END FITTING FOR R744 MOBILE AIR CONDITIONING SYSTEMS

Anthony GARCIA
High Pressure Transfer Activity
European R & D department

VDA Winter meeting
February 14th – 15th, 2007
• HUTCHINSON leader in manufacturing air conditioning, power steering and brake assembly lines
**CO2 End fitting development**

- **Thermodynamic cycle of R744 brings technical challenges:**
  - Material *permeability* to R744 (supercritical state)
  - Material *extraction* by supercritical R744
  - *Very low level of leakage* (<0.5 gr/year) in high working pressure and temperature

- **Challenges and objectives:**
  - HUTCHINSON, in cooperation with LJF, has developed a R744 end fitting based on the low leak connector development knowledge (DPS™)
  - The R744 end fitting will have the same shape than current (R134A)
  - OEM product lines will use same assemblies tools
The HGS end fitting is patented
Specifications

- **Major key points of German OEM’s specifications (draft release)**
  
  - Tightening torque is 10Nm +/- 10%
  - Tightness should be guaranteed after several opening and closing
  - Decompression resistance (for rubber material)
  - Leak < 0.5 gr/year according occurrence matrix
  - Mechanical resistance
    - Pressure cycling
    - Burst pressure
    - Traction
Leak measurement bench

- HUTCHINSON has developed a specific test bench
  - The fluid used is R744
  - Pressures and temperatures are manageable
  - No handling needed during tests
    - Safety
    - An infrared spectrophotometer is used for the measurement
      - accuracy: 0.02 gr/year
      - Leaks are measured in real conditions, with a good accuracy of measurement
Rubber Material choice

• Is it possible to find a rubber material compatible with R744?
  • Tensile stress at break evolution after 7 days in R744 at 150°C and 90 Bars

• No leak after 5 cycles @ 14 MPa / 100°C with R744
  (according German OEM’s specifications)

Choice of specific HNBR material
(ref: 9DT1889)

With authorization of “Le Joint Français”, a HUTCHINSON company
Few preliminary results ....

![Graph showing leak (g/year) vs. pressure and temperature.]

- Leak (g/year) for different pressures and temperatures:
  - 6 Mpa / 23°C: 0.05
  - 8 Mpa / 35°C: 0.05
  - 9 Mpa / 120°C: 7.6
  - 11 Mpa / 95°C: 25.0
  - 15 Mpa / 60°C: 24.0
  - 15 Mpa / 170°C: 22
  - LP side: 19.0
  - HP1 side: 32.0
  - HP2 side: 47.0

- Additional data points:
  - 6 Mpa / 23°C: 10.7
  - 8 Mpa / 35°C: 9.5
  - 9 Mpa / 120°C: 14.0
  - 11 Mpa / 95°C: 13.8
  - 15 Mpa / 60°C: 22
  - 15 Mpa / 170°C: 20.5
  - 12.75
  - 14.33
  - 13.78

- DPS adapted:
  - 1 O ring
  - 2 O rings

Anthony GARCIA

Saalfelden, 14th-15th, February 2007
Hutchinson Gas Seal (HGS)

**Fixation by screw -M6-**
(option : nut/bolt)

**Gasket sealing (metal/rubber coating)**

**Male part**

**Female part**

**sealing line**

Hutchinson Gas Seal (HGS)
Latest design leak results

Target: < 0.5 gr/year
Fittings : current performances

- **Influence of the tightening torque**

HGS M6 end fitting samples test Results (average)
leak rate data @30°C– pressure = 7 MPa
Fittings : current performances

- **Influence of mounting / dismounting operations**

**HGS M6 end fitting samples test Results** (average)
leak rate data @30°C - pressure = 7 Mpa
tightening torque = 10Nm

![Bar Chart]

- after 1st mounting / dismounting
- after 2nd mounting / dismounting
- after 3rd mounting / dismounting
- after 4th mounting / dismounting
- after 5th mounting / dismounting
• **Pressure cycling** (according German OEM’s spec)
  – 255 000 cycles
  – AND leak < 0.1 g/year @ 70 bars / 23°C

• **Traction**
  – Effort = 6 000 N
  – AND leak < 0.1 g/year @ 70 bars / 23°C

• **Burst pressure** (according German OEM’s spec)
  – No oil leak on fitting area at 51 MPa
  – Burst pressure > 58 Mpa
**status and next validation steps**

<table>
<thead>
<tr>
<th>Test</th>
<th>Target OEM's Specification</th>
<th>HUTCHINSON Results</th>
<th>Status/Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightness</td>
<td>&lt; 0.5 gr/year</td>
<td>&lt; 0.5 gr/year</td>
<td>OK</td>
</tr>
<tr>
<td>Distortion</td>
<td>10 Nm</td>
<td></td>
<td>March 2007</td>
</tr>
<tr>
<td>Traction</td>
<td>&gt; 6000 N</td>
<td>&gt; 6000 N</td>
<td>OK</td>
</tr>
<tr>
<td>Torsion test</td>
<td></td>
<td></td>
<td>waiting for new release specification</td>
</tr>
<tr>
<td>Rotation Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Rock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration test</td>
<td></td>
<td></td>
<td>June 2007</td>
</tr>
<tr>
<td>Burst pressure</td>
<td>&gt; 51 Mpa @ 165°C</td>
<td>&gt; 58 Mpa @ 165°C</td>
<td>OK</td>
</tr>
<tr>
<td>Impulse test</td>
<td>no leak after test</td>
<td></td>
<td>OK</td>
</tr>
<tr>
<td>Decompression test</td>
<td>&lt; 0.5 gr/year</td>
<td></td>
<td>March 2007</td>
</tr>
<tr>
<td>Resistance to cold</td>
<td></td>
<td></td>
<td>June 2007</td>
</tr>
<tr>
<td>Corrosion test</td>
<td></td>
<td></td>
<td>June 2007</td>
</tr>
<tr>
<td>Assembly forces</td>
<td>&lt; 5 N</td>
<td>50 N</td>
<td>NOK?</td>
</tr>
<tr>
<td>Disassembly force</td>
<td>&lt; 5 N</td>
<td>40 N</td>
<td>NOK?</td>
</tr>
</tbody>
</table>

**Note**: For R134a applications using O-rings technologies, forces values are from 20 N to 50 N.

It will be difficult to achieve 5N with O-rings technologies!!
Conclusion

• With the HGS end fitting, HUTCHINSON demonstrated that it is possible to have a rubber based sealing system where:

  – The leak is lower than 0.4 gr/year for HP side and lower than 0.1 gr/year for LP side
  – Tightness is guaranteed with a tightening torque from 8Nm to 12Nm
  – Tightness is guaranteed after 5 mounting / dismounting operations
Thank you for your attention

and to our partners