SES6-CT-2004-502630

HySafe

"Safety of Hydrogen as an Energy Carrier"

Network of Excellence
Sustainable Energy

Second status report on code validation and applicability based on the results of SBEPs

Draft: Preliminary analysis of the results of V3 benchmark exercise

Period covering: March 1st, 2004 to May 5th, 2006

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Part 1. Analysis of the predictions for the total hydrogen mass in the area of calculation domain.

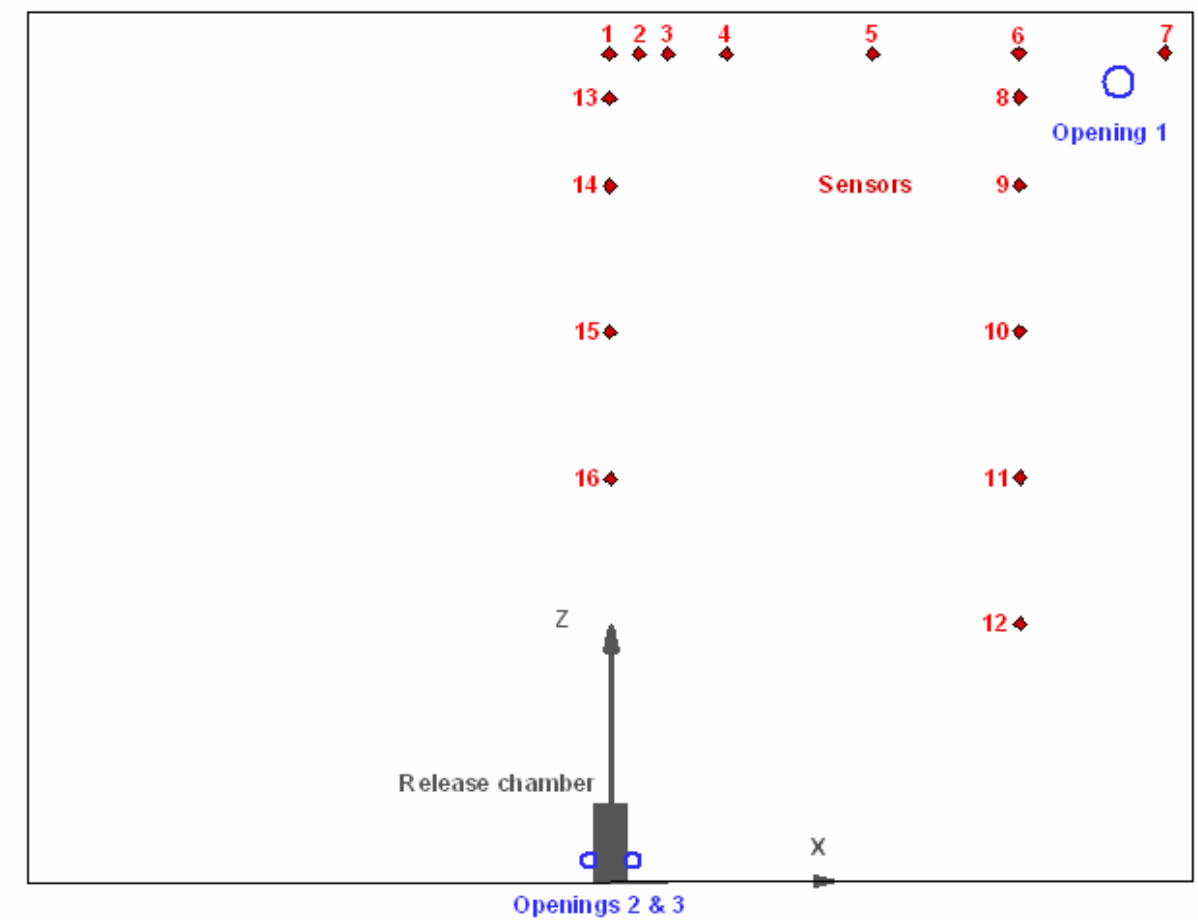


Figure 1. Calculations for the total hydrogen mass in the domain.

Accurate method (Used by CFD codes):

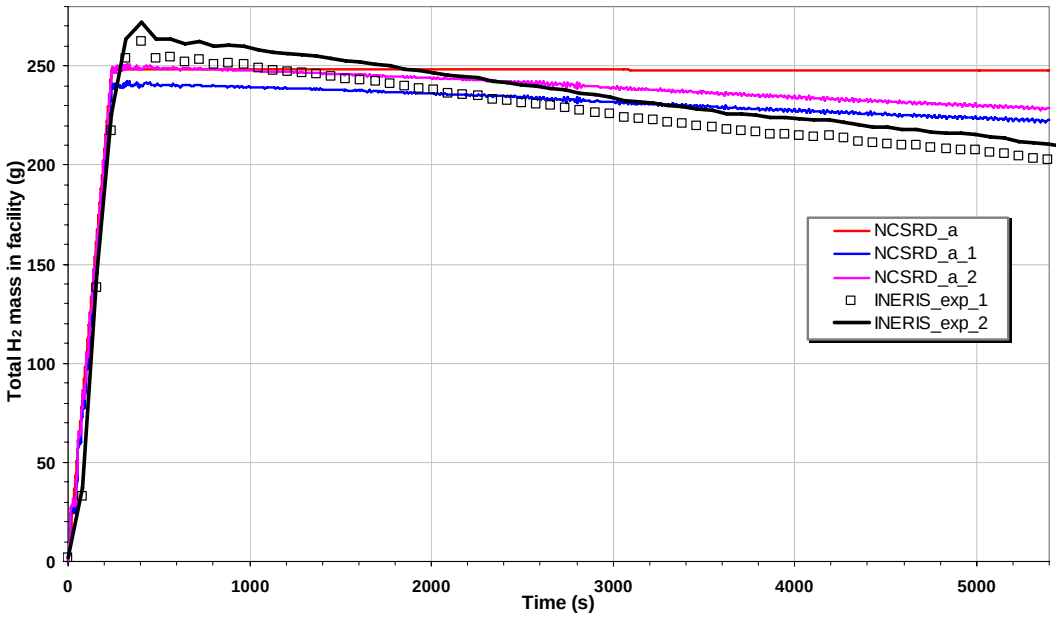
$$M = \sum_i C_i V_i \rho_{H2}$$

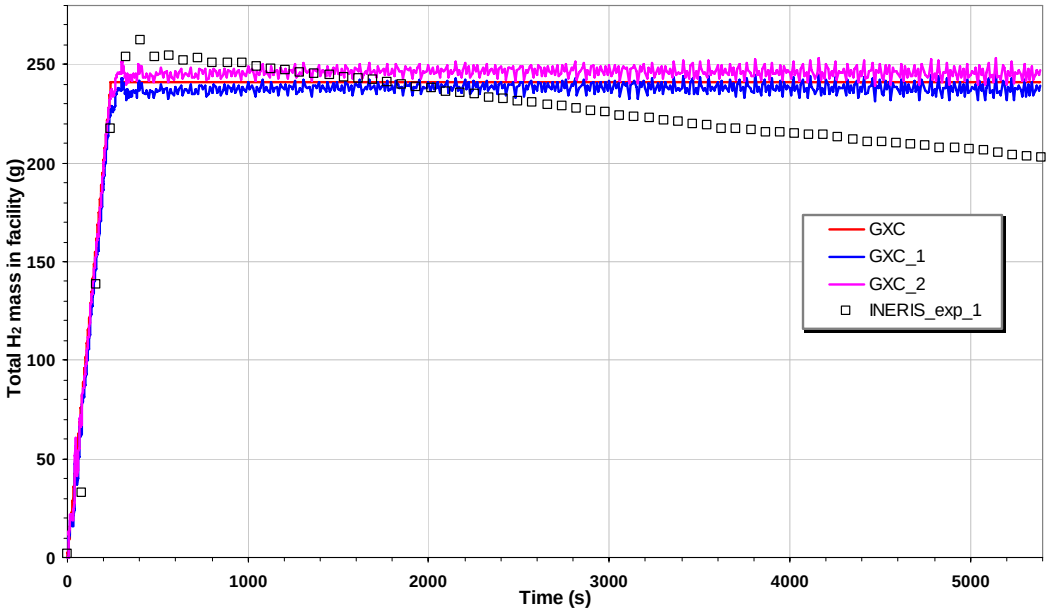
Approximate method 1 (Used by INERIS):

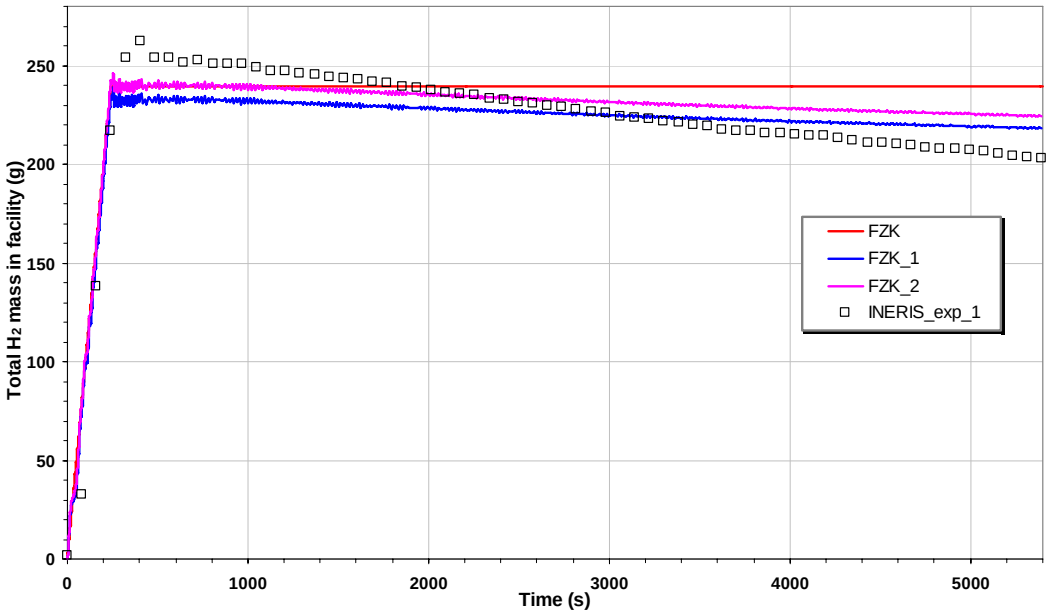
$$M_1 = \left\{ \begin{array}{l} \frac{C_6 + C_8}{2}\left(z_6 - z_8\right) + \\ \sum_{i=8}^{11} \frac{C_i + C_{i+1}}{2}\left(z_i - z_{i+1}\right) + \frac{C_{12}}{2} z_{12} \end{array} \right\} A_{hor} \rho_{H2}$$

Approximate method 2:

$$M_2 = M_1 + C_6\left(z_{top} - z_6\right)A_{hor}\rho_{H2}$$

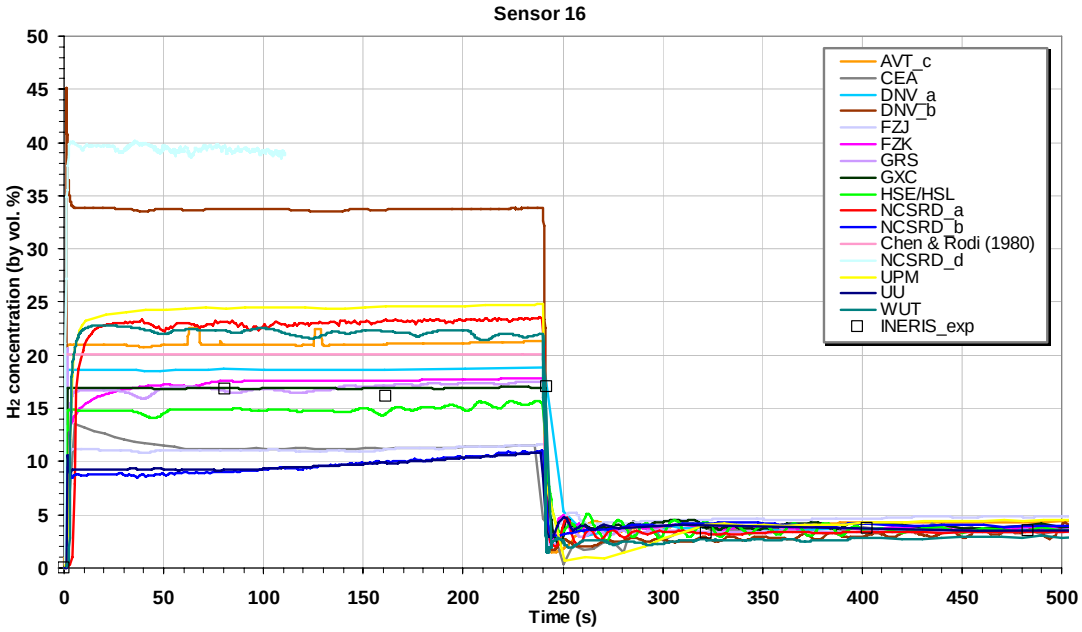


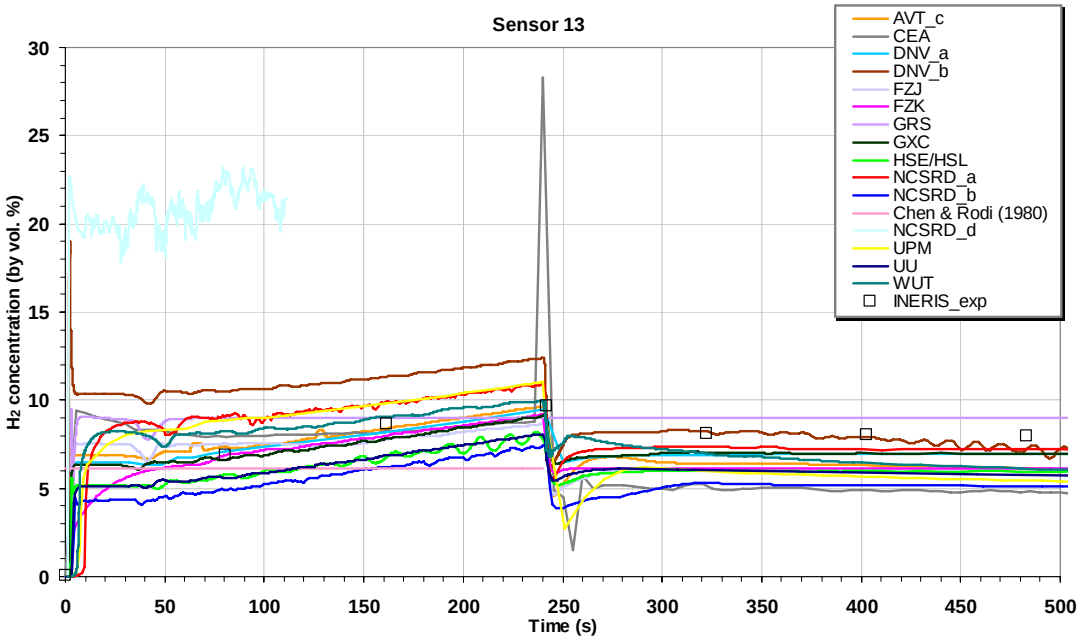


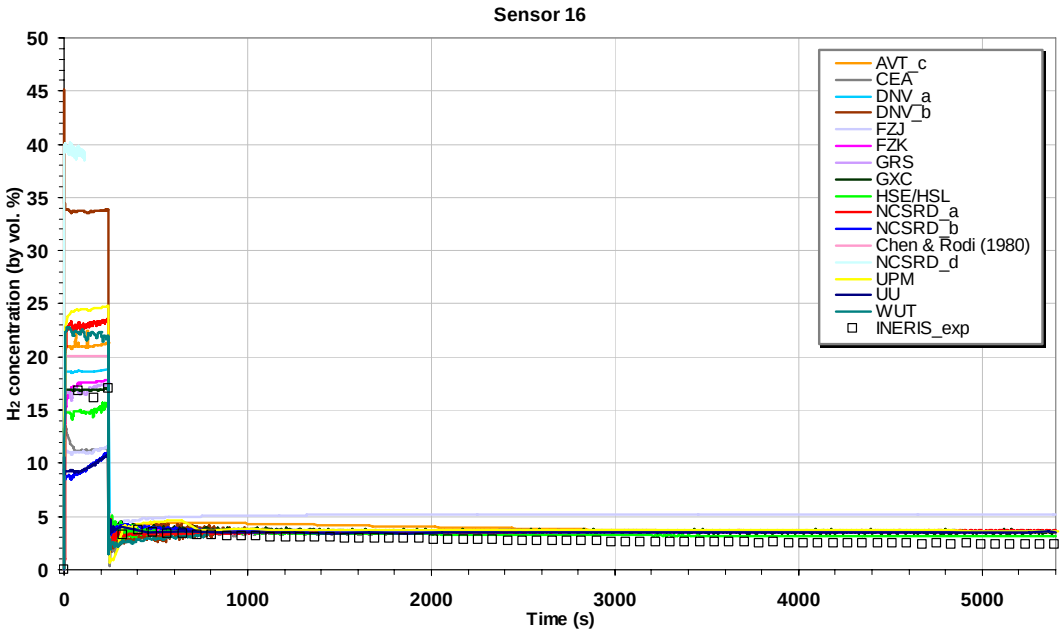


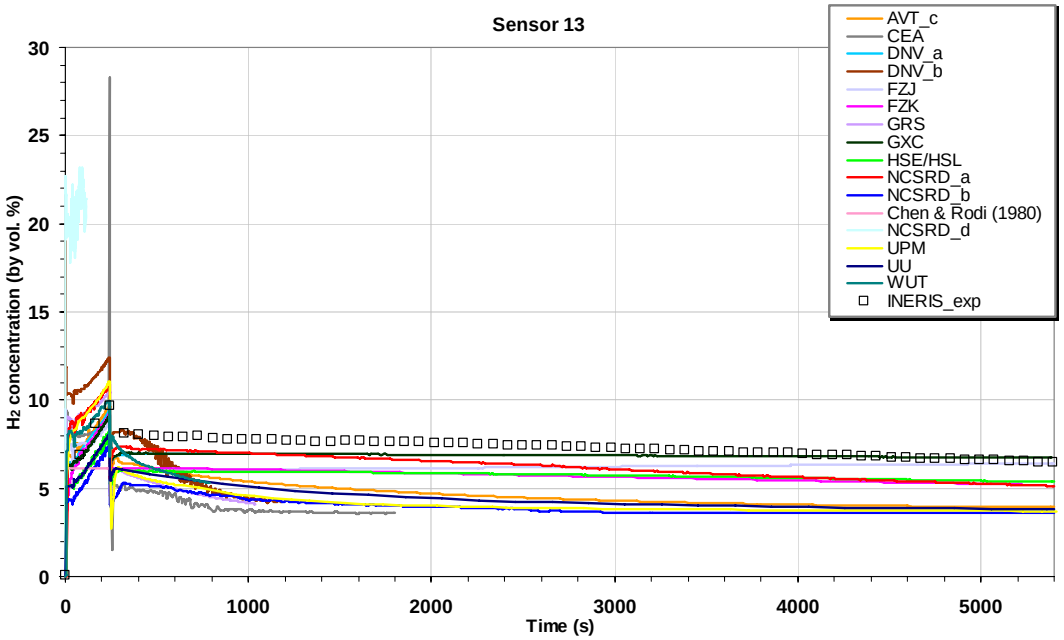
To be exactly determined: is the loss of hydrogen experienced by INERIS partly artificial, generated due to the approximate method applied to calculate the total H2 mass?

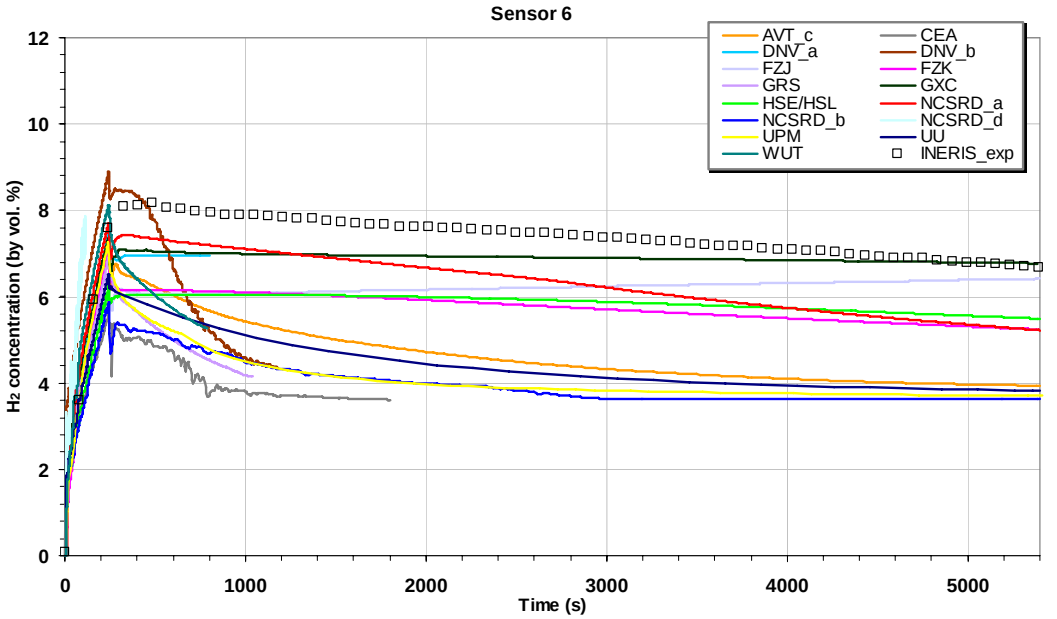
Part 2. Analysis of the predictions for the hydrogen concentrations at different locations.

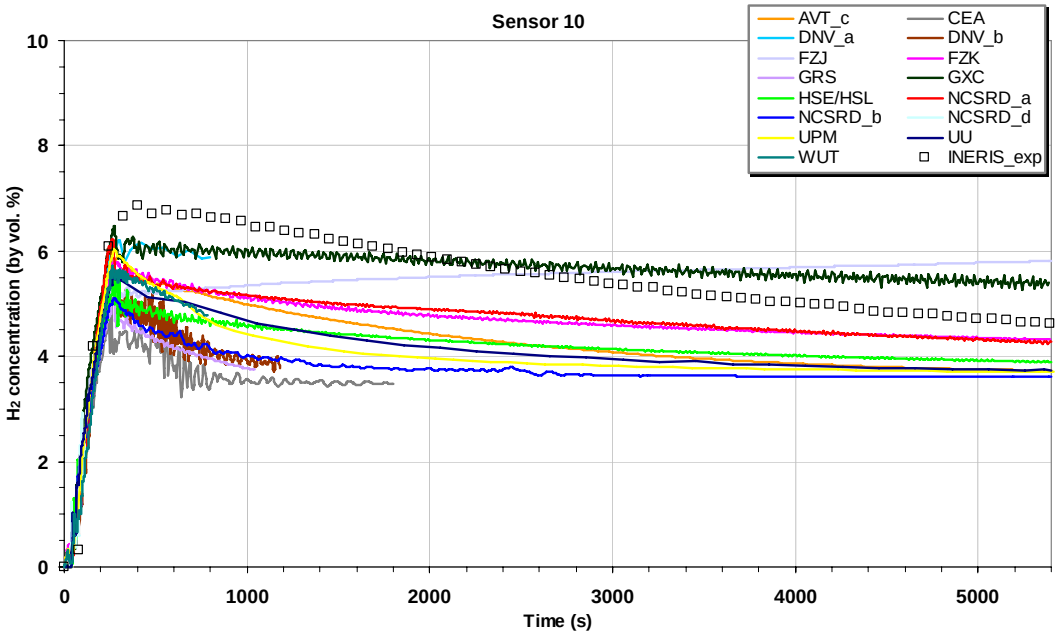


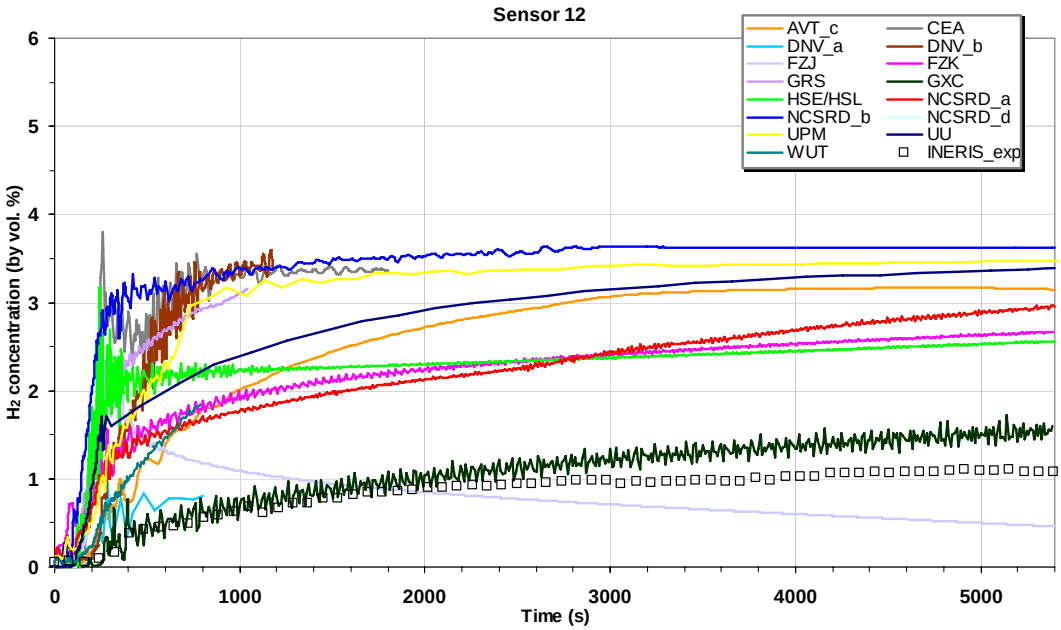



Sensor 16
H2 concentration (by vol. %)
Time (s)
AVT_c
CEA
DNV_a
DNV_b
FZJ
FZK
GRS
GXC
HSE/HSL
NCSRD_a
NCSRD_b
Chen & Rodi (1980)
NCSRD_d
UPM
UU
WUT
INERIS_exp


Sensor 13
H2 concentration (by vol. %)
Time (s)
AVT_c
CEA
DNV_a
DNV_b
FZJ
FZK
GRS
GXC
HSE/HSL
NCSRD_a
NCSRD_b
Chen & Rodi (1980)
NCSRD_d
UPM
UU
WUT
INERIS_exp


Sensor 6
AVT_c
CEA
DNV_a
DNV_b
FZJ
FZK
GRS
GXC
HSE/HSL
NCSRD_a
NCSRD_b
NCSRD_d
UPM
UU
WUT
INERIS_exp
H2 concentration (by vol. %)
Time (s)
0
2
4
6
8
10
12
0
1000
2000
3000
4000
5000


Sensor 10
AVT_c
CEA
DNV_a
DNV_b
FZJ
FZK
GRS
GXC
HSE/HSL
NCSRD_a
NCSRD_b
NCSRD_d
UPM
UU
WUT
INERIS_exp
H2 concentration (by vol. %)
Time (s)
0
2
4
6
8
10
0
1000
2000
3000
4000
5000



To be exactly determined:

- Why does GXC produce 17% h2 concentration at sensor 16 during the release period, using a turbulent Schmidt number of 0.7?
- What steps should be taken in the next INERIS-TEST-6C calculations to make results obtained with same turbulence model converge?

Appendix

Prandtl and Schmidt numbers for hydrogen at 288 K

$C_p = 14300$

$\lambda = 0.19$

$\mu = 8.8 \times 10^{-6}$

$D = 6.1 \times 10^{-5}$

$\rho = 0.0853$

$$\mathrm{Pr} = \frac{C_p \mu}{\lambda} = 0.66$$

$$Sc = \frac{\mu}{\rho D} = 1.69$$

All units in SI

$$D = 2.0 \times 10^{-4}$$

$$Sc_{GXC} = \frac{\mu}{\rho D_{GXC}} = 0.51$$

$$Sc_{turb,\ GXC} = Sc_{GXC}$$