INMM 30th Spent Fuel Workshop

Hitachi Zosen's current development with respect to SCC resistant canister, and a new shock absorber material

January 14, 2015

Ryoji Asano, Marina Morita
Hitachi Zosen Corporation

1. SCC Resistant Canister
1. SCC Resistant Canister

To make a canister surface residual stress compressive, as a preventive maintenance against SCC

---

I. SCC Resistant Canister

Specifications for SCC resistant canister

- **Material**
  Austenite stainless steel, Type 304L or 316L

- **Surface processing methods**
  (objective to make surface stress compressive)
  (1) Completion of fabrication at factory: *Zirconia Peening on whole surface*
  (2) After lid welding at NPS: *Burnishing on Weld and Heat Affected Zone (HAZ)*
I. SCC Resistant Canister

Measurement of residual stress in the weld (Zr peening)

![Graph showing residual stress (MPa) vs. Depth from surface (mm)]

- Grindig
- Grindig+Buffing
- Grindig+Buffing+Zirconia peening

Residual stress (MPa)

Depth from surface (mm)

I. SCC Resistant Canister

Stress corrosion cracking test in 42% MgCl₂ aqueous solution at 143°C (JIS G0576): SUS304L

- As welded
- Grinding
- Grinding +Buffing
- Grinding + Buffing +Zirconia peening

Cracks perpendicular to the weld line.

Cracks caused by grinding

Cracks are reduced by buffing

Crack is not observed
I. SCC Resistant

Measurement of residual stress in the weld (ball burnishing)

A: Base metal
B: Grinding
C: Soft burnishing
D: Hard Burnishing

I. SCC Resistant Canister

Stress corrosion cracking test in 42% MgCl₂ aqueous solution at 143°C (JIS G0576): SUS316L

Milling surface has tensile residual stress, but the SCC instruction pattern is not confirmed.
I. SCC Resistant Canister

Stress change of the compressed area under tensile load

![Graph showing stress change](image)

**Peened Area**

**Tensile test**

**XRD**

**Residual stress (MPa)**

-0.2% Proof stress: 243 MPa

Design stress < 0.2% Proof stress

---

**I. SCC Resistant Canister**

**Pitting corrosion test**

For long-term use, the SCC generation from the site of tensile layer beneath the compression layer by pitting is a potential concern.

(Material: 304L, 316L)

![Diagram showing corrosion areas](image)
2. Shock Absorber Material: R-PUF – Rigid Polyurethane Foam

Background
Wood has been mainly used as shock absorber material because it has enough absorption capability with limited size.

It has become difficult to reliably procure wood that satisfies the characteristics specified by design.

R-PUF was chosen as shock absorbing material for two reasons

- Crush strength characteristic is adjustable
- R-PUF can be prepared at low cost comparable to the cost of the lowest-priced wood.
2. Shock Absorber Material: R-PUF

Function of impact limiters

- To absorb impact energy at drop accidents
- To provide some insulation during fire accident

Drop weight test

Crushing stress-strain curves for different densities and temperature conditions were obtained.
2. Shock Absorber Material: R-PUF

Comparison with woods (Image)

- Parallel to annual ring
- Perpendicular to annual ring

Balsa Wood
Fir Plywood
Oak Wood

Energy absorption (kJ)
Density (ton/m³)

Self-extinguishing – Limits heat source in fire event

Just after 30 minutes 800°C fire test

Flame extinguished after 10 minutes.
2. Shock Absorber Material: R-PUF

![Drop test results diagram]

**Conclusions**

1. SCC Resistant Canister

   - Both Zr peening and ball burnishing are effective methods to make canister surface stresses compressive.
   - SCC is not induced provided that the surface stress is compressive.

2. Shock Absorbing Material: R-PUF

   - Stress strain curves of R-PUF under each temperature condition were obtained by drop weight test.
   - The 1/3 scale model drop test shows that the impact limiter composed of R-PUF has superior shock absorbing performance.
   - Ability to customize shock absorbing properties
   - Excellent self-extinguishing performance.