

APPLICATION OF ISS CONTAINMENT REQUIREMENTS TO SODI AND ARES PAYLOADS

3RD IAASS CONFERENCE 'BUILDING A SAFER SPACE TOGETHER'

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APPLICATION OF ISS CONTAINMENT REQUIREMENTS TO SODI AND ARES PAYLOADS

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 - Experiment description
 - Limit of containment requirement applicability
 - Alternative hazard control approach

APPLICATION OF ISS CONTAINMENT REQUIREMENTS TO SODI AND ARES PAYLOADS

WHY CONTAINMENT IS NEEDED

- Men and women are on ISS
- ISS and launchers infrastructure guarantee a human life compatible environment

WHAT NEEDS TO BE CONTAINED



Fires
Explosions
Impacts



Jamming/malfunction of mechanism
Intoxication/Poisoning/Contamination
Damages to critical equipment



Et cetera ...

Flammable materials
Chemical reagents
High pressure fluids
Preloaded mechanical parts
Rotating parts
Huge equipments
Small equipment
Shatterable materials
Toxic/Biohazardous materials
Et cetera ...

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GENERIC CONTAINMENT REQUIREMENTS

Physical barriers are used to separate two or more things:

- vessels, boxes, filters, any kind of container ...
- but also negative pressure, electromagnetic fields, et cetera ...

What shall be prevented:

- Sudden energy release
- Hazardous materials release

Important concepts:

- Critical & Catastrophic hazards
- Levels of Containment
- Design For Minimum Risk

What is needed:

- Structural integrity
- Functional integrity (i.e. fans)
- Load control
- Leak tightness
- ...



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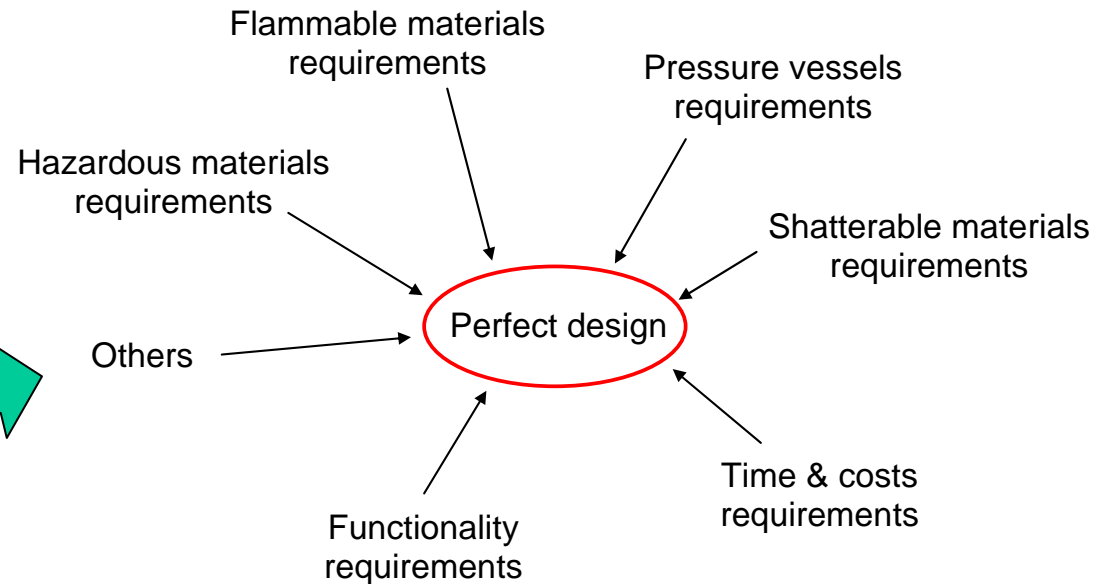
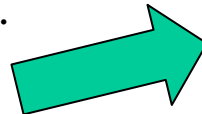
GENERIC CONTAINMENT REQUIREMENTS

Safety policy and requirements documents provide rules for design and verification:

- NSTS 1700.7B
- NSTS 1700.7B ISS ADDENDUM
- ESA-ATV-1700.7b
- ...



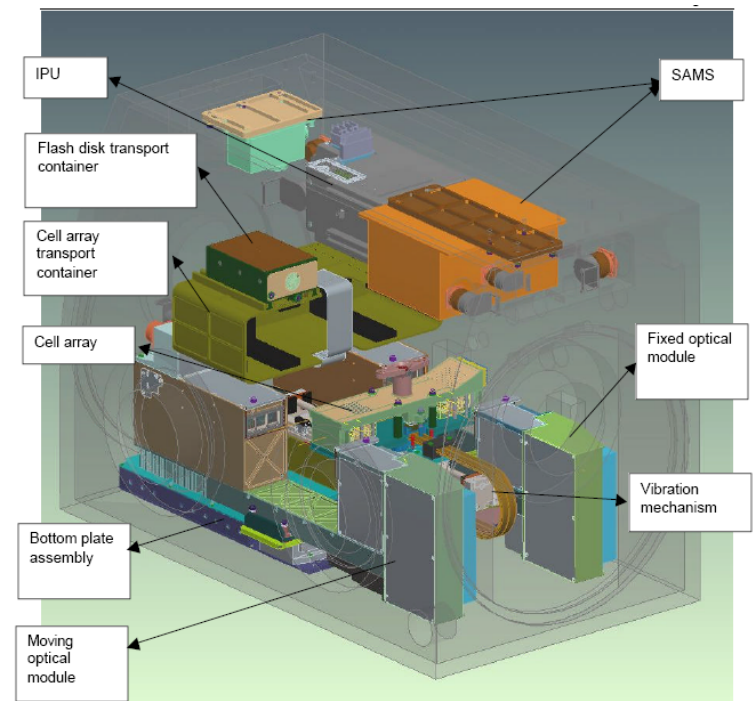
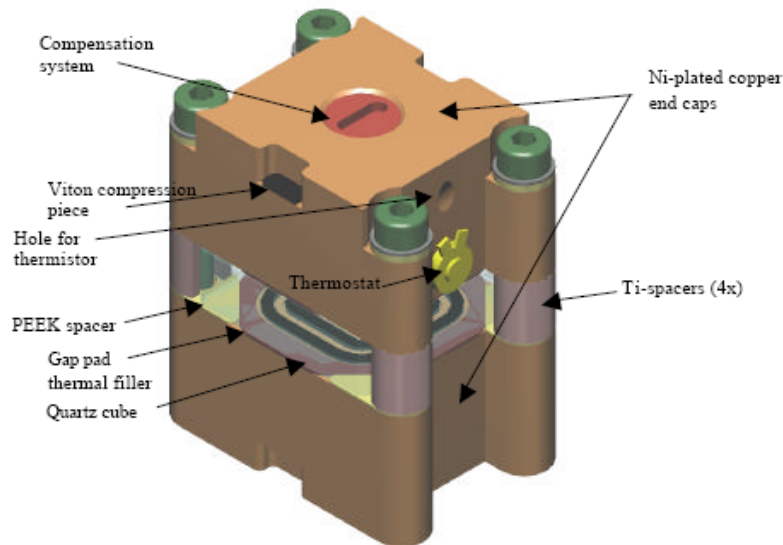
- Hazardous materials req.
- Pressure vessels req.
- Shatterable material req.
- ...



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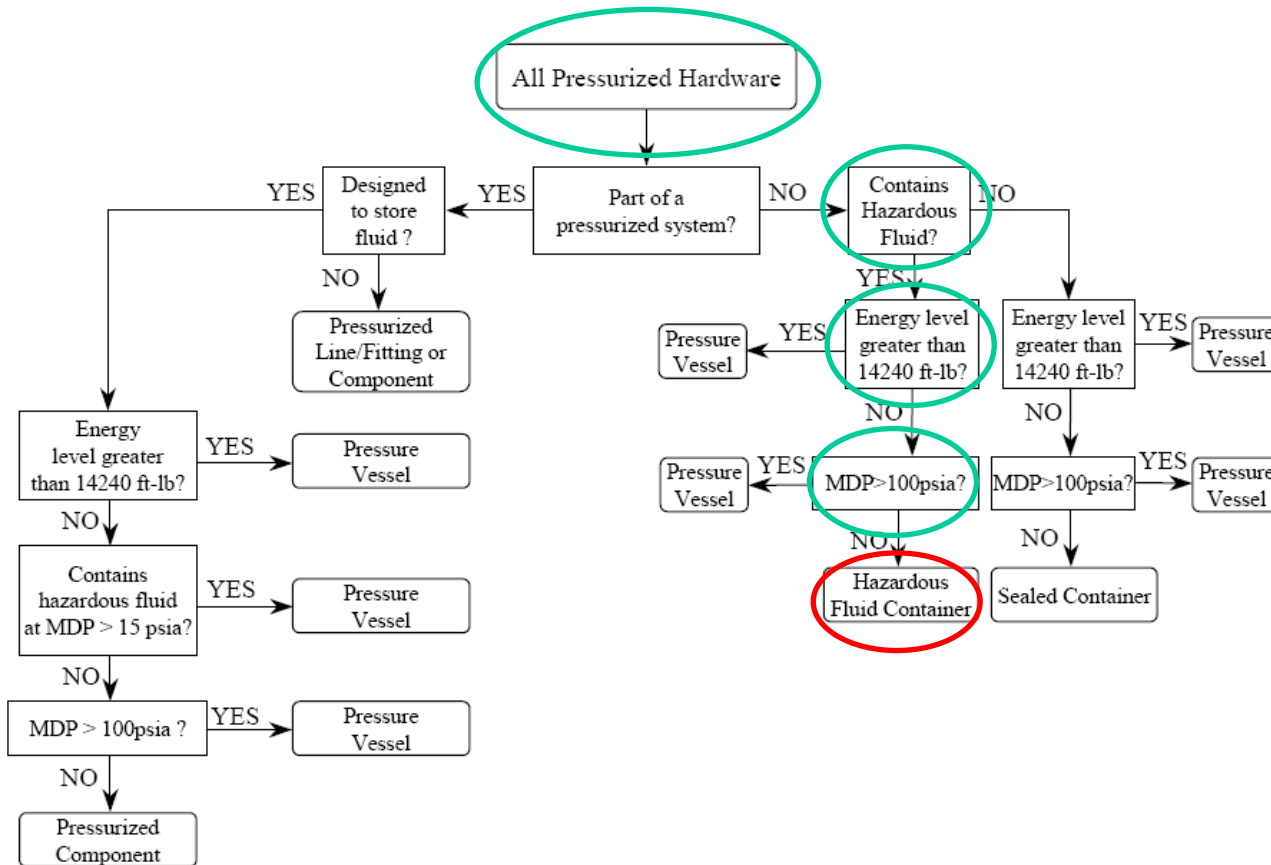
SODI: Brief experiment description

- Study of diffusion and aggregation in liquid solutions
- Three different experiments : DSC, IVIDIL, COLLOID
- Samples contained in cells and observed via an optical systems
- Operated inside MSG rack
- Soft stowed launch in Shuttle or Soyuz



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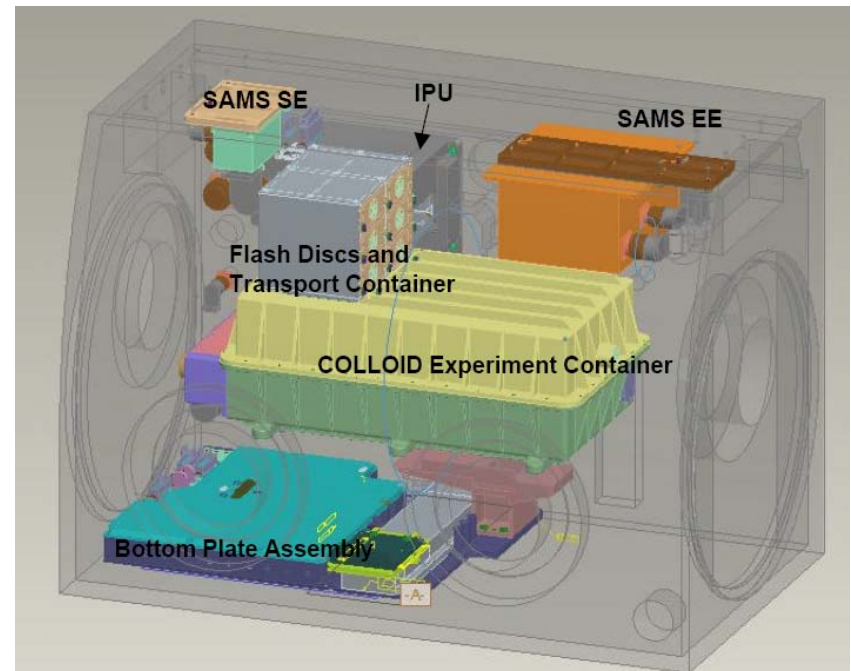
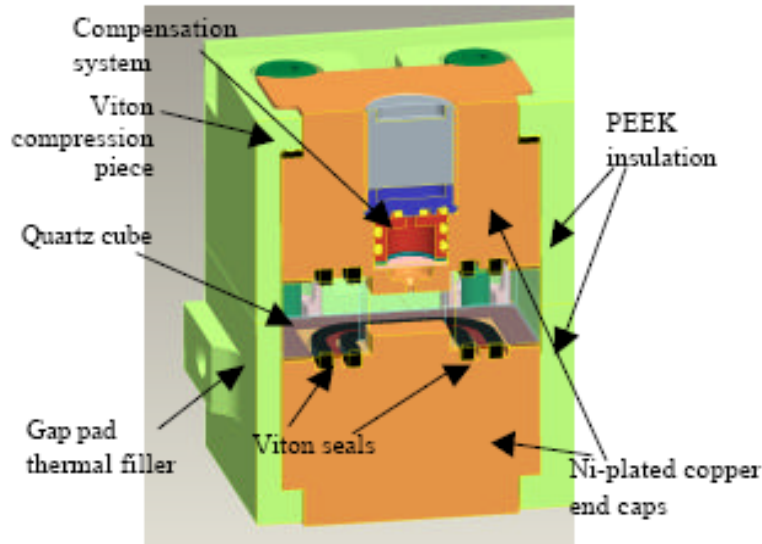
SODI: Pressurized hardware classification



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SODI: Pressurized hardware classification

- DSC/IVIDIL samples are THL 1
- COLLOID samples are THL 2



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SODI: Shatterable material classification

Three possible approach can be followed for shatterable materials:

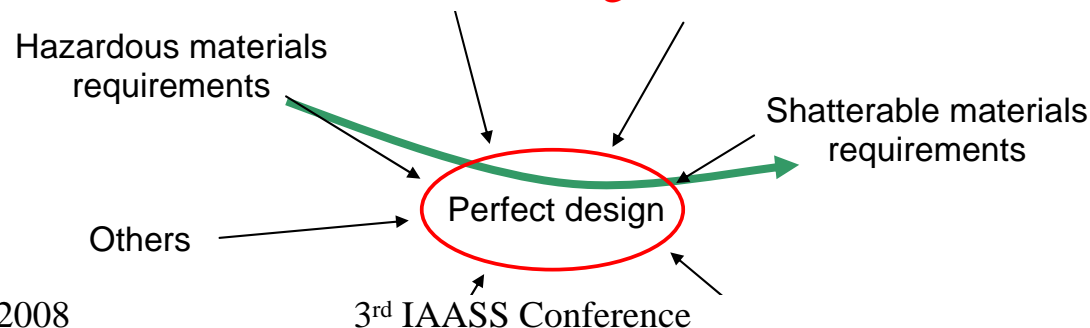
- Shall be safe from breakage
- Shall be contained
- Release of particles larger than 50 mm shall be prevented

Possible classification according to shatterable material requirements:

- DSC/IVIDIL cell windows shall be safe from breakage
- COLLOID cell windows are contained

BUT : COLLOID cells provides containment for THL 2 fluids

COLLOID cell windows shall be safe from breakage



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SODI: Hazard controls

Only one Unique Hazard Report covers both hazardous material release and shatterable material hazards

Hazard causes are:

- Inadequate provision of containment levels
- Propagation of crack-like defect
- MDP control overheating leads to MDP exceedance
- Improper workmanship
- Improper filling (wrong fluids and/or quantities)
- Material incompatibility
- Ageing of elastomeric materials (seals)
- Mishandling during ground transportation and handling (DSC/IVIDIL)
- Inadequate on-orbit assembly and storage (DSC/IVIDIL)

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SODI: Hazard controls

Inadequate provision of containment levels:

- Review of design for containment during all mission phases
- Qualification leak test at 1xMDP (qualification of assembly procedure)
- Acceptance leak test at 1xMDP before final filling
- Acceptance leak test at ~ 1 bar delta pressure after final filling
- SODI structural analysis
- Glass strength analysis
- Vibration test

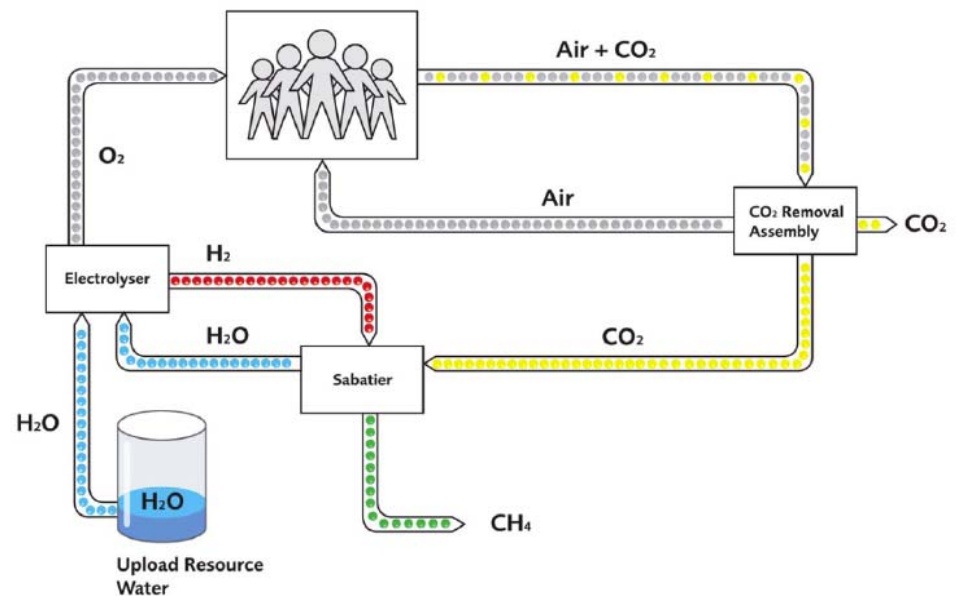
Propagation of crack-like defect:

- Proof test at 1.5xMDP (proof test not driven by glass because $SF > 5$)
- Acceptance leak test at 1xMDP after proof test
- Glass visual inspection at 75x magnification before and after proof test
- Qualification leak test of a fail safe configuration (3 bolt out of 4)

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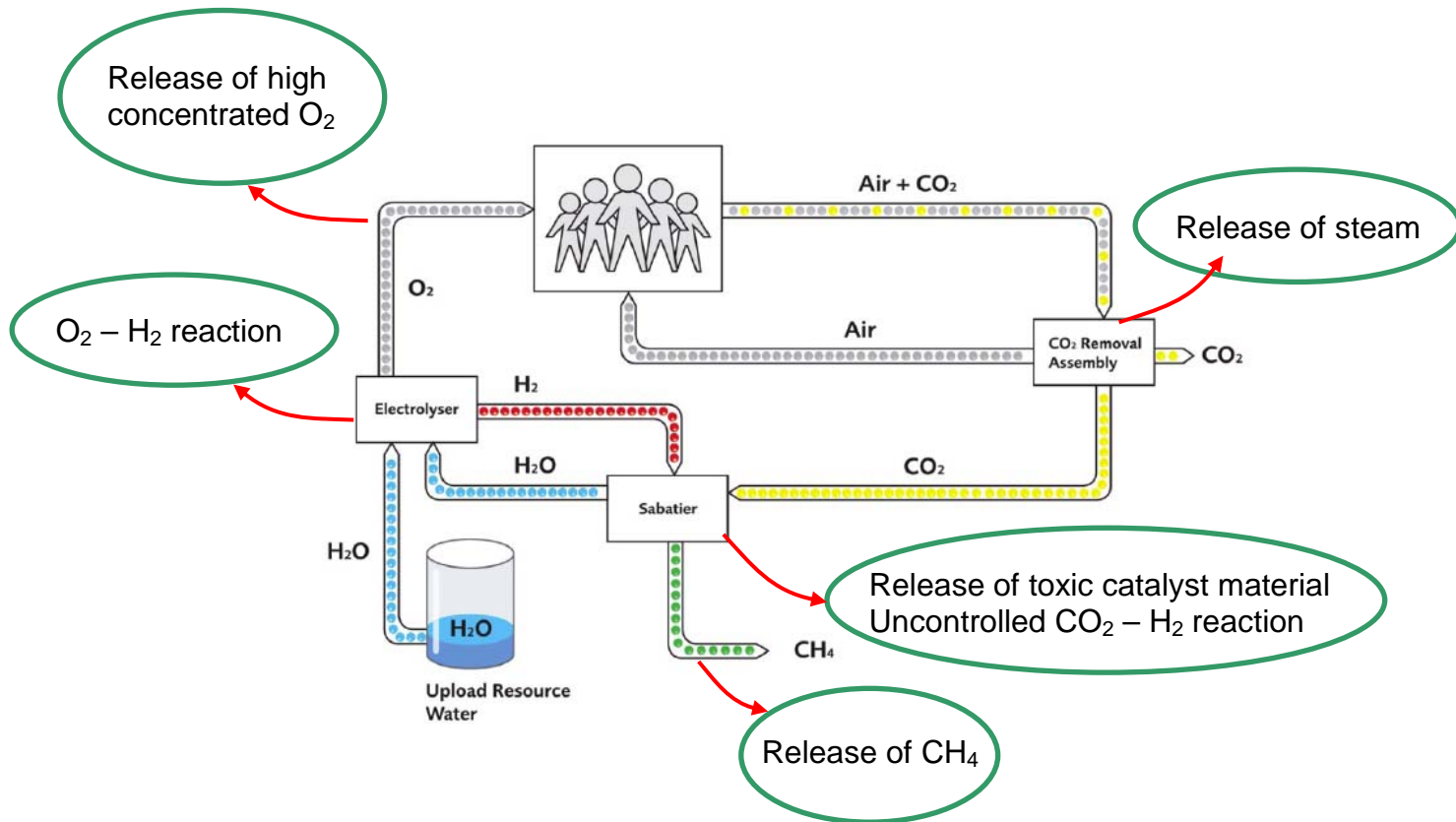
ARES: Brief experiment description

- ARES is a regenerative life support experiment for ISS
- Provides breathable oxygen for a crew of 3 people
- Reduces CO₂ level in concurrence with ISS
- Recycles CO₂ into water
- Launch with HTV inside a ISPR



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ARES: hazard discussion



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ARES: Hazard controls

Containment requirements applied to the release of:

- steam
- CH₄
- catalyst materials

Control for H₂ - O₂ reaction:

- Application of containment requirements as feasible
- Measurement of O₂ concentration in H₂ lines
- Control of differential pressure between O₂ and H₂ compartments
- Small quantities of O₂ and H₂
- Structure able to sustain loads from an undesired reaction

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ARES: Hazard controls

Control for the release of high concentrated O₂:

- Reduction of concentration before the release into COLUMBUS environment
- Containment of lines with highly concentrated O₂
- No ignition sources where O₂ is highly concentrated

Control for H₂ – CH₄ undesired reaction:

- Small quantities of CH₄ and H₂
- Control of reagents quantities
- Control of reaction parameters as pressure and temperature
- No reaction outside the catalyst is possible

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CONCLUSIONS

SODI and ARES examples show the importance of a safety analysis performed at system level

The application in series of requirements could result in unfeasible experiments and/or a poor level of safety

Relationships between experiments different functionalities shall clearly be understood to define a single verification approach that takes into account requirements mutual influence

