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Evaluation of Thermal Margin Analysis Models for SMART

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1. Introduction

Thermal margin of SMART would be analyzed by three different methods. The first method is subchannel analysis by MATRA-S[1] code and it would be a reference data for the other two methods. The second method is an on-line few channel analysis by FAST[2] code that would be integrated into SCOPS/SCOMS. The last one is a single channel module analysis by safety analysis.

Several thermal margin analysis models for SMART reactor core by subchannel analysis were setup and tested. We adopted a strategy of single stage analysis for thermal analysis of SMART reactor core. The model should represent characteristics of the SMART reactor core including hot channel. The model should be simple as possible to be evaluated within reasonable time and cost.

2. Subchannel Analysis Models

Target of our single stage subchannel analysis is 1/8-symmetry core of SMART. The octant core has seven and 1/8 assemblies, consist of one 1/8 fuel assembly and six 1/2 fuel assemblies and four fuel assemblies.

A limiting radial fuel assembly power profile in view of DNBR(Departure from Nucleate Boiling Ratio) was selected as shown in Fig.1(a). The profile was selected from profiles that has high peaking factor Fr at each burnup step and has minimum pin-to-box factor whole burnup steps. Flat radial power profile that has minimum pin-to-box factor is more conservative in DNB analysis. The selected radial power profile was redistributed so that the hottest assembly to be located at center of the core and colder assemblies to be located at peripheral of the core as shown in Fig.1(b).

Axial power profile was chosen from MOC-ARO condition because it is one of typical operating conditions as shown in Fig.2.

A full subchannel analysis model for 1/8-symmetry core has 2,333 subchannels and total of 2,119 fuel rods

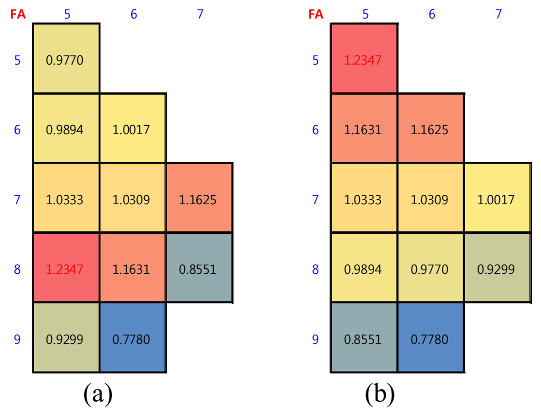
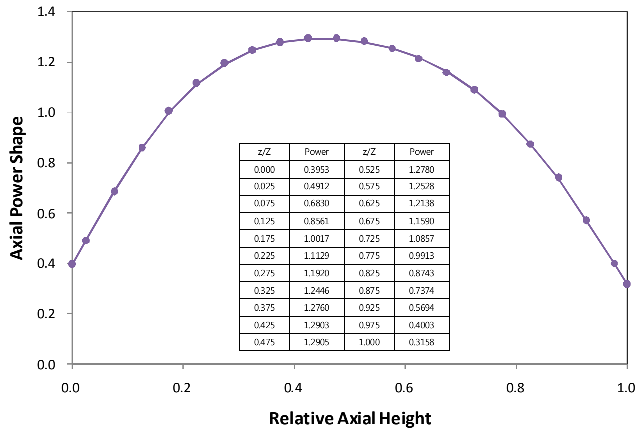


Fig.1. Fuel Assembly Radial Power Profile for 1/8-Core.



z/Z	Power	z/Z	Power
0.000	0.3953	0.525	1.2780
0.025	0.4912	0.575	1.2528
0.075	0.6830	0.625	1.2138
0.125	0.8561	0.675	1.1590
0.175	1.0017	0.725	1.0857
0.225	1.1129	0.775	0.9913
0.275	1.1920	0.825	0.8743
0.325	1.2446	0.875	0.7374
0.375	1.2760	0.925	0.5694
0.425	1.2903	0.975	0.4003
0.475	1.2905	1.000	0.3158

Fig.2. Axial Power Profile of MOC-ARO Condition.

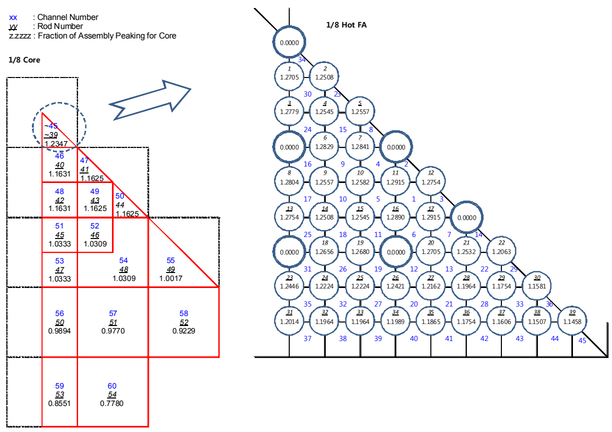


Fig.3. 45-Channels Model for 1/8-Symmetry Hot Fuel Assembly and 60-Channels Model for 1/8-Symmetry Core.

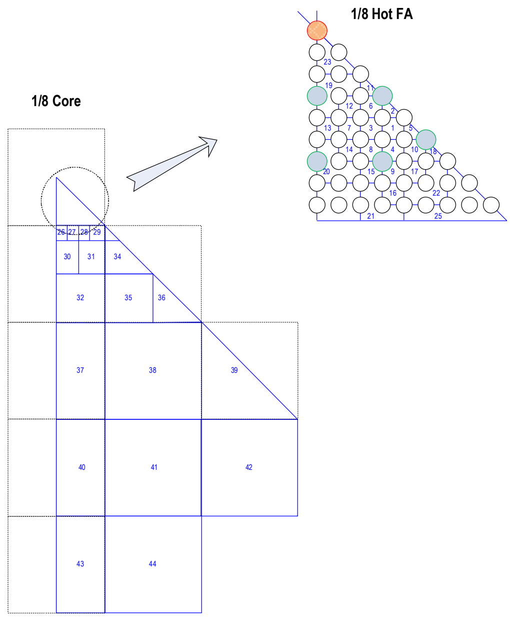
and tubes. It is the reference subchannel analysis model ('2333-chn model') to other lumped models for this study.

Several lumped subchannel models were also developed. A '45-chn model' targeted only a 1/8-symmetry hot fuel assembly that has total 45 subchannels. A '60-chn model' targeted 1/8-symmetry core with '45-chn model' with lumped 15 subchannels for another fuel assemblies.

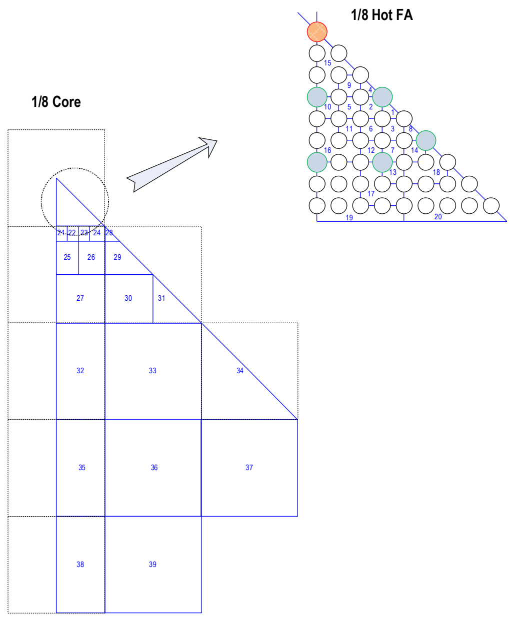
A '44-chn model' for 1/8-symmetry core consists of 25 subchannels for hot fuel assembly and 19 channels for the other fuel assemblies as shown in Fig.4(a). A '39-chn model' consists of 20 subchannels for hot fuel assembly and 19 channels for the other fuel assemblies as shown in Fig.4(b). These models were developed under assumption that the hottest channel is typical matrix channel or thimble channel, respectively.

3. Results

Minimum DNBR from hot channel models were compared to that from single channel safety analysis model. The optimum hot channel model must ensure if it's results is more conservative than that of real full channel model and more optimistic than that of the safety analysis module. The results from selected hot channel model always lie between real full channel model and single channel safety analysis model.



(a) Typical hot subchannel



(b) Thimble hot subchannel

Fig.4. 44 and 39 Channels Models for 1/8-Sysmmetry Core

ACKNOWLEDGEMENTS

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