Technology Considerations for Deployment of Thorium Power Reactors

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Deployment of any nuclear reactors, in particular innovative designs, requires a healthy combination of design and safety concept maturity, design/concept validation, integration into a national energy policy, co-operation between vendor/operator/regulator bodies, and finally a sound economic/financing plan and perhaps most importantly for long-term success, supportive government policy and acceptance by an educated public.

Thorium as a fuel in a nuclear reactor has been considered, researched, and proposed for many decades in most reactor types, in fact since the beginning of peaceful uses of nuclear energy. Its inherent advantages and disadvantages over uranium are well known, but changing external factors, such as resource access, economics, and public policy have affected the level of interest and investment over the past 60 years. Some technical challenges also still remain and would require effort in terms of R&D, regulation and policy.

In light of the current lack of clear economic or overwhelming scientific advantages, perhaps the main argument for starting a thorium fuel cycle implementation is socio-politic, namely greater public acceptance stemming from the fact that (1) Th does not carry the military connection of U/Pu and (2) the waste from any Th-based fuel cycle will have less long-lived MA's.

This paper briefly summarizes the above aspects as they relate to unique challenges and opportunities for a potential thorium-based water-cooled power reactor program and suggests areas for technical collaboration. Based on past efforts and current knowledge, water-cooled reactors are capable of accommodating thorium-containing or even thorium-based fuel designs, known technology challenges can be mastered and there are no "show-stoppers" in a gradual transition to a complementary thorium/uranium-based nuclear energy program, while there remain significant obstacles to full Th/^{233}U implementation.

The potential of thorium-based fuel options being a "better" or "superior" fuel compared to U/Pu-based fuels is clear. However, there are a few remaining areas that need further development work to generate knowledge and reduce uncertainties in existing physical parameters and implementation concepts. These are summarized and suggestions for international collaboration are made to help a gradual near-term introduction of Th fuel into the cores of current or advanced water-cooled power reactors.

For example, in a homogeneous core concept the fuel meat itself consists of a fissile/fertile material mix, while in a heterogeneous core implementation the fissile and breeding fuel regions (pins, bundles, or assemblies) are physically separated and only neutronically coupled (also referred to as seed/blanket configuration). The technical challenges are different whether considering a heterogeneous or homogeneous core implementation.

In order to maximize the chances of success for a pilot transition from U/Pu to Th fuel cycle in an existing water-cooled reactor, cooperation among nuclear countries is absolutely necessary and a formal internationally financed program would be ideal. Therefore, a long-term vision and steady effort, including international collaborations on thorium issues (technological, economical and socio-political) is required to make a gradual transition possible that could eventually be called "Renewable Nuclear Energy."

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He has worked since then at Atomic Energy of Canada holding positions of Research Engineer, Section Head for Containment and Severe Accident Behaviour, and Branch Manager of Thermalhydraulics R&D. His expertise is in primary heat transport system and containment thermalhydraulics, safety analysis and experimentation to provide R&D support to PHWR vendors, operators and regulators.

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