Preliminary reactor physics calculations of a fluidized bed nuclear reactor concept

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Abstract

A nuclear power reactor concept has been proposed. The feasibility of this concept has been investigated by preliminary reactor physics steady-state calculations. The calculations are based on homogenized unit cell concept using diffusion theory. The parameters constituting the k_{eff} as a function of fluidized bed height for various enrichments have been studied as well as a function of calandria tube diameters, and collapsed heights. Light water was taken as moderator/coolant as compared with organic compound and heavy water. The results show the viability of the proposed concept.

Zusammenfassung

Vorläufige reaktorphysikalische Berechnungen eines Flußbett-Reaktorkonzepts

Es wird ein Konzept für Leistungsreaktoren vorgeschlagen und anhand von reaktorphysikalischen, stationären Berechnungen zur Abschätzung untersucht. Die Berechnungen gehen von der Diffusionstheorie mit homogenisierter Einheitszelle aus. Es werden die Parameter für k_{eff} als Funktion von der Höhe des Flußbetts für verschiedene Anreicherungen ermittelt, ebenso für Durchmesser des Moderatorbehälters und Höhenabsenkung. Als Moderator/Kühlmittel wird Leichtwasser mit organischen Verbindungen und Schwerwasser verglichen. Die Ergebnisse zeigen, daß das vorgeschlagene Konzept praktikabel ist.

INIS-EDB-DESCRIPTORS

FLUIDIZED BED REACTORS
REACTOR PHYSICS
FEASIBILITY STUDIES
NEUTRON DIFFUSION EQUATION
CRITICAL SIZE
CRITICALITY
MULTIPLICATION FACTORS

1. Introduction

In order to develop an independent nuclear technology and facilitate the transfer of such technology, a nuclear reactor concept based on the existing knowledge and knowhow has been proposed by one of the authors F.S. [1]. The feasibility study from the reactor physics point of view of the concept is performed considering a specific case of the generalized concept.

The design utilizes the fluidized bed concept. A cylindrical calandria as shown in Fig. 1a contains seven 25 cm diameter calandria tubes. The one centimeter diameter spherical fuel pellets floating in the coolant are contained in the vertical 2 cm thick calandria tubes made of zircaloy. The coolant flows upward through a bed of solid fuel pellets which they become borne or fluidized. The reactivity control is partially accomplished by the change in buckling through the control of coolant flow velocity. The fuel is made of 2.5 % enriched uranium dioxide cladded by zircaloy-4. Refuelling is performed continuously and while the reactor is in power.

Some of the advantages of this concept may be summarized as follows: (1) Relatively simple design resulting in more reliable reactor which would be possible to be built even by a country with modest industrial infrastructure. (2) Since each calandria tube or a batch of tubes may be made to feed an independent loop containing modest amount of energy, thus a probable loss-of-coolant accident is necessarily a small one and can be counteracted by a simple emergency core cooling system. (3) Possible use of thorium or natural uranium as fuel thus becoming independent of the monopolized enrichment services available. (4) Good heat transfer conditions. (5) Simple and safe control systems. (6) Continuous refuelling system resulting in higher reactor availability. (7) Need for lower reserved reactivity and therefore no need for burnable poison. (8) Simple refuelling machine. (9) Simpler fuel fabrication method since there are no

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