Case Report

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Thorium Reactor: New Generation ADS

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ABSTRACT

ADTR- THORIUM – Less Nuclear Waste-Produce Medical Radioisotope: Thorium is a good choice in accelerator driven reactor and reliable in compare with other reactors. Review the ADTR in experimental scale is the aim of this study. Next generation accelerator driven reactor would be used thorium mixed fuel. Some medical radioisotopes may be produced easier in ADTR.

Abbreviations: BWRS: Boiling Water Reactors; PHWRS: Heavy Water Reactors; MSRS: Molten Salt Reactors; PWRS: Pressure Light Water Reactors; FNRS: Fast Neutron Reactors; HTRS: High-Temperature Gas Cooled Reactors; ADS: Accelerator Driven Subcritical Reactors

Introduction

Thorium reactors are a fascinating prospect for the future of clean, safer nuclear power with hopes of more efficient production. Further research still needs to be completed, and regulations surrounding the fuels must be implemented to limit proliferation. These reactors are cleaner, and with more international research projects beginning and research being completed by international bodies and governments, thorium reactors are becoming a more than likely future for nuclear driven power production. Thorium reactors use thorium as their primary fuel source, whereas uranium based reactor uses uranium-235 as its main fuel source. Some advantages of thorium reactors: 1 -minimal radioactive waste and longevity 2-environmental benefits of thorium reactors [1]. thorium and uranium have an interesting relationship in that they are both complements and competitors to each other. Put very simply, thorium can used together with conventional uranium-based nuclear power generation , meaning a thriving thorium industry would not necessarily make uranium absolute. [2].

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Seven types reactors able to use thorium. There are seven types of reactor into which thorium can be introduced as nuclear fuel.

1) Heavy water reactors (PHWRS)
2) Boiling water reactors (BWRS)
3) Pressure light water reactors (PWRS)
4) MOLTEN SALT REACTORS (MSRS)
5) High-temperature gas cooled reactors (HTRS)
6) Fast neutron reactors (FNRS)
7) Accelerator driven subcritical reactors (ADS)

In this work concentrates on thorium fuel and check the spectrum flux In ADS reactor. it shown the behavior of thorium in accelerator driven subcritical core. Radioactive waste eliminated in reactor used thorium as fuel, also transmutation nuclear waste in ADS core is considerable. In this review study just attention on thorium in ADS system. Nuclear waste is neither particularly hazardous nor hard to manage relative to other toxic industrial waste. type of radioactive waste:

1) Low-Level Waste
2) Intermadite –Level Waste
3) High-Level Waste
4) Very Low-Level Waste

Radioactive waste is not unique to the nuclear fuel cycle. Radioactive materials are used extensively in medicine. Agriculture research manufacturing Non-destructive testing, and mineral exploration. Unlike hazardous industrial materials the level of hazard of all radioactive waste –its radioactivity diminishes with time. Also, attention on safety of thorium in different reactor is attractive. Where and when is waste produced? Radioactive waste is produced at all stages of nuclear fuel cycle-the process of producing electricity from nuclear materials. The fuel cycle involves the mining and milling of uranium ore, it is processing and fabrication into nuclear fuel its use in the reactor its reprocessing (if conducted), the treatment of used fuel taken from the reactor, and finally disposal of waste.

Whilst waste is produced during mining and milling and fuel fabrication the majority (in terms of radioactivity) comes from the accrual burning of uranium to produce electricity. Where the used fuel is reprocessed, the amount of waste is reduced materially [3]. Economic advantage it is currently estimated that the first ADTR power station can be operating toward the end 2030.economic assessment has demonstrated that an ADTR power station could be built at costs per MW output equivalent to conventional nuclear power systems for the first reactors. Although the cost of accelerator is estimated as 10% of overall capital cost, saving are made elsewhere such as containment building owing to operation at atmospheric pressure. There will be further benefits of lower operating and maintenance costs, decommissioning and waste treatment costs [4]. The concept design has been subjected to a series of safety reviews, and incorporation of inherent safety within the design has been central to the design process such safety measure

a) Use of an accelerator with control rods enables operation to be established with the reactor in a subcritical state all times

b) Operating the reactor with a keff of 0.995 provides an additional safety margin against criticality excursions. Compared with that percent in critical reactors

c) Lead coolant being chemically non-reactive so will not catch fire and provides a large heat sink in the unlikely catch fire and provides a large hat sink in unlikely event of an accident

d) Operation of the primary system at atmospherics pressure reducing design demands and consequences from any failure scenario

e) The accelerator providing means of virtually instantaneously reducing power

f) Compared with the time lag inherent in use of control rods.

g) Use of more established accelerator technology improves reliability

h) Use of technology to measure keff ensures a reliable control system and more.

List of the pros of a thorium reactor:

1) It eliminates the threat of nuclear weapons

2) It comes from a plentiful supply

3) It is a technology that can be mass –produced

4) It eliminates the threat of nuclear waste

5) It produces high levels of energy

6) It eliminates the safety concerns of traditional nuclear power

7) It offers the potential to reduce war and eliminate poverty

8) Storage costs for spent fuel would be reduced

9) It is a highly efficient technology compared to fossil- fuel power generation

10) Thorium is safer to mine

List of cons of thorium reactor:

1) There is no current infrastructure to support thorium use

2) The start-up process could be lengthy and costly

3) Not every thorium design is self-sustaining

4) The fissile materials created by a thorium reactor provide different dangers

5) It costs more

6) Research into thorium energy is politically restricted [5]

Also, attention on ADTR safety aspects attractive. The ADTR has several attractive features from a materials security standpoint. a-long refueling time means fuel shuffling is not necessary and so is possible for fuel to remain in situ for many years b- the selected fuel cycle is a net consumer of plutonium c- a significant degree of self-protection through radioactive decay of uranium-232 which over a relatively short timescale generates a high energy gamma source d- thorium fuel does not require enrichment thus reducing availability of this proliferation linked technology [6]. One important point in ADTR produced some medical radio isotopes. Nuclear medicine uses radiation to provide diagnostic information about functioning of a person s specific organs or treat them [7] also anticipated produced some medical radioisotopes by used thorium fuel in ADTR.

Conclusion

In this simulation shown thorium accelerator driven subcritical reactor in experimental scale. Although ADTR is not new Idea, study on different aspect of it such as safety, choose fuel and check the reactor behavior attractive. It is important to note that thorium is not a fuel like Uranium. They produced less waste as the thorium fuel cycle

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products less long lived radioactive isotopes [8]. The sub criticality is an essential advantages of ADS, as mentioned before. There is an additional safety effect: in the case of a loss power (station black – out) the accelerator beam providing the external neutron source is shut off automatically and the chain reaction in the reactor stops [9]. Review the ADTR in real condition and check the safety of it would be attractive and challenging.

Discussion

(Figures 1-3).

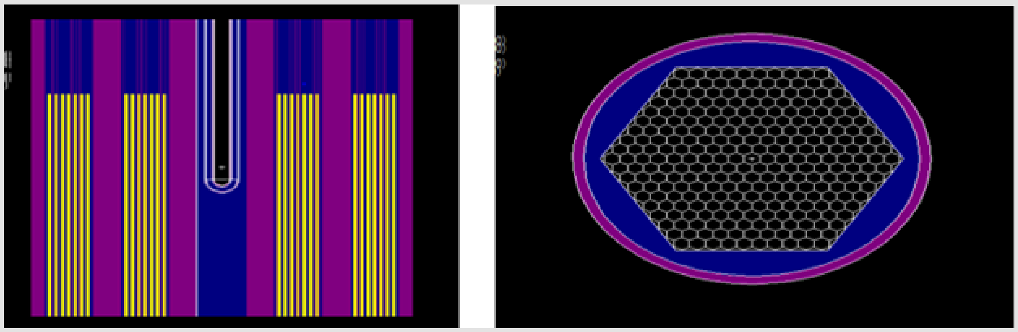

Figure 1: a. b part of ADTR simulated by MCNP.

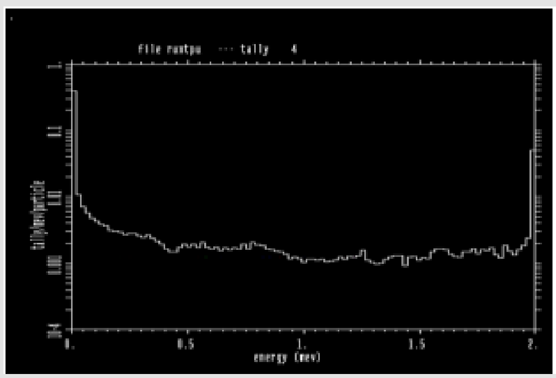

Figure 2: Volume flux of thorium fuel rod in ACTR CORE.

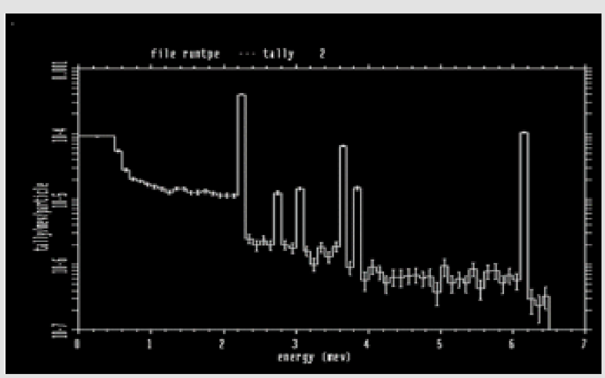

Figure 3: Surface flux of thorium fuel in ADTR core.

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