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Thorium's Promise

I thank the Society for giving me the podium. I speak tonight about thorium. Element 90 solves many problems. Our world is confronted by unstable markets. The instability is traceable to higher energy costs and the effects of overdependence on crude oil, methane and coal. The production of oil may be peaking soon worldwide, just as India and China are poised to put greater percentages of their populations into the modern life style that is dependant on cheap and available energy. Preaching to the choir, I point to nuclear power as the way our developed world can acquire and master development based on a steady supply of low cost reliable energy. The challenge is to manage better the nuclear waste from the 441 civilian nuclear reactors worldwide. Once this waste issue is resolved, nuclear power development will break and displace carbon fuels more than ever before.

Thorium provides important benefits because it can be used to dispose of plutonium and minor actinides from spent fuel. Thorium generates U 233 which is more fissile than U 235. It generates U 233 without producing significant quantities of plutonium, neptunium, curium and americium. No isotopic enrichment is needed with thorium. These simple facts irrevocably change the nuclear waste issue. It is possible to design and build reactors that produce power and medical isotopes while fissioning the world's surplus plutonium. Plutonium-Thorium fuel provides a waste management solution that provides process heat, electrical energy medical isotopes as products while burning the plutonium and transmuting the minor actinides. The thorium converter reactor makes nuclear power sustainable because plutonium and long lived waste materials are converted to power, marketable products and much shorter lived radio toxic materials. Because the EPA and the DOE seem to be developing a storage plan for Yucca Mountain to last 25,000 generations, this country's energy future is at risk. I propose an alternative that is superior because spent fuel can be recycled and its troublesome transuranics transmuted and fissioned away.

The answer is to develop small factory built cores to burn transuranics using thorium containing fuels. The cores of the converters would be passively controlled and delivered by rail. The small reactors could be installed in underground tunnels for security and containment purposes. Heat would be transported to the surface or to a turbine room near the surface. The core would be encapsulated, long lived and able to produce power heat and beneficial medical isotopes at the same time.

In a nutshell, thorium fits because it provides the fertile matrix in which plutonium from the world's fleet of 441 civilian reactors is best fissioned. Thorium is better than uranium 238 for this function because uranium 238 is but one capture away from becoming Plutonium 239. The object now is to dispose of plutonium and not to generate it. I have reminded some of the guys at Livermore about this and have provided them with IAEA Techdocs 1349 and 1450. These publications have kept the thorium option open. I recommend these publications as they show proof of my claim that effective plutonium disposition involves use of Thorium.

Although I am a late comer to this field I am able to bring innovation to apply to this strategic field. The neutron generator developed at the Berkeley Lab got me thinking. The D+T generator produces 10 to the 14^{th} neutrons/second at a 14 M ev spectrum and the D+D generator produces about 10 to the 12^{th} neutrons/second at a 2 M ev spectrum. The DD generator can be used to start up a small reactor.

I want to bring the nuclear power industry closer to a zero emission proposition, linking the generators, thorium, with plutonium disposition and power production and isotope synthesis.

The key to technological advancement in the commercial sector is sustainability. By definition zero emission technologies enjoy sustainability because wastes are not generated. Waste not want not. Nuclear power has been hamstrung by waste and non-proliferation questions. Thorium is non proliferative because Uranium 232 produced along with Uranium 233 has a decay sequence that includes bright gamma emitters. IN the past this hobbled thorium's development because remote robotic fuel handling was beyond technical capability. Now spent thorium fuel can be recycled robotically along with spent uranium fuel. The components of spent fuels that I call bioactive like carbon 14 or iodine isotopes can be separated. The heat producing isotopes can be segregated. Uranium can be recovered and up or down blended. Plutonium and minor actinides can be gathered for disposition. The lower the volume of waste and the shorter the holding period, the more sustainable the power production side of the industry can become.

The point is that after recycling there will be insignificant plutonium and minor actinides in either spent thorium fuel or spent uranium fuel. This approach is far less troubling than the party line announced by the EPA and the Department., the 25,000 generation plan.

I have two conceptual reactors. One the Model P which purifies recycled uranium spent fuel and the other the Model T which is the thorium converter reactor. The model P burns plutonium and transmutes minor actinides, providing power, medical isotopes and fuel for the model T. The T has a long lived a self regulating core which is quite small and designed for autonomous service. The spectrum of both reactors will be in the tens of K evs to many K evs to facilitate generation of uranium 233 and the transmutation needed for isotope production so that the minor actinides are transmuted to be fissioned away.

Because I wanted to get water out of the core along with graphite, I came up with an inert metal matrix to hold the dispersed fuel in oxide carbide or nitride forms. This alloy has good mechanical and neutronic properties. It will form up the fuel plates and the structural components. The idea is to develop the alloy computationally and this work is just starting. When I have the results, this group will be the first to know. I manage heat with heat pipes and thermal reservoirs.

Many challenge me by saying thorium is not practical because the infrastructure is set up for the uranium plutonium cycle. My answer is that the world infrastructure is incomplete because neutrons are not being used to fission and transmute transuranics from spent fuel. Until waste treatment reactors come on line, the industry will not have the access to world capital reserves that the oil, coal and methane industries presently enjoy.

Sustainability is the transformative concept demanded by present conditions. Correcting the waste issue by producing power and isotopes at the same time will provide greater business opportunities as the world's fleet of reactors produce tons and tons of materials that need to be transmuted and fissioned away.

Whether you believe in global warming science or not, this dispute provides the rationale for the implementation of green, sustainable nuclear fuel cycles. National governments have strong desires to be independent of one and other in respect to heat, power and transportation fuels. Collectively most governments are committed to abide by lower carbon gas emission standards and to suppress the proliferation of special nuclear materials as best they can. This week there was good news on the non-proliferation front. Collective diplomacy has perhaps changed internal policies of North Korea. Nations do work together on non-proliferation. Successes have occurred. South Africa, Libya North Korea to name a few. Our internal policies must adapt also to world conditions. Spent fuel is valuable if it is manage properly. Fission products can be harvested. Fissile materials can be controlled as new fuel. Thorium provides a safe passage out of over dependence on carbon fuels because it can be harnessed to clean up the spent fuel problem while providing electricity, process heat and valuable medical products. The use of neutrons for purification and the synthesis of medicines from poisons will make the industry financible and profitable over the long term. Oil and Coal will get the back seat for a while I speculate if the world grids can be powered up to the percentage of the grid of France.

We have the available computational power to make nuclear energy the greenest and the least expensive. We have a rising tide of public opinion dissatisfied with the carbon fuels and acquiring an awareness that nuclear power can be developed to become much cleaner and safer than it was during its formative years.

I point to thorium in small cores as the true economy of scale. Small reactors can be built on the production line in a factory, delivered by rail, and returned by aftermarket recycling. The size of the shielded reactor would be the size of a rail road tank car. The unit would be walk away safe, have a ten year core life and provide power and process heat. The economy of scale is not the one or two reactor multi-gigawatt plant, it is rather a cluster of self regulating small reactors that are tuned to particular applications: waste management, isotope production, nuclear steam for enhanced hydrocarbon recovery or conservation.

I will answer questions with Bob Schenter after he enlightens us on the advantages of a higher spectrum for medical isotope production.

In conclusion, I submit that Hanford has the knowledge base, expertise to assist in the validation of these advanced reactor and fuel concepts. As I get results I will hope to enlist your support for the fuel studies and the work needed to prepare a set of plans and specifications for the small pilot plant that could demonstrate my ideas.

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