PHYTRA4 – The Fourth International Conference on Physics and Technology of Reactors and Applications.
Marrakech, Morocco, September 17-19, 2018, on CD-ROM, GMTR, Rabat, Morocco (2018)

METHODS FOR NEUTRONICS OF HIGH TEMPERATURE REACTORS: DRIVERS, RECENT PROGRESS AT INL, AND OUTSTANDING PROBLEMS

Abderrafi M. Ougouag* and Hans D. Gougar
Idaho National Laboratory
MS-3860, PO Box 1625
Idaho Falls, ID 83415, USA
abderrafi.ougouag@inl.gov; hans.gougar@inl.gov

ABSTRACT

The morphology of high temperature reactors is reviewed and its implications for neutronics modeling are pointed out. Methods developed to meet those needs are reviewed and their main features presented. Recent developments are discussed. Ongoing work and new directions of methods development are also outlined. The paper main focus is on pebble bed reactor physics and methods. It is also primarily focused on developments that were carried out at the Idaho National Laboratory. It is shown that although neutronic methods for HTRs are maturing, significant challenges linger and the topic remains an area for significant research and development.

Key Words: neutronics, high temperature reactors, pebble bed reactors, nuclear data preparation

1. INTRODUCTION

The overall morphology and local composition of many recently designed or studied high temperature reactors (HTR) are significantly more complex than those of light water reactors (LWR). Gas-cooled, graphite moderated HTRs possess more levels of heterogeneity than the two levels common in LWRs. The average neutron mean free path in HTRs is substantially longer than in LWRs, resulting in major spectral inter-penetration between adjacent regions and a difficulty in matching spectral zones to physical regions. For example, a prismatic block is not necessarily a spectral zone, whereas it is common to assume an assembly is in LWRs. Other characteristics, such as the presence of burnable poisons, have consequences on the validity and applicability of common neutronics methods. This paper presents a survey of the physical features of HTRs and identifies their implications for neutronic modeling needs. Then a number of methods developed at the Idaho National Laboratory to meet those specific needs are summarized. Finally, outstanding modeling problems are identified and briefly discussed. Although the focus of this paper is methods for pebble bed reactors as implemented at INL, some limited attention is also given to developments elsewhere and to some related problems in the modeling of prismatic block reactors.

* corresponding author