U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

SETO CSP Program Summit 2019

High Temperature Pumps and Valves for Molten Salt

Asegun Henry, Department of Mechanical Engineering, MIT
Ken Sandhage, School of Materials Engineering, Purdue University
Marc Buckler and Christine Anderson, Flowserve

Overall Goals of the Project

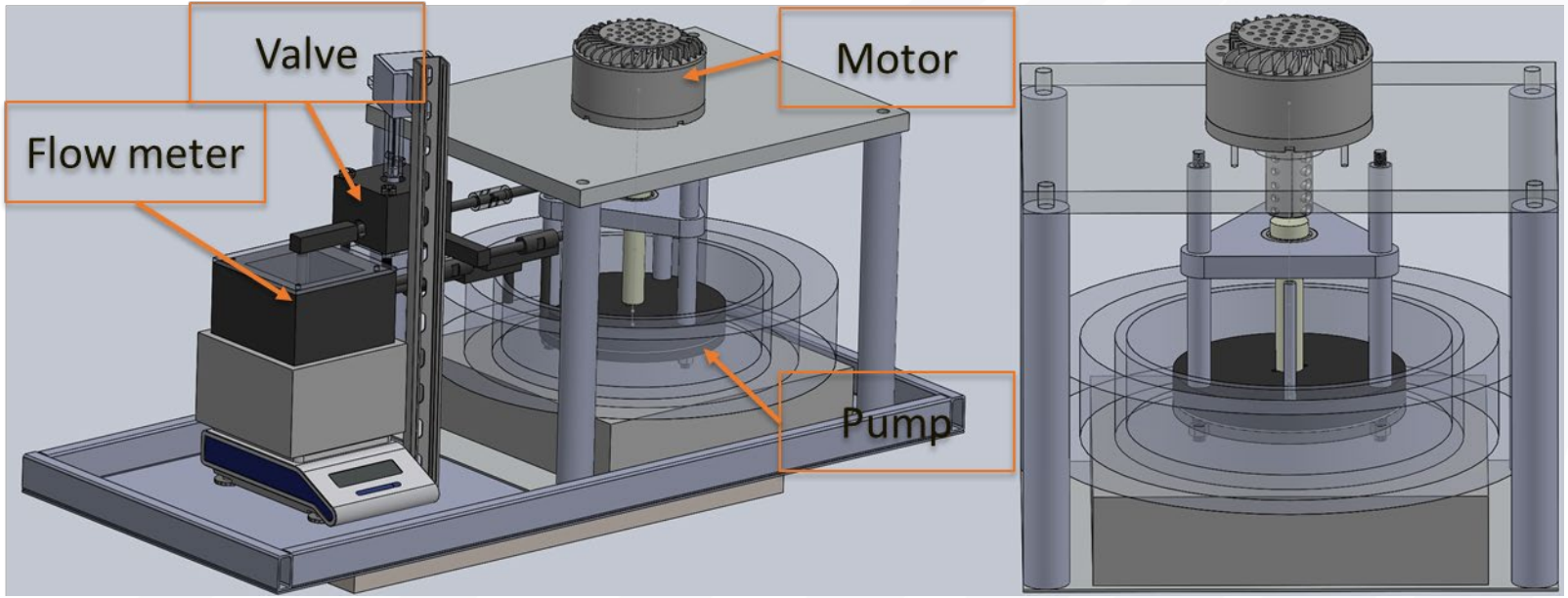
- **Objective (1):** Demonstrate a centrifugal pump with an impeller, shaft, bearing, and housing made of a refractory material that is corrosion resistant, mechanically stiff, and creep resistant at 800˚C when exposed to a ternary chloride salt

- **Objective (2):** Demonstrate a refractory material that can be used to make a corrosion resistant, mechanically stiff plug valve for operation in a ternary chloride salt at 750˚C

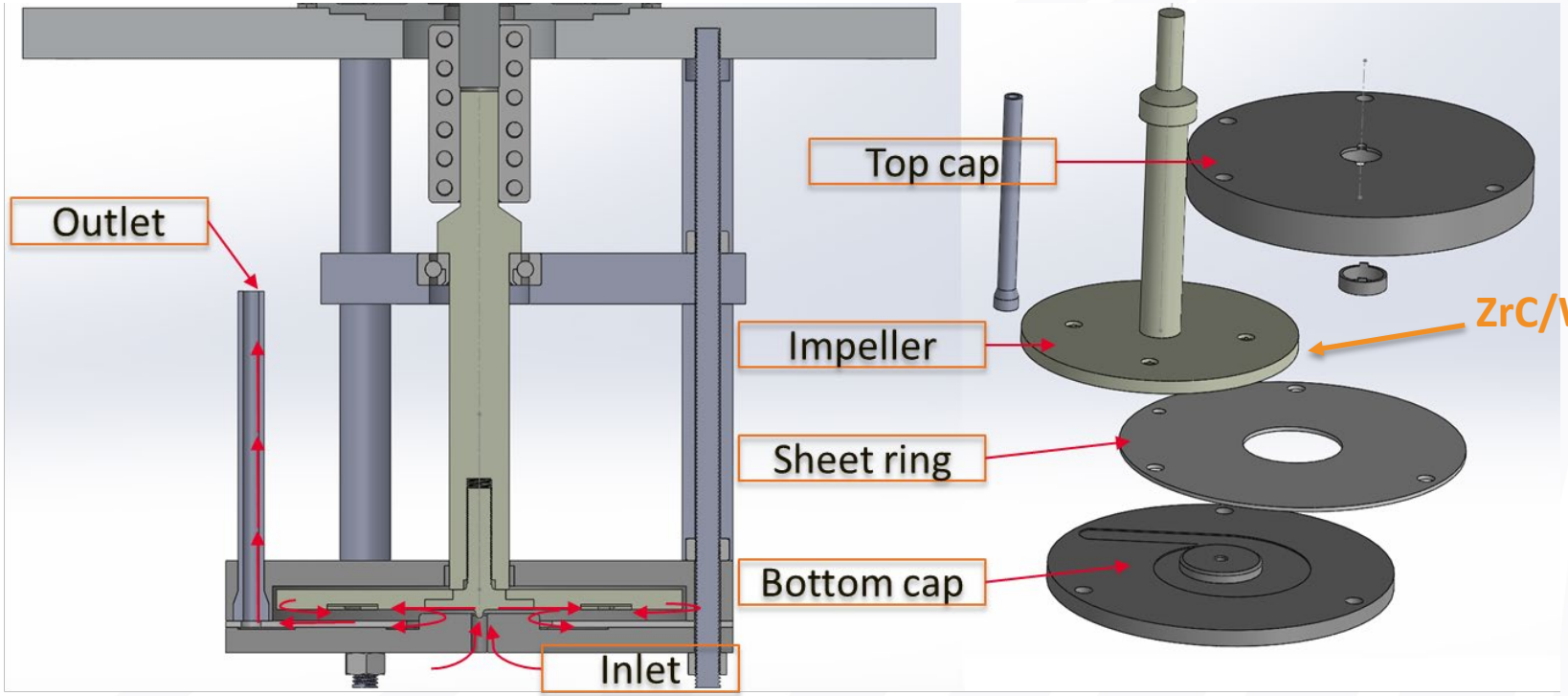
- **Objective (3):** Design a full scale vertical turbine pump (VTP) that uses the tested materials and could be deployed in a full scale CSP plant employing a ternary chloride salt at 750˚C

- **Objective (4):** Design a pump made from conventional materials (i.e., Ni-based alloys) that can be used at 750˚C to pump molten salt in a 2 MW pilot scale plant

Circulation Loop



Pump Components

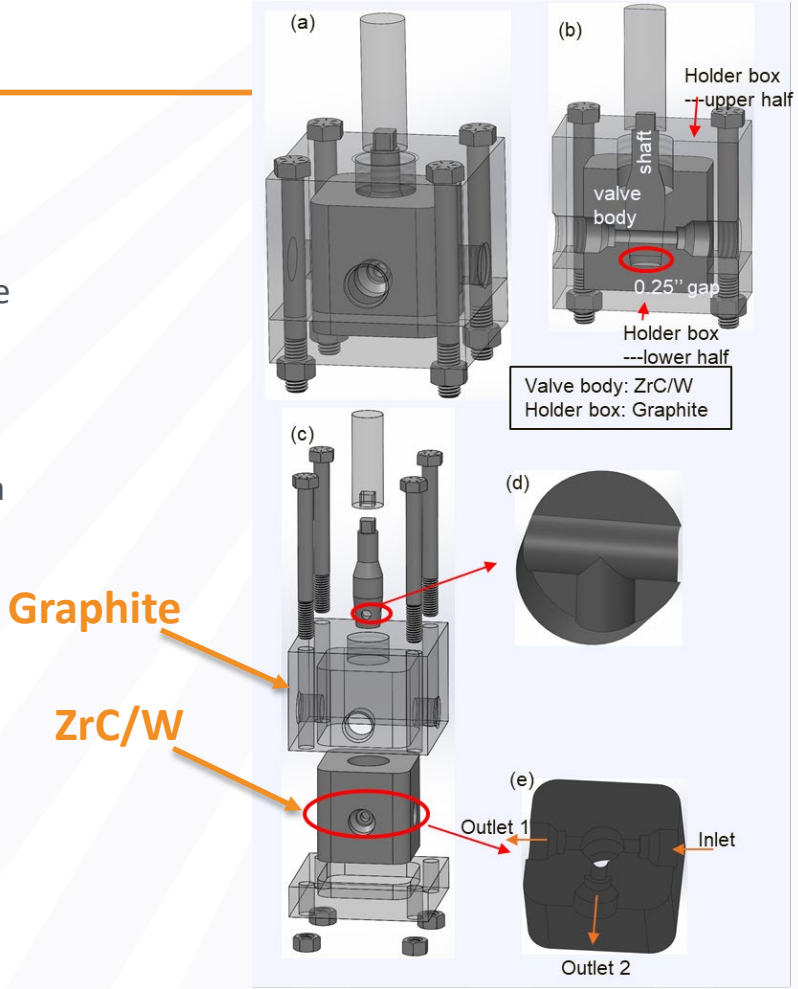


Goal is to subject the pump to the same types of stresses it would experience in the full scale application → 6000 RPM

Valve Components

Advantages with refractories:

- **Creep:** We propose to use a ceramic/metal composite material, ZrC/W, which has much higher creep resistance than Ni alloys like H230 and 740H
- **Fabrication:** ZrC/W can be fabricated into the requisite complex shapes needed for pumps and valves by using a novel net-shape, reactive melt infiltration process
- **Corrosion:** DCP-derived ZrC/W composites exhibit high temperature corrosion resistance in low-oxygen-bearing molten MgCl2-KCl salt



Questions

Overall circulation setup

- The system is held inside the chamber
- The system provides the inert Ar environment.
- The chamber's walls are water-cooled