Flexible Mechanical Seal Concepts
July 9, 2003

- Reviewed two primary concepts:
  - High temperature flexible shaped seal using compressive loads for sealability
    - Conventional Sealing approach but “Honey I Shrunk the Seal!!”
  - Mechanical Bellows + Glass Seal
    - Novel concept that doesn’t require significant preloading to effect seal. Glass on sealing surfaces seals asperities reducing demands on surface finishes

High temperature flexible-shaped seal using compressive loads for sealability

Current Status

- Superalloy materials (e.g. Waspalloy) available to 800deg C for short life (3000 Hrs). No concepts proven for 10,000 hrs.
- Superalloy materials have finite grain sizes (~1 mils). This may be a problem for making very small, thin-walled seals.
- Requires high quality surface finish of seal and adjacent members (cost).
- Limited ceramic seals made in flexible (e.g. bellows) configuration.
  - Ref. Cerametec

High temperature flexible-shaped seal using compressive loads for sealability

Development Needs

- Creep resistant materials (metal, ceramic) for long life (10,000+ hrs.)
- Geometries, cross-sectional shapes for good resiliency (e.g. bellows, “C-shape”, E-, W-, V, other)
- Designs that package in the small space available
- Need new mfg techniques reduce size to 200 micron (e.g. 0.008 in) height.
- System design that allow for sealing groove.
- Metallic System: Electrical isolation needs to be addressed.
- Techniques for providing high quality surface finish of seal and adjacent members (cost).

High temperature flexible-shaped seal using compressive loads for sealability

Development Approach:

Pursue development programs that address:

- Metals:
  - Novel mfg techniques for making small flexible structures. (thin (<0.001 in) thick. Spray, CVD, other
  - Creep resistant, oxidation resistant alloys
- Ceramics:
  - Novel mfg techniques for making small flexible structures.
  - Fracture tough, ceramics that can accommodate thermal growth. Creep resistant materials for long life for 10,000+ hrs.
- Assess high temperature lubricants to allow relative movements

- Perform analyses of candidate seal geometries/materials under expected loads, deflections.

- Fabricate and test promising seals using button cells approach. Assess voltage change vs. cycling at temperature.

Mechanical Bellows + Glass Seal

Current Status

- Removing load through seal reduces the demands on material strength
- Corners for “picture-frame” pose significant problems
  - Problem dealing with “corner outward diagonal growth”
  - Stiffness
  - Possible Soln: Fabricate cells and seals in circular/axisymmetric configurations. Analyses still required to determine feasibility of concept.
- Glass/metal seals have been produced (reducing risk)
- High temperature superalloy materials have finite grain sizes (~1 mils). This may be a problem for making very thin walled seals.
- Eliminates need for high quality surface finish of seal and adjacent members (cost).
- Metal alloys are available that can sustain the 800degC temperatures.

Mechanical Bellows + Glass Seal

Development Needs

- Geometries, cross-sectional shapes for good resiliency (e.g. bellows, C, W, V, other)
- Investigate issues associated with circular vs. rectangular picture frame seals.
- Designs that package in the small space available
- Need new mfg techniques reduce size to 200 micron (e.g. 0.008 in) height.
- Glasses with the appropriate properties: wetability, sealability, cycle capability, etc.

Mechanical Bellows + Glass Seal

Development Approach:

Pursue development programs that address:

- Metals:
  - Novel mfg techniques for making small flexible structures. (thin (<0.001 in) thick. Spray, CVD, MEMS other
  - Oxidation resistant alloys
- Ceramics (if there is merit):
  - Novel mfg techniques for making small flexible structures.
  - Fracture tough, ceramics that can accommodate thermal growth.

- Perform analyses of candidate seal geometries/materials under expected loads, deflections.

- Fabricate and test promising seals using button cells approach. Assess voltage change vs. cycling at temperature.