



Hydrogen – Safety

Edgar Glomnes – Technical Safety Tjeldbergodden



- Tjeldbergodden the process
- Hydrogen
- Requirements
- Performance Standards
- Experience / Incidents



Natural gas -> Synthesis gas -> Methanol





REFORMING OF GAS

Main Reactions Secondary Reformer:

Combustion H2 + $\frac{1}{2}$ O2 = H2O

Catalyst Bed CH4 + H2O = CO + 3 H2 CO + H2O = CO2 + H2









Hydrogen characteristics

- Hydrogen has atomic number 1, and standard atomic weight of 1.008
- Density 0.09 g/L (Methane 0.7g/L, Luft (N2) 1,3g/L)
- Ignition energy 1/10 of methane
- 4-75% is the Flammeable range Lower and Upper Explosive Limits for H2 (methane 5-17%)
- Leak easily
- Can change metal structure
- Can form gas pocket between cladding and base metal
- Invisible flame
- Inverse Joule Thomson effect.





Requirements Ptil -> fuction based frame work -> safe operation

Requirement / Standarder

- Technology licensors
- Engineering companies
- API 571 (HTHA) Damage Mechanisms Affecting Fixed Equipment in the Refining Industry
- API 941 Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants
- ASME B 3.1.12
- API 6Z ventiler (under utarbeidelse)
- EX requirement hydrogen -> Gas group «IIC»
- Nytt: Equinor Hydrogen Preliminary guidance for safety strategies

Local

- TRA
 - Fire/ explosion
 - CO and N2
 - Self ignition and/or hot surfaces
- Knowledge
 - Competence of own staff
 - H2, N2, O2 and CO
- M&M, ISO contactors
 - Language
 - HyTorc skills
- Culture

Experience

- Few leakages in general
- Few leakages in flanges (including startups)
- Some metal dusting issues, but more related to temperature range than hydrogen
- High temperature measurement
 - Type R failed -> now Type N



Performance Standards

• PS2 & 15

- Natural ventilation (light gases)
- Plant/area layout
- PS1
 - Materials suited for hydrogen
 - Inspection / damage mechanism
 - Flanges / HyTorc skills
- PS3
 - H2 detectors (catalytical) LEL
 - CO detectors (electro chemical) alarm at 20ppm
- PS 6
 - Atex Gas group «IIC»





Incidents

- Ignition of a vent
 - Gas rate 1g/s
 - Caused by static electricity (thunder storm)?
- Draining a small volume of synthesis gas (on purpose)
 - Flames occurred
 - Caused by static electricity or self ignited due to pressure drop (pressure drop will increase temperature)
- Leak in weld due to material degradation





Questions?

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