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Sockeye Plans - NEAMS TH Deep Dive FY20

January 2021

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Changing the World's Energy Future

Idaho National Laboratory

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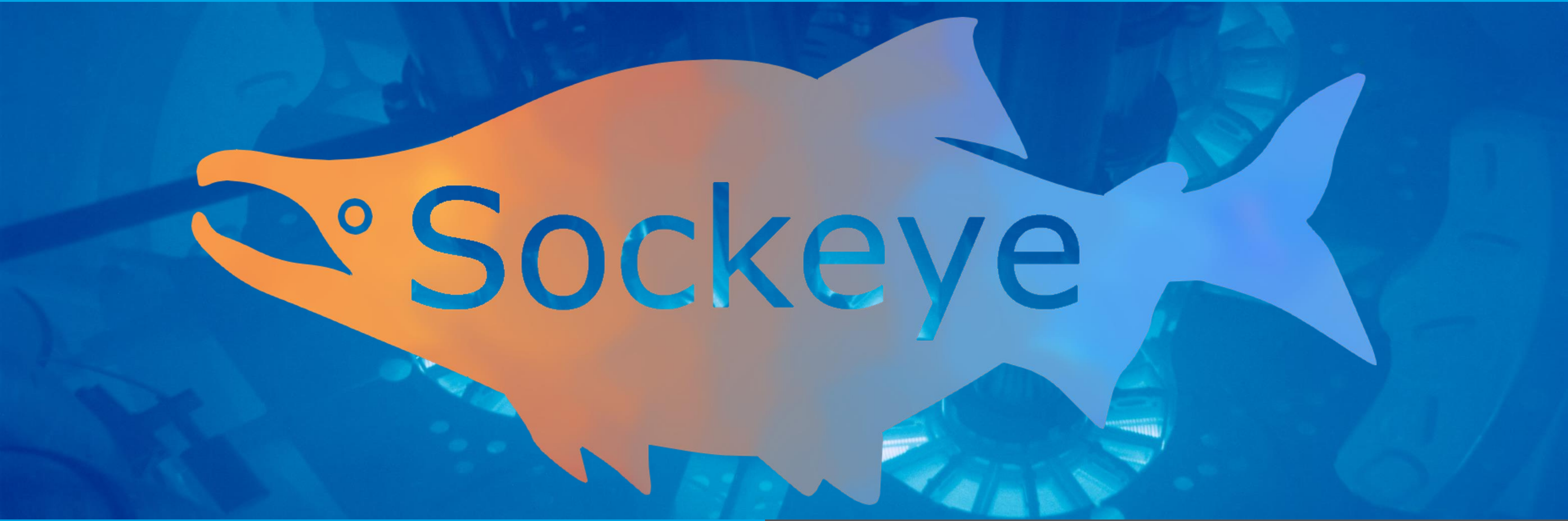

Sockeye FY21 Plans

NEAMS Thermal-Hydraulics Area Deep Dive

January 12, 2021

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NEAMS Milestone

- March 31: Customer-driven modeling improvements and documentation
  - Incorporate wick saturation dependence of capillary pressure
  - Make examples for custom friction closures
  - Make examples for different heat transfer conditions
  - Make examples demonstrating capillary and sonic limits
  - Document spatial discretization
  - Create frozen startup limit utility
  - Optional: Additional tasks as suggested by WEC functional requirements and needs
  - Deliver milestone report

V&V

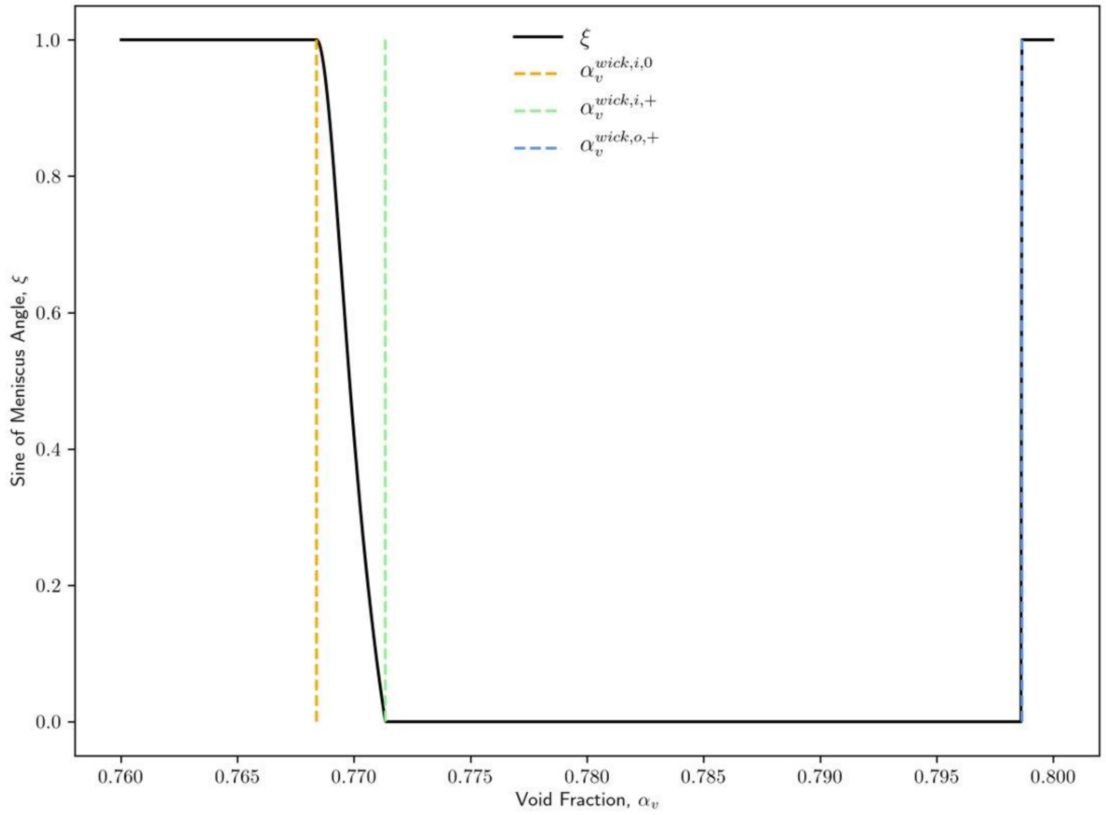
- Currently, validation results include the following:
  - Comparison to SAFE-30 experiment data (partial transient – need robust phase disappearance)
  - Comparison to analytical approximate solutions (pressure drops, velocity profiles)
- A few experiments will be yielding data soon, some with internal data:
  - MAGNET experiments
  - University of Michigan NEUP project
- A few comparisons can be made to other, simpler models:
  - Thermal resistance network
  - Lumped model
- Hired summer intern for this task
- Starting proposal with Dr. Ali (ISU) for future validation through CAES Summer Visiting Faculty Program

Development Tasks

- Robust phase disappearance:
  - Dryout is an accident condition that can occur when conditions are outside operating envelope.
  - Pooling is a routine condition that occurs for even well-designed heat pipes.
  - For robustness, need to avoid invalid calls to the equation of state, which frequently occur in phase disappearance limit.
- Variable porosity and permeability
  - NRC would like to model buildup of blockages in wick, which can affect these quantities.
- Radial thermal resistance through liquid layer
  - Non-negligible temperature difference through liquid annulus, currently unaccounted due to 1-D nature of equations
  - Perhaps can be incorporated in some fashion via heat transfer coefficient closures

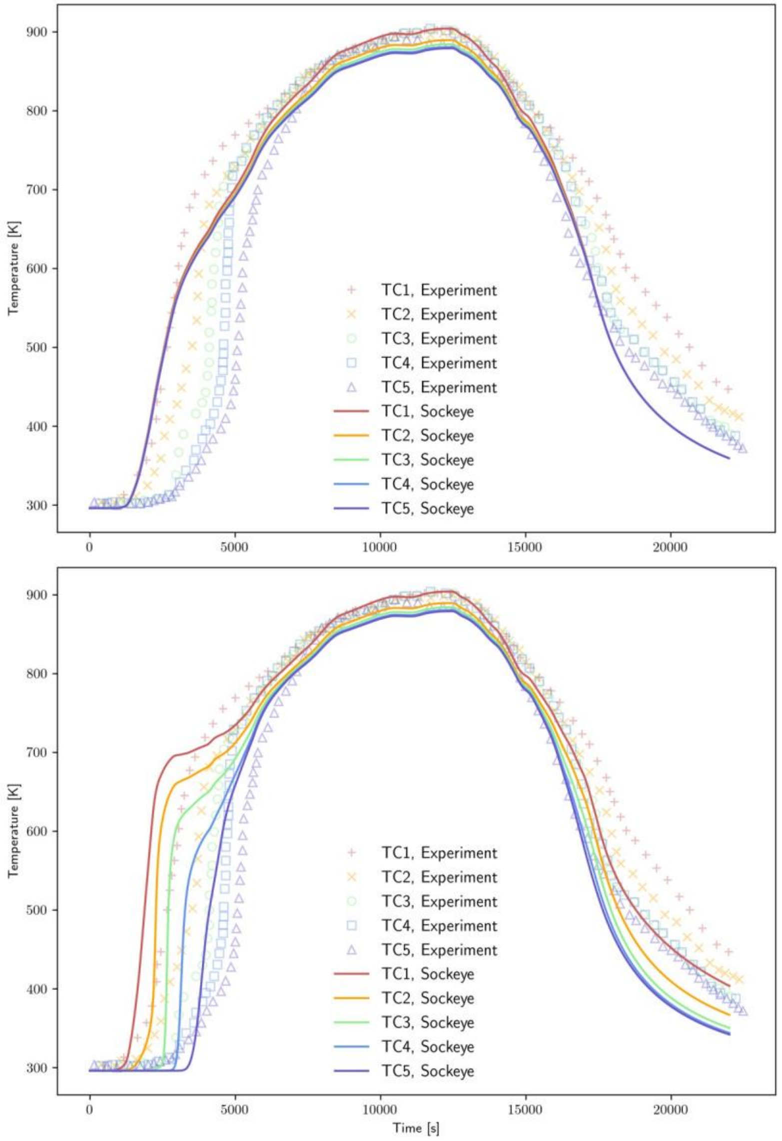
Development Tasks: Capillary Pressure Changes

- Currently, interface curvature (and thus, capillary pressure) is mapped from the void fraction solution, depending on geometrical parameters.
- In reality, curvature should not go through a fixed void fraction mapping – it should depend on local conditions.
- For startup conditions, computed capillary pressure currently can exceed local vapor pressure.



Development Tasks: Conduction Model Improvements

- Conduction model currently uses uniform arbitrarily high thermal conductivity in vapor core (top figure).
- For startup, need to consider the finite melt front propagation speed.
- Consider a model where thermal conductivity in core ramps up during startup due to local temperature conditions (bottom figure).
- Further improvement could be to account for latent heat of fusion.
- Also, operational limits could be incorporated into thermal conductivity.



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