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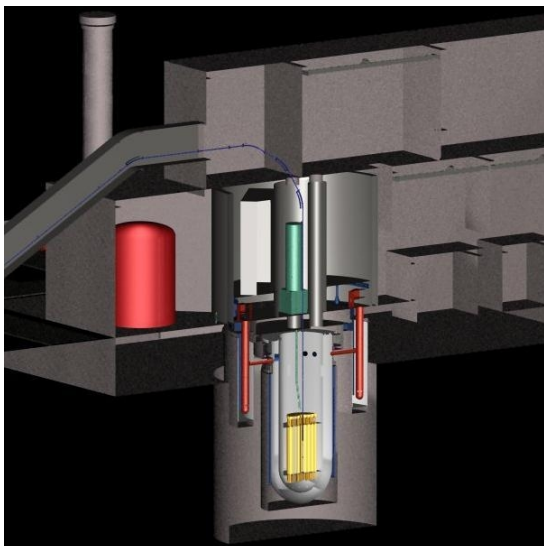
Accelerator Driven Thorium Reactor power station

Sustainable technology for 21st century energy requirements

The Accelerator Driven Thorium Reactor (ADTR™) power station is the name given by Aker Solutions to the energy source for a new type of nuclear power station.

It is targeted at the global energy market, aligning itself with fourth generation reactor concepts that will come to fruition by 2025-2030.

Caption: 3-d sectional view of the ADTR™



Key features of the ADTR™:
Self-sustained fuel cycle
Inherently safe
Waste reduction
Load following
Atmospheric pressure system
Power producing actinide burner
Uniquely controllable
Applies existing technology
Medium size suits smaller grids
Proliferation resistant
Meets Gen IV goals
No enrichment required

The reactor is designed to drive a steam turbine/ generator balance of plant similar to other nuclear power stations in design.

The ADTR™ power station uses thorium as its main fuel. As a nuclear material, thorium is not fissile; it is described as “fertile” which means by capturing nuclear particles or neutrons it “breeds” or converts to a type of uranium which is able to react in a fission process and produce energy. In order to provide these neutrons, initially a small amount of reactive material is required along with the use of the accelerator which, through a process known as spallation, provides further neutrons. These spallation neutrons initiate the fission process that goes on to breed further fissile uranium from the thorium.

Aker Solutions’ ADTR™ power station concept has the following benefits:

- It is based on the use of thorium as a fuel, which is an abundant mineral deposit; there is 3 to 5 times more thorium in the world than uranium.
- The concept incorporates intrinsic safety features which are fundamental to its design. A significant advantage of this type of process over conventional reactors is that the accelerator is the main source of reactor control; turn off the accelerator and the reaction reduces virtually instantaneously.
- The ADTR™ power station has proliferation resistance advantages compared to other reactor systems, specifically long fuel residence time mitigates against material diversion, the degree of self-protection afforded by irradiated fuel and no enrichment process is needed.
- Construction below ground means that the reactor is highly resistant to damage from aircraft impact.
- Actinides from a thorium reactor are 0.006 times the amount from a conventional reactor.
- The ADTR™ power station can be configured as an actinide ‘burner’ reducing long term waste burden.

The market potential for a thorium-based power station

To combat the predicted climate change and related global warming issues, many countries across the world are planning large expansion programmes in nuclear generation. The World Nuclear Association has assessed the potential for growth in nuclear generation capacity throughout the world by 2030 and the total expected capacity increase by 2030 is huge.

It is likely that, in the medium term, the demand for uranium will increase. Although at present, the effect of this on uranium price is only a marginal increase, in the future this is likely to change with demand-led price rises predicted. The option to use an alternative nuclear fuel will become more attractive.

There are significantly more thorium reserves than uranium. However, thorium is more expensive to mine (currently about twice the cost per tonne compared to uranium). But it is important to note that virtually all the thorium mined can be used as fuel compared to only 0.7% of the uranium recovered in its natural state. Put simply, in energy equivalent terms, 1 tonne of thorium mined is equivalent to 200 tonnes of uranium mined, which is equivalent to 3.5 million tonnes of mined coal. Also the need for enrichment is very expensive but there is no requirement for thorium enrichment for the ADTR™. Thorium works out considerably cheaper per unit electricity generated.

The ADTR™ power station offers significant potential, particularly in specific markets where a nuclear infrastructure is not already established.

The 600MW size of the ADTR™ power station fills a market gap and would be beneficial for smaller developing countries wishing to move to nuclear, but with immature grid systems not readily capable of accepting large conventional reactors (>1000 MW's).

Time to market will be by approximately 2030, consistent with the commercialisation of other Generation IV reactors. Studies have also shown that unit cost/KWh is extremely competitive with conventional nuclear reactors and other energy sources such as coal, gas, wind and solar.

Professor Carlo Rubbia and Accelerator Driven Systems

Aker's interest in the ADTR™ power station concept originated from an investment study into the viability of a thorium mine in Norway. In parallel to the mine consideration, Aker Solutions investigated the potential exploitation of thorium. This led to the identification of the work done by Professor Carlo Rubbia in the 1990's on Accelerator Driven Systems.

Subsequent meetings resulted in the engagement of Professor Rubbia to advise in the engineering development of his ideas, leading to the potential commercialisation of the technology as a power producer.

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