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Technical Aspects of CH2 Storage Systems for Vehicle Applications

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Technical Aspects of CH2 Storage Systems for Automotive Applications

Dr. Gerardo Friedlmeier

CH2 Tank System Development

DaimlerChrysler AG

Fuel Cell Project (EP / BZE)

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Technical Aspects of CH2 Storage Systems for Vehicle Applications

Onboard CH2 Storage: General Aspects

- CH2 is the most widely used form of onboard H2 storage (maturity, simplicity, well-to-wheel efficiency)
- Significant synergies with CNG storage technology (>2 Mio. CNG vehicles on the road worldwide!)
- CH2 Pressure levels: 250 bar established, 350 bar now starting, future goal: 700 bar (range increase)
- Main challenges: Range, public acceptance, cost
- Zero-tolerance for safety issues in the initial phase due to public perception (Hindenburg, Challenger)
- H2 safety can be guaranteed by careful design, extensive component and system testing as well as active onboard failure detection (H2, P sensing...)
- Vehicle / H2 safety shall always have highest priority !!

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CH2 Storage System Configuration (Example)

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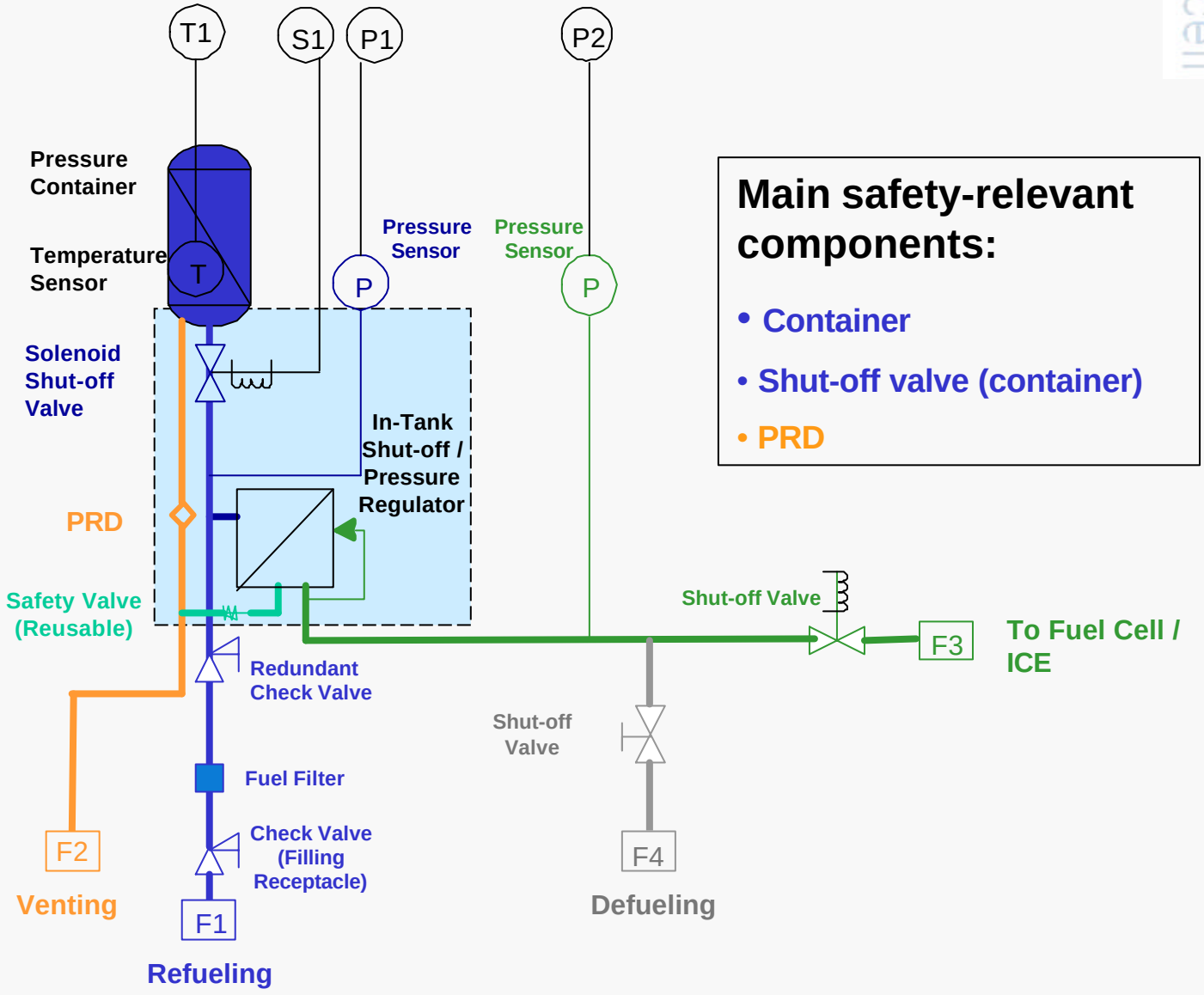

Main safety-relevant components:

- Container
- Shut-off valve (container)
- PRD

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Lightweight Cylinder Technology
(Example: Type 3 - Al Liner)

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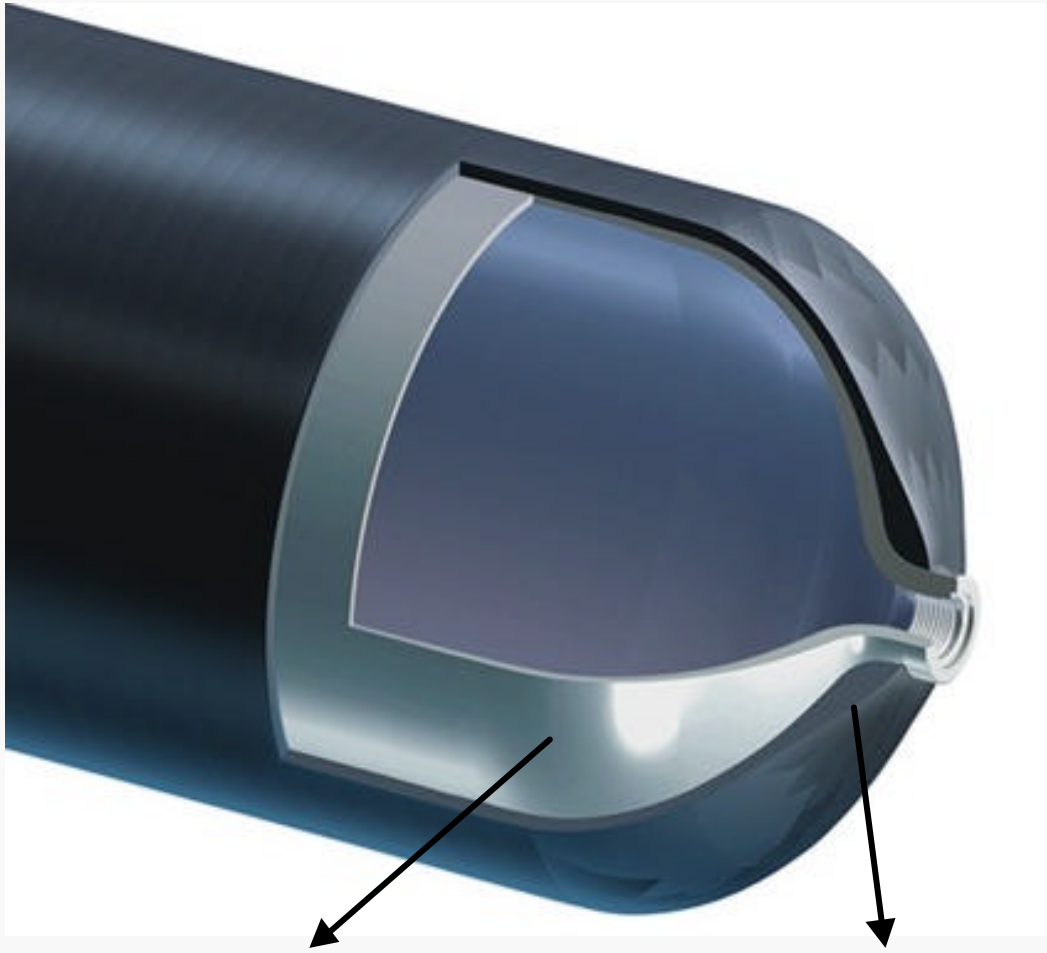

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Typical Specs Onboard CH2 Storage
(Example: 350 bar system)

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- **Fuel:** pure H2 (>99.8% H2 for FC)
- **Working Pressure (WP):** 350 bar (@ 15°C)
- **Max. Filling Pressure(*):** 438 bar (@ 85°C)
- **Burst Pressure:** [3] 823 bar (SF = 2.35)
- **Operating Temp. Range:** -40 °C to +85 °C
- **Service Life:** [3] 15 years / 15,000 cycles
- **Refueling Time:** < 3 min (@ 5 kg H2)
  (if not further limited by refueling station)
- **Leak Rate:** bubble-free, < 1 $Ncm^3/l/h$

(*) Commonly defined as = 1.25 x WP

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Selected Safety & Function Testing

(Component and System Level - Use and Abuse)

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- Pressure Cycling Test (must Leak Before Break)
- Hydrostatic Burst Test (must reach spec. burst press.)
- Bonfire Test (must vent through PRD)
- Gunfire Test (leak, but no fragmentation)
- Composite Flaw Tolerance Test
- Environmental Test (salt, gasoline, methanol, NaOH, ...)
- Acid Environment / Corrosion Test (SO_2H_4)
- Vibration Tests
- Drop Tests
- Extreme/Cycling Temperature Tests
- Leak Tests
- Fast Fill Tests, etc.

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Bonfire Test (Video)

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Source: Powertech

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Gunfire Test (Video)

Technical Aspects of CH2 Storage Systems for Vehicle Applications

Source: Powertech

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Typical Safety Tests on Vehicle Level

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- Leak Tests
- Crash Tests
- Vibration Test
- Bonfire Test
- Grounding Test
- ...

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Safety-Enhancing Measures on Vehicle Level (Example)

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- Hydrogen sensing in specific locations (leak detection)
- Various failure detection functions using suitable pressure and temperature Sensors:
  - Cycle life monitoring (shutdown if exceeded)
  - Leak testing
  - Venting event monitoring
  - Pressure monitoring (too high, too low)
  - Temperature monitoring (too high, too low)
  - Overfill monitoring
- Hydrogen shut-off during crash
- Use of tires with sufficiently low electrical resistance
- ...

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Challenges Onboard CH2 Storage

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- "Get used to use hydrogen" (consumers, authorities...)
- Avoid significant differences between standards and regulations applicable to onborad CH2 storage systems in Europe, the US and Japan
- Standardization of the refueling process
- Standardization of a data interface for communication between vehicle and refueling station
- Achieve acceptable cost levels
- Make the 700 bar technology happen

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