The HOGNOSE Model

- **High-speed Oxide Growth in a Numerically Optimized Simulation Environment**
- Solves for oxygen concentration and temperature in a 1D mesh
- Accounts for varying oxygen diffusivity due to stress, stoichiometry, and microstructure variations
- “Fitting” of a low level factor (oxygen diffusivity and stoichiometry variation) is used to compare to literature data

*paper on HOGNOSE submitted to Journal of Nuclear Materials*
HOGNOSE – Out-of-reactor Validation

- 360 °C, 18.6 MPa
- Stoichiometry variation of 3-4 orders of magnitude
- Simulated PWR chemistry
- Adaptive timestepping

Baseline diffusivity $= 9.1 \times 10^{-18} \text{ m}^2/\text{s}$
understressed thickness $= 2.0 \mu\text{m}$

Baseline diffusivity $= 1.57 \times 10^{-17} \text{ m}^2/\text{s}$
understressed thickness $= 2.0 \mu\text{m}$

Baseline diffusivity $= 1.66 \times 10^{-17} \text{ m}^2/\text{s}$
understressed thickness $= 1.9 \mu\text{m}$

Baseline diffusivity $= 9.1 \times 10^{-18} \text{ m}^2/\text{s}$
understressed thickness $= 2.0 \mu\text{m}$

Baseline diffusivity $= 1.57 \times 10^{-17} \text{ m}^2/\text{s}$
understressed thickness $= 2.0 \mu\text{m}$
Coupling HOGNOSE and MAMBA-BDM to BISON-CASL

- MOOSE MultiApp/Transfers, PostProcessors & AuxVariables

- HOGNOSE converts oxide AND CRUD into an effective BISON thermal resistance

- BISON temperature profile iteratively fed back to HOGNOSE and MAMBA-BDM

Thermal hydraulics, neutronics, fuel performance, and materials coupling
BISON 3 pellet rodlet with 16 HOGNOSE simulations denoted by a HOGNOSE simulation.

Cladding Surface Temperatures After Three Fuel Cycles

Temperature (degrees C) vs. Axial Location (cm)

- Blue: BISON: no oxide
- Green: BISON: EPRI oxide
- Red: HOGNOSE oxide with CRUD
- Turquoise: HOGNOSE oxide

* denotes a HOGNOSE simulation.
BISON 3 pellet rodlet with 16 HOGNOSE simulations

Oxidation Kinetics

- Blue: HOGNOSE with CRUD effects
- Green: HOGNOSE only
- Red: BISON with EPRI model
BISON 3 pellet rodlet with 16 HOGNOSE simulations

0 days
200 days
400 days
600 days
800 days

Oxide Thickness (m)

9e-6
8e-6
7e-6
6e-6
5e-6
4e-6
3e-6
2e-6
1e-6
0