Production and Assembly Procedure

Procedure for Casting Mold Assembly

Phase 1: Slurry Preparation

1. Mix the zirconia powder and water at a 100:12-14 ratio. A hydrophobic liquid can also be used in place of water at the same ratio, but moisture likely won't be a problem at these high temperatures
2. Mix thoroughly to get an even composition and start to eliminate air bubbles using an ultrasonicator and/or a vacuum chamber.
3. For the vacuum chamber, wait until it stops bubbling then remove the casting slurry.

Phase 2: Molding

1. 3D Print the two assembly pieces
2. Place Fuel cell in designated area in the center of the cast [3]
3. Apply paste to the faces that will meet together on both parts (bottom of [1], top of [2])
4. Thread the fuel cell wires through the top holes on the top cast part [4].
    a. Optional: drill two holes at the bottom of [2] if needed to thread the bottom wires
    b. Use some sort of stopper at the bottom to prevent leakage
5. Apply ¼ in bolts to the holes in [1] and [2] to align the cast and press together
6. Apply clamps to the cast as paste dries
7. Once set, pour the cast mixture into the mold until it fills up to the bottom of the wire beam
8. Once the mixture is set, melt off the printed mold to expose the finished manifold

Phase 3: Post Processing/Curing

1. Air dry the part overnight. The manual says 8 hours but should be extended.
2. Bake for 4 hours at 200 degrees Fahrenheit. For extra cautionary measures, heat up the furnace or oven slowly to ensure no cracks will form.
3. Cure at 250 degrees Fahrenheit for 3 hours, heating and cooling the furnace slowly.
4. (Alternate) If using the Hydrophobic liquid binder, cure at 450 degrees Fahrenheit for 1 hour instead of step 3. Use extreme caution in heating and cooling the part

For reference, please see https://www.aremco.com/wp-content/uploads/2015/08/A0_Catalog_15.pdf, page 16

Procedure for Pressure Vessel Assembly

1. Prepare ceramic insulation by wrapping around 1” OD zirconia tubes until insulation OD is 3”. Insulation should be 3” long.
2. Cut away excess insulation so it fits flush within pressure vessel and flush against respective wall of the manifold.
3. Repeat steps 1-2 for 0.5” OD zirconia tubes. Insulation should be 1.4375” long.
4. Through the large opening insert ceramic insulation for 1” OD tubes until flush with the opposite wall. Repeat for other side.
5. Place a 1” OD zirconia tube through insulation until at least ¼” length is exposed on the other side.
6. Apply ceramic paste to outside of both zirconia tubes at manifold connection and inside of manifold where connection will be made.
7. Attach free zirconia tube into manifold until it hits inside stopper.
8. Insert manifold into pressure vessel such that the attached zirconia tube goes through the empty ceramic insulation until it is exposed on other side of vessel.
9. Ensure the other 1” hole for the manifold is aligned with the previously inserted zirconia tube.
10. Push zirconia tube into manifold until it hits inside stopper and ensure connection is sealed.
11. Feed electronic wires through top and bottom holes of pressure vessel.
12. Place excess ceramic insulation to openings above and below the manifold to secure it in place.
13. Feed wire into electrical passthroughs.
14. Place the electrical passthroughs on the top and bottom of the pressure vessel and secure into place.
15. Screw 1” NPT Lenz fitting onto one of the zirconia tubes exposed end. Do not tighten fully.
16. Attach 1” to ½” NPT reducing bushing to long end of a Swagelok Tee adapter that will attach to the Lenz fitting.
17. Add ½” to 3/8” to opposite side of Tee adapter.
18. Attach Cartridge heater to 3/8” bushing so it goes through the Tee adapter.
19. Screw Swagelok Tee adapter onto Lenz fitting attached to pressure vessel.
20. Attach a second Swagelok Tee adapter perpendicularly onto the middle of the Tee adapter in the current assembly.
21. Add a ½” to 1/8” reducing bushing to the middle of the second Tee adapter.
22. Place the pressure transducer onto 1/8” bushing and secure.
23. Attach exposed opening of the second Tee adapter to the air/gas supply.
24. Ensure all connections are secure.
25. Repeat steps 15-24 for second zirconia tube.
26. Repeat step 6 for 0.5” OD zirconia tubes.
27. Insert 0.5” OD zirconia tube with insulation around it into opening until flush with manifold.
28. Repeat step 10.
29. Place the two silicon O-rings on the outside of the pressure vessel around the large opening.

30. Place the flange over the O-rings and secure onto pressure vessel using the ¼”-20 screws and the respective holes.
31. Add the 0.5” NPT Lenz fitting into the center of the flange on the second side and secure.
32. Add Swagelok Tee adapter to Lenz fitting.
33. Place the ½” to ¼” reducing bushing to long end of Tee adapter and secure.
34. Place the thermocouple into the first side and reducer and secure.
35. Attach exposed opening of the Tee adapter to the air/gas outlet.
36. Repeat step 24.
37. Repeat steps 26-36 for the second 0.5” OD zirconia tube.