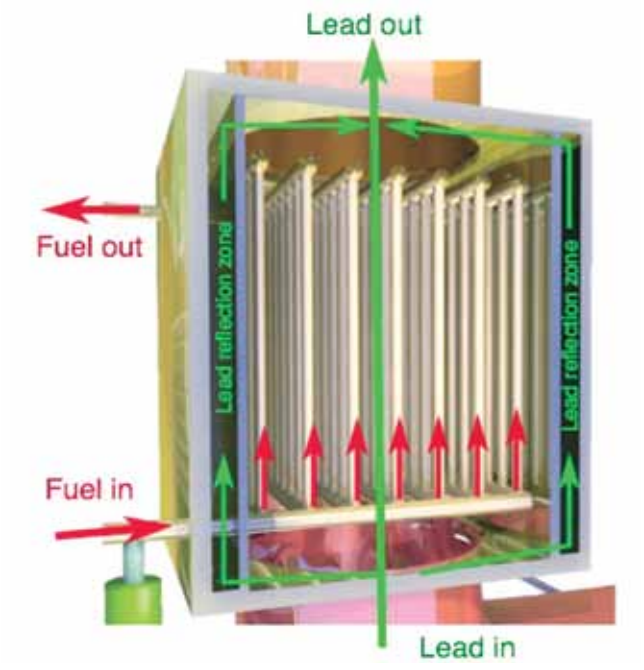
"Does it makes sense to use nuclear waste? No more permanent repositories? No enrichment or reprocessing facilities? Electricity for less than 1 cent per kWh? Fuel for vehicles at 20-40 cents per liter of gasoline equivalent? Isn't that science fiction?" Those quotes are from the website of the Dual Fluid Reactor (DFR) developer. Because the concept is really very interesting, I want to explain here how the DFR would work.[3]

Figure 1 shows the entire system. As in an internal

2. The Russian series of fast neutron reactors have so far been small demonstration models. The BN-800 is the next step, getting up to the commercially viable stage—ed.

3. This is one of a number of designs for a molten salt reactor under consideration. The Chinese are planning to build a demonstration reactor in cooperation with the U.S. Oak Ridge National Laboratory—ed.

FIGURE 2
The DFR Reactor Core



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The number of thin tubes, actually tens of thousands, is reduced for illustration. Molten lead is the coolant; the fuel is a small amount of fissile material, such as uranium or thorium, mixed with molten salt.

combustion engine, there is only as much fuel in the reactor as needed (about 50 milligrams per second). All of what would today be considered "nuclear waste" can be used as fuel. Today's nuclear power plants have a much larger accumulation of fuel in the reactor core, which makes it more difficult to handle, so that elaborate and expensive safety systems are required. At the top right is the Pyroprocessing Unit (PPU), where the loop of fresh liquid fuel is mixed in and what has been consumed is filtered out. Underneath is an intermediate storage tank for the fission products. There are also storage tanks for the liquid fuel (below). The reactor core, which is shown (enlarged) in **Figure 2**, is very small, but has tremendous capacity. The fuel dissolved in the molten salt flows here through many thin tubes. Liquid lead flows through the large, thick tube which surrounds the multiple thin tubes, moving from bottom to top, to draw off the heat. Note also the fuse: If the power fails or is switched off, the salt is no longer cooled but melts, and the fuel flows into the safe, subcritical fuel storage tanks.

The Dual Fluid Reactor was developed in Germany at the Institute for Solid-State Nuclear Physics in Berlin. This nuclear reactor can use all the types of uranium (including the nuclear waste) and even thorium, because it works with fast neutrons. Therefore it is also called a fast reactor (or fast breeder). It has a closed fuel loop and needs no additional fuel rod manufacture, which today accounts for half of the cost of nuclear energy (using only uranium-235).

This is the next generation of nuclear power plants: Just put in the radioactive stuff, and out comes the energy and valuable resources. Permanent waste depositories are no longer needed.

This reactor uses no solid fuel rods from enriched uranium, but rather the fuel is mixed in very small amounts with molten salt (ca. 50 milligrams per second, or ca. 200 g per hour). The energy released is constantly extracted and exploited, e.g. for production of electricity.

The concept is reminiscent of an internal combustion engine, in which the fuel is consumed in small quantities, making the whole process very safe. In this concept, there is a chemical pyroprocessing module in the fuel loop, which continuously controls the mixture of fissile materials and fission products. Nuclear reactors with liquid fuel loops have already been built and successfully tested (e.g., the 1965 molten salt reactor experiment).

For reactors of this kind, which have only one loop, however, there is a slight problem: That single loop has to transport the fuel and dissipate the heat at the same time, making it difficult to draw off the heat fast enough. Then you can increase the fluid's velocity of circulation or the amount of liquid, to cool the system as a whole. Both, however, make simultaneous chemical processing much harder, if they occur during operation, without stopping the system.

With the dual fluid reactor, however, the heat is drawn off through a second liquid cooling loop, which flows around the fuel loop, but is separate from it. The result is a small pyroprocessing module, which only has to deal with the small amount of fluid in the fuel loop per minute. This is a new concept. It allows the DFR to form a closed fuel loop, with everything processed on site. The energy contained in the uranium will be used fully, and no permanent repository is required.

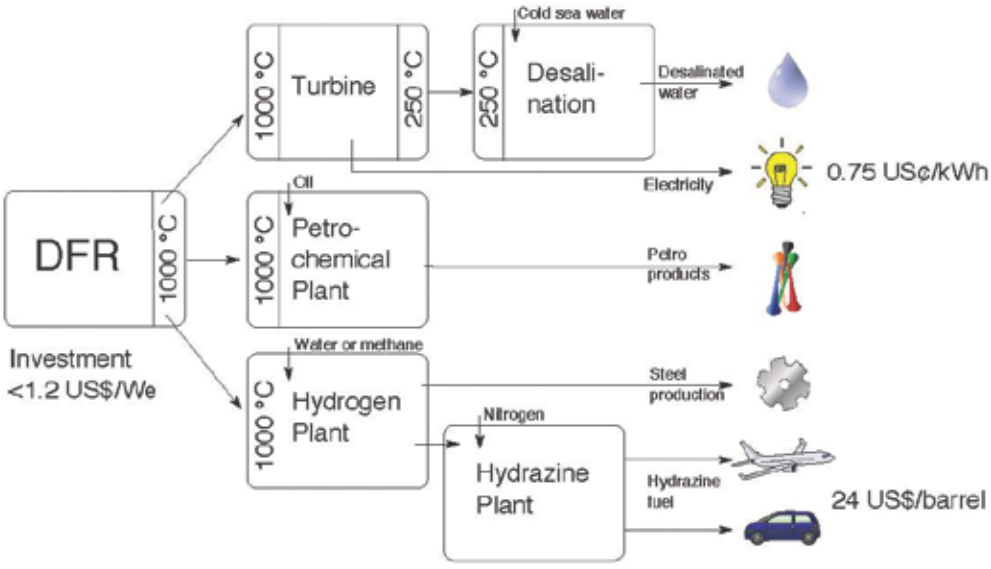
One DFR can, by transmutation, neutralize the transuranic elements and other long-lived fission prod-

ucts that are released by five conventional nuclear power plants in a year (and which currently would require permanent disposal).

Meltdown Is Impossible

A further point which should be even more interesting to most people is that the DFR does not require safety systems, since it cannot overheat. The horror scenario of a meltdown is also impossible, since the melted state of the fuel is normal. Even if an airplane were to crash into the reactor during its operation, only a very small amount of hazardous materials could be released into the environment, because there are only a few milligrams in the loop.

FIGURE 3
Applications of the Dual Fluid Reactor



http://festkoerper-kernphysik.de/dfr

Why is it impossible for the DFR to overheat? Most people know that metals and liquids expand when they are heated. As a result, the atoms are not as close together. Similarly with the DFR, the liquids in the loop expand when the reactor gets hotter.

Thus by design, the neutrons (which drive the nuclear fission process) more rarely encounter the fissile material, the fission rate decreases, and the reactor cools down. It is therefore physically impossible to overheat the reactor by nuclear fission.

This technology has already been built and tested (e.g., in April 1986 at Germany's Experimental Breeder Reactor II). It works. However, there is still a fuse. It is really needed only to turn off the reactor, at which point a tube is clogged with solid salt, which is cooled continuously so that it will not melt. If, for example, the power fails or is turned off, the frozen salt melts and the fluid flows out of the fuel loop into the storage tank.

Because there is very little radioactive material in the liquid, the residual decay heat is very slight and presents no problem. The liquid fuel simply cools down and solidifies. When the reactor is started, the solidified liquid fuel is heated up with heating elements. Then it can be pumped back into the loop by the reactor, and the nuclear fission begins.

I hope I have aroused your curiosity, although there is still much to report. If you want to know more, you can visit the website of the developer. I recommend these links:

http://dual-fluid-reactor.org/
http://festkoerper-kernphysik.de/dfr

Phony Environmentalism and Real Science

In conclusion, I must stress again that this is not just a nice gadget. We see how important a good power supply is in the developing countries, especially Africa, where for decades the austerity policies of the International Monetary Fund have been enforced. The West has failed here completely. Many people still lead a miserable life or die in childhood, because they have no clean water and no sanitation.

With energy, you can desalinate seawater, and grow food in dry regions, where there is a great deal of sunshine and plants can flourish. With electric pumps, every household on Earth could have a refrigerator, a washing machine, and a bathroom with a toilet and sink, as is normal in the West. This would improve hygienic conditions, and the risk of epidemics would be much lower.

With enough energy, everyone on Earth could have

a decent life. The energy consumption of an average person in a developed Western country is 1/3 for electricity, 1/3 for heating, and 1/3 for fuel. The DFR can produce electricity, heat for high-temperature processes, and even very cheap fuel, taking over the entire power system. Currently food is being converted into biofuels, while worldwide a billion people go hungry. The reactor is very small, because it works at normal pressure and therefore requires no large, expensive pressure vessels. As a result, mobile units could be built and deployed in crisis regions.

I would like to conclude with a brief comment about growth and progress in nature. The fairy tale of "limits to growth," and environmentalism in that context, are just a fraud to justify the policy of population reduction. Living processes in general are connected to flows of matter and energy. Higher energy flows enable greater and more complex life forms (compare, for example, a bacterium with a mammal).

Nobody seriously doubts that a development to more developed forms of life has occurred since the origin of life on Earth, and that this was accompanied by an increase in complexity and of flows of matter and energy flows. Also, no one will doubt that life is of a higher order than the inanimate. It is obvious that this process of progress occurs not only on Earth, but in the whole universe.

Man, in contrast to all other living things, can increase deliberately increase the flows of matter and energy flows, since he explores nature and therefore increases life on the planet. Man is curious, and his scientific and technical progress is a natural process. Those who work against this principle are working against nature and only cause suffering to Creation. The assertion that man is only a "freak" of nature is a lie. It is spread under the pretext of environmental protection by those who think themselves smarter than nature.

The better we understand nature, the better we will be in harmony with it. The BRICS countries want to follow this path, and we could do it again in the West, if we got the banks under control and threw overboard the ideology of phony environmentalism.

Translated from German by Susan Welsh

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