



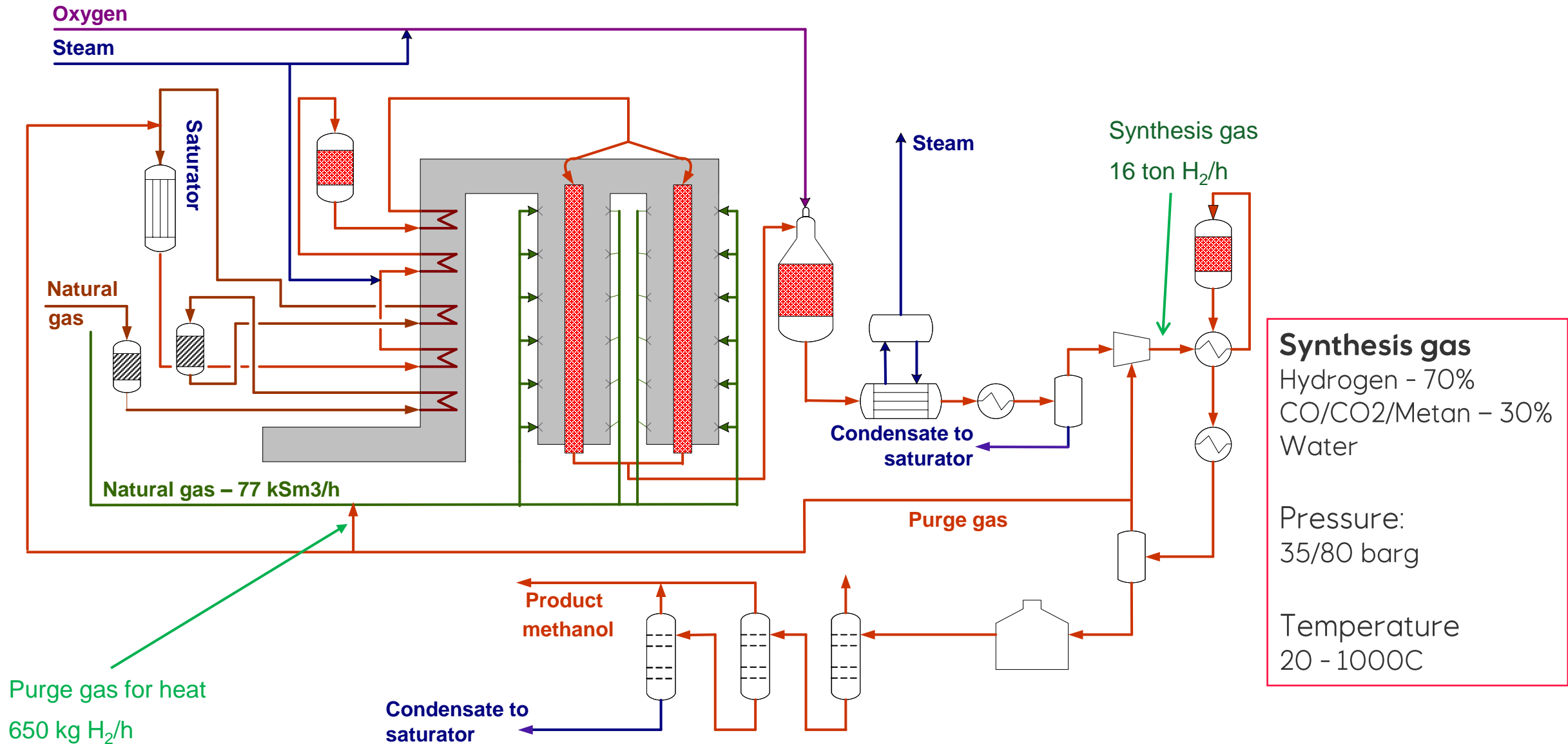
## Hydrogen – Safety

Edgar Glomnes – Technical Safety Tjeldbergodden

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



# Natural gas -> Synthesis gas -> Methanol



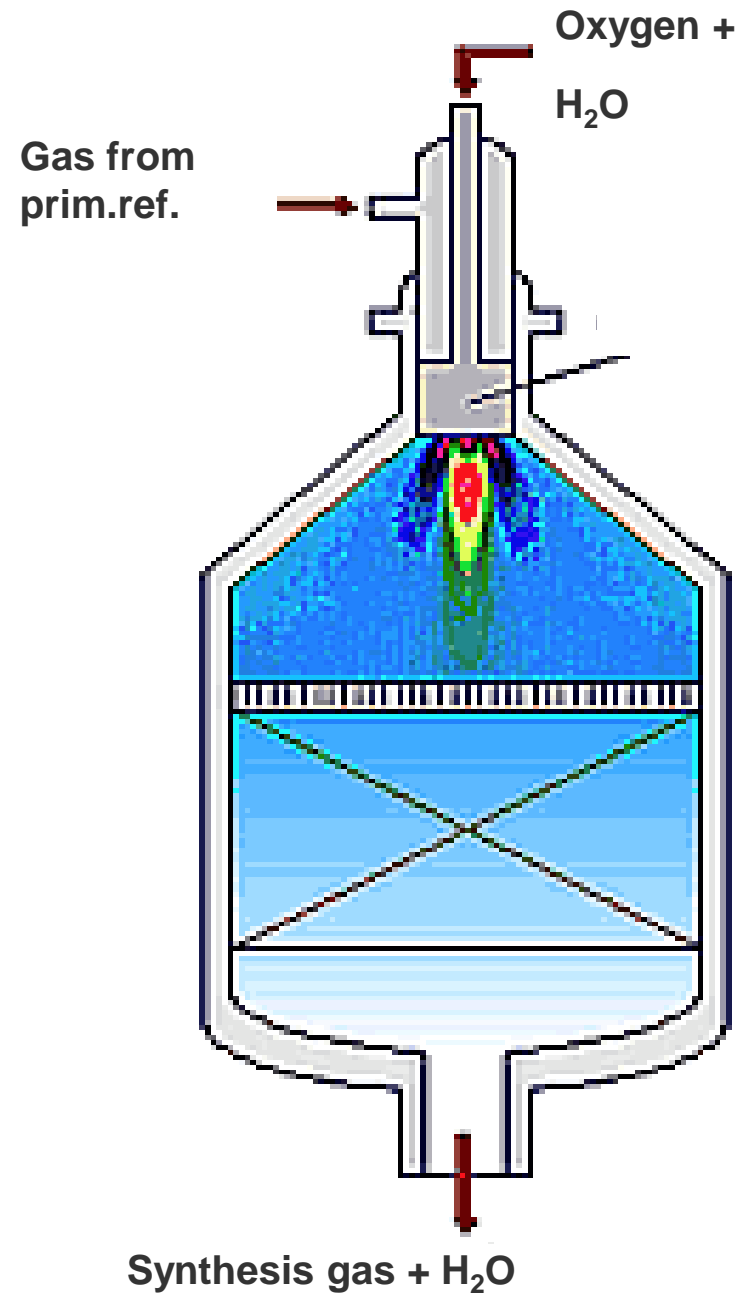
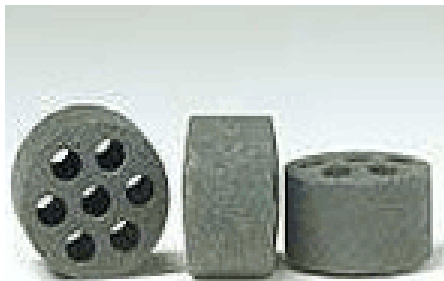
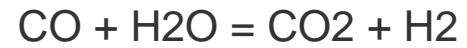
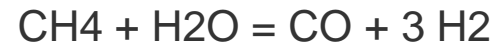
## REFORMING OF GAS

Main Reactions Secondary Reformer:

Combustion

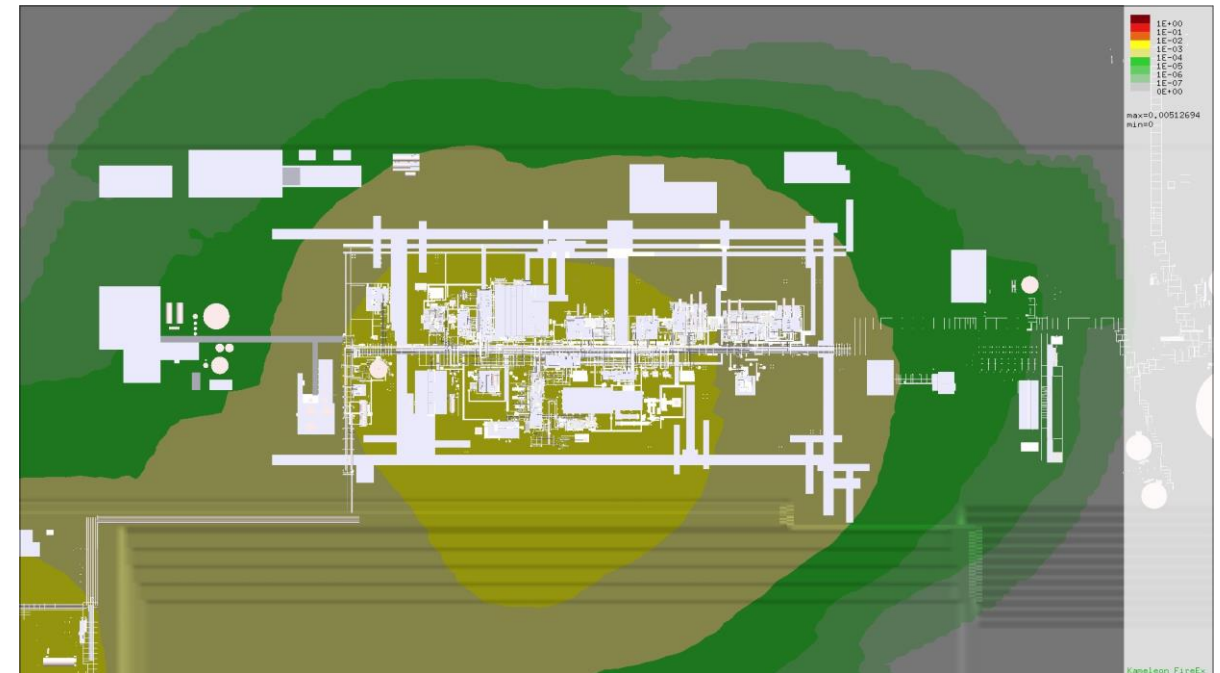


Catalyst Bed



# 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 Flammable 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 -> function 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?