



Thermal Hydraulic Static Operation of a Chloride Molten Salt Shut-Off Valve

Dimitri Madden¹, Aaron Overacker¹, Kenneth M. Armijo¹, and Tom Gosling²

¹Sandia National Laboratories, Org. 8923 & ²Gosco Valves

BACKGROUND:

- DOE Gen 3 Liquid-Pathways for increase efficiency require operating temperatures >700°C
- Ternary chloride salt (20%NaCl/40%KCl/40%MgCl₂ by mol. wt. %) planned as a potential heat transfer fluid
- An advanced ball valve was developed S.S316 boronized nickel ball valves capable of >700°C operation with significantly reduced cost per valve
- Flexitalic LLC provided multi-wound spiral wound gaskets for flanged fittings on chloride salt piping systems

Objectives:

- Test the operation and functionality of the Gosco valve with static molten ternary chloride salt at incremental temperatures up to 750°C
- Test the efficacy of using a multi-material spiral wound gaskets in replacement of welded connections

Test Setup

- The ball valve was placed between two segments of 1.25" OD Inconel 625 piping with flanged connections
- The valve piping sourced from a heated reservoir of ternary chloride salt

- All piping components were supplied with N₂ ulage gas
- Compressed air supply controlled by a solenoid was supplied to an attached Kinetrol actuator for remote actuation
- All wetted valve and piping components were wrapped in heat trace



Figure 1. Gosco Valve Set-Up Exposed (left) and Insulated (right)

Testing Procedure

- Salt was initially heated in reservoir to 550°C, challenges were encountered heating the Gosco valve
- After several hours of heating, 8.9lbs of salt was pushed via pressure into the valve body at 500 °C
- The valve was actuated 10 times successfully, actuation was not smooth and salt levels were not maintained in the piping system
- Test was subsequently shut down after potential system failures were noted

Results:

- A standard API 598 test was conducted on the valve and yielded no change from pre-salt exposure
- A 720psig shell test was conducted with no leakage
- A seal test on the valve actuator showed significant leakage
- The Inconel 625 flanges and piping system did not fail or leak
- The Flexitalic gaskets appeared to be in good condition after testing and did not show signs of failure

Conclusions:

- Testing did not reach 500°C so conclusions about >700 °C functionality cannot be made
- Valve components were not wetted for extended periods of time so corrosion analysis cannot be adequately performed
- At 500°C all proposed methods of valve cost reduction were successful. The boronized nickel valve did not show signs of damage and survived post-exposure testing
- Flanged connections with Flexitalic gaskets did not fail or leak
- All complications and failures can be attributed to failure of the Kinetrol actuator
- New actuators with longer brackets and viton seals are desired for retesting