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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Two White Flint North
11545 Rockville Pike
Mail Stop T8A23
Washington, DC 20555

Subject: Programmatic Review of Presentation Package

Dear Mrs. DeMarco:

The enclosed presentation package is being submitted for programmatic review. These materials will be presented at the Geological Society of America 2002 Annual Meeting and Exposition on October 30, 2002, in Denver, Colorado. The title of the presentation is:

> "The Cold-Trap Process and Its Effect on Moisture Distribution and Chemistry of Water in Drifts" by R. Fedors, J. Prikryl, L. Browning, F. Dodge, and S. Mayer

NRC has previously reviewed and approved the abstract for this presentation and the associated NRC Form 390A. Please advise me of the results of your programmatic review. Your cooperation in this matter is appreciated.

Sincerely,

Budhi Sagar
Technical Director

/ph
Enclosure

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THE COLD-TRAP PROCESS AND ITS EFFECT ON MOISTURE DISTRIBUTION AND CHEMISTRY OF WATER IN DRIFTS

Randall Fedors, James Prikryl,
Lauren Browning, Franklin Dodge, Stefan Mayer

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GSA 2002 Room A201 9:25a Oct 30, 2002

SwRI

What is "Cold Trap" Process ?

- The cold-trap process in tunnels involves:
  - Evaporation from warmer areas and condensation on cooler or hygroscopic surfaces
  - Movement of vapor driven by thermal gradients
  - Continuous source of moisture from mountain scale vapor transport and ambient percolation
- Relevant literature topics
  - Natural convection in horizontal eccentric cylinders
  - Condensation in pipes, boundary layer transfer

The Cold Trap and Yucca Mountain

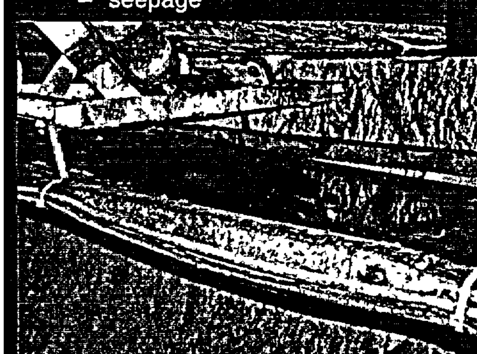
The cold-trap process describes a mechanism for in-drift water movement

Why is it important?

- Provides localized liquid water that may contact drip shields and waste packages leading to corrosion
- After possible waste package failure, liquid water provides a pathway for radionuclide transport
- Occurrence and effect varies

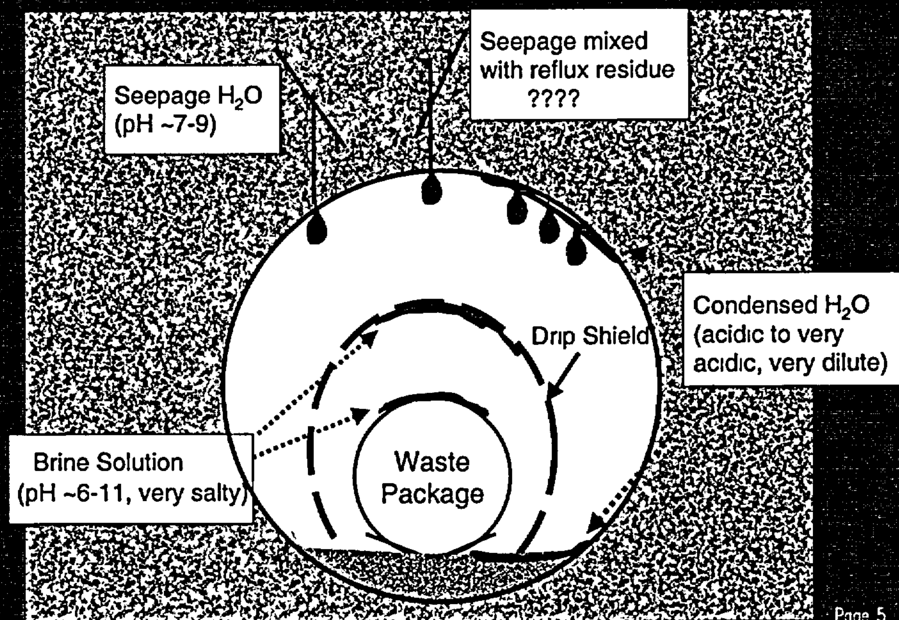
Passive Test

- Possible components of water in Passive Test in Cross-Drift tunnel at Yucca Mountain
  - condensation
  - seepage



- Condensation surfaces
  - rock bolts, wire mesh, conduit, infrastructure, invert, drip shield
- Dripping locations
  - drip shield, waste package, invert

Water Sources and Chemistry



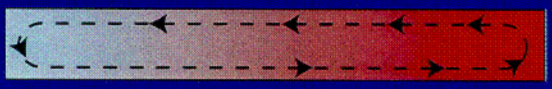
Goals of Investigation

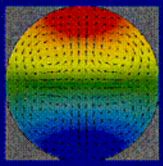
To determine the importance of H_2O to drip shield/waste package lifetimes and develop experiments and models to estimate the:

- quantity of condensed H_2O as a function of time and location in the repository setting
- chemical compositions of condensed H_2O reacted with natural and engineered materials (i.e. rock bolts, wire mesh) at various temperatures
- range of H_2O compositions resulting from mixtures of brine, seepage and condensed waters

Conceptual In-Drift Flow Patterns

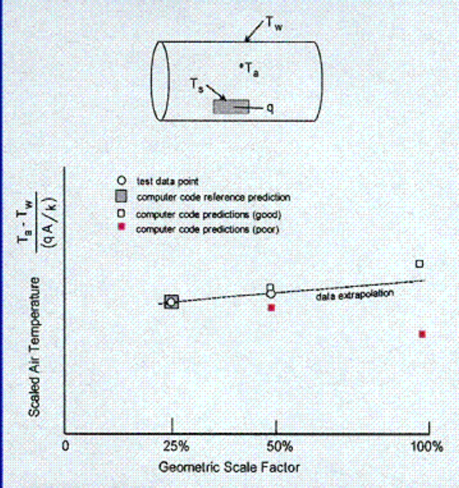
- Interplay between
  - strong local temperature variations leading to prominence of cross-sectional flow patterns
  - strong large-scale temperature variations leading to prominence of axial flow





Thermal Scaling

- Maintain temperature difference and assume heat transfer coefficient is constant
  - T_a for scaling is problematic
  - Heat transfer not constant across scaling
- Scaling Issue: Grashof number estimation is critical for flow, must get flow correct to get condensation correct
- Confidence gained if computer simulations adequately compare to test results at 2nd scale

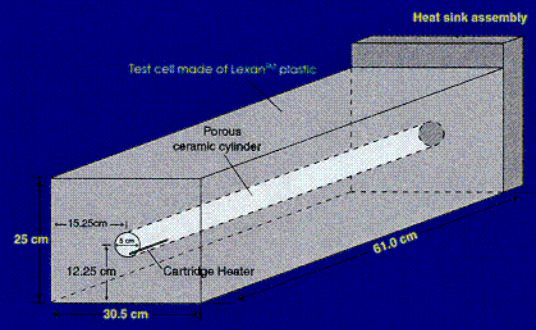


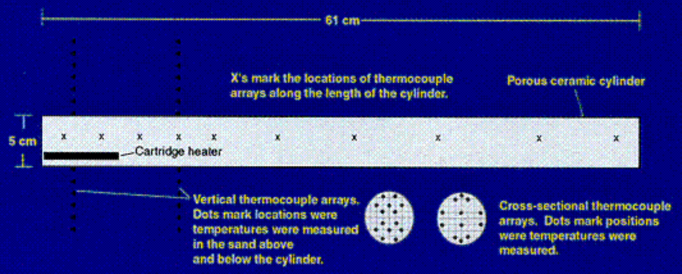
C01

Condensation Model Approaches

- Simple approach
  - drop all condensate out at cold end
- Physically realistic approach
  - drop condensate out when dew point reached
  - diffuse and convect water to condensation point as condensation occurs

Laboratory Model





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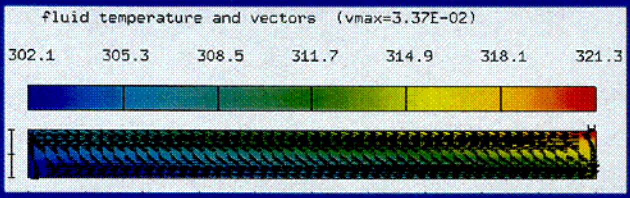
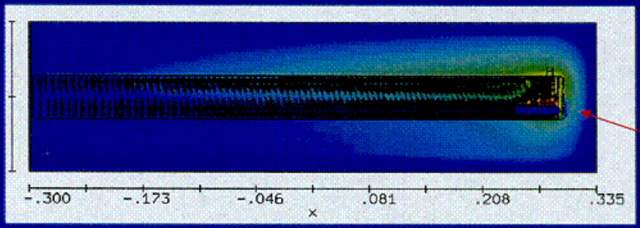
Air Flow Pathways and Temperature Profiles Modeled by FLOW-3D



Insulated boundary at drift

Effects of:

- conduction
- radiation
- boundary condition
- convection
- latent heat transfer

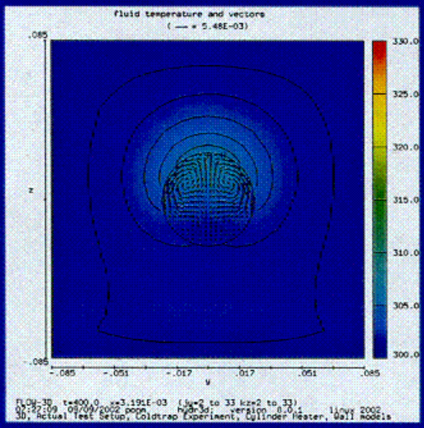


Heater Temp not displayed

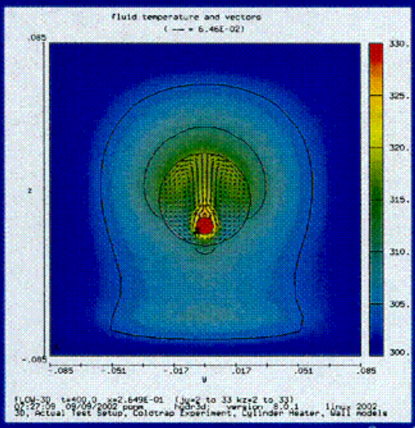
Wallrock (sand) included

Typical Cross-Sectional Views Modeled by FLOW-3D

Mid-Tunnel Position

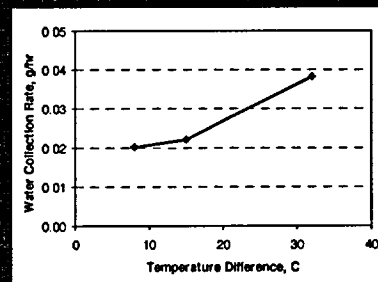


Above Heater

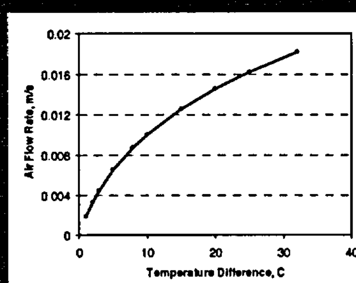


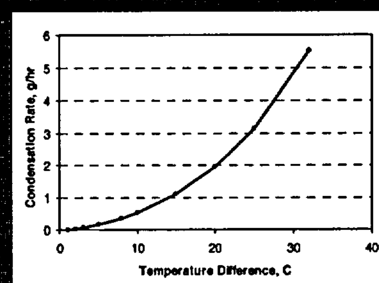
C03

Measured Condensation Flux



Calculated Air Flow and Condensation Flux





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Discrepancy Between Models

- Analytical solution assumes all condensation occurs on cold wall
  - Based on air flowlines from CFD simulations, only a small fraction may condense on the cold wall
- Note: Modules will have to be added to CFD codes (e.g., FLUENT, FLOW3D) to simulate cold trap

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Summary

- Cold trap process is a mechanism for water to contact waste packages in cooler zones and edges of drifts
  - modify chemistry of solutions
  - potential to accelerate re-wetting of invert and drift shadow
- Modeling results based on laboratory experiments useful for:
  - understanding linked physical processes
  - developing methods for larger-scale model
- Large uncertainty caused by:
  - lack of understanding physical processes
  - lack of supporting data