Large-Scale Storage of Gases in Geological Storage Facilities (WP5)

MefHySto
Metrology for Advanced Hydrogen Storage Solutions

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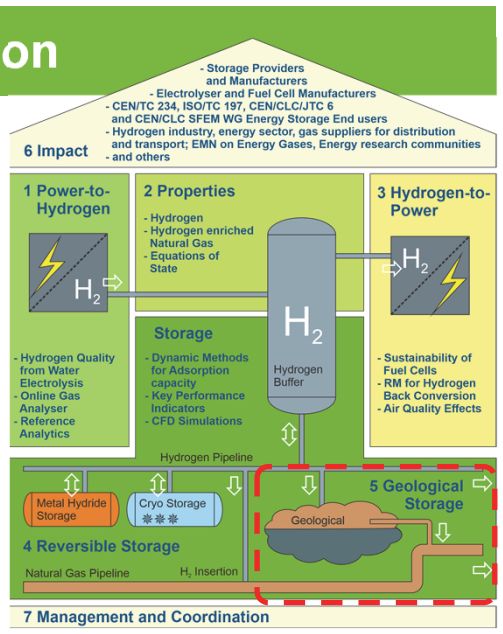
MefHySto Introduction

- Duration 2020–2023
- EU Funding 2.3 M€
- Coordinator BAM
- 14 Partners



- Ambitious new EU energy target of using 32 % of renewable energy by 2030
- Cannot be reached without advanced energy storage solutions, e.g., H_2 storage
- Measurement science is critical for realisation of this commitment
- Financial concerns of amount of hydrogen generated – stored – back-converted

Work Package 5 Introduction

- Measurement Technology
- CFD Simulations
- Flow Metering

Tasks

- Determination of the requirements for the measurement technology
- Measurement of storage-relevant impurities (blanket, glycols) and traces of hydrocarbons in hydrogen
- Flow metering in gas mixtures (20/80; 50/50; 80/20)

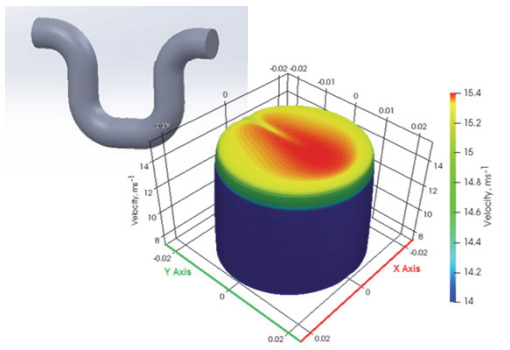


Figure 1: Flow metering CFD Simulations (@CMI)

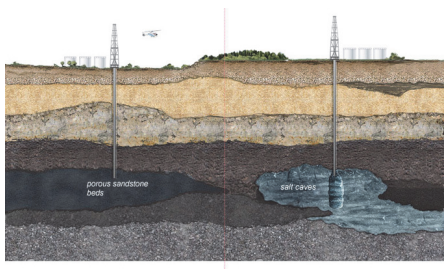


Figure 2: Porous sandstone beds vs. salt caves [1]

Current Situation Underground Storage

- Storage facilities are being converted from natural gas to hydrogen
- Only in individual cases new caverns (costs, permits)
- Very high costs, especially because of the bore holes (material adaptation)
- **Therefore mixtures as well as pure hydrogen have to be analyzed at UGS**
- Relevant H_2 admixture earliest in 2024/25; converting procedure still unclear; 10 and 20 mol.-% H_2 seem safe levels
- Main problem: cost and amount of hydrogen required H_2 (target green H_2, grey for the first steps (?), blue from Norway using CCS)
- H_2 cavern possibly in 2026 (relevant order of magnitude)

Findings

- Course of the changeover of UGS from natural gas to hydrogen varies depending on the type of the storage
- In caverns a changeover to high H_2-contents can be achieved quickly
- Porous formations must be converted over long periods of time
- Analytical requirements compiled (expert statements by underground storage operators) – see **Table 1**

	Component / substance group	backround	type of UGS - relevance		relevance		frequency of use	Measurement in natural gas at UGS	type of measurement	measurement relevant for		limit*			
			cavern	Aquifer	injection	exit				NG/H_2 -mixtures	pure hydrogen	natural gas	Mixture	Hydrogen 1 (≥98 Mol.-%)	Hydrogen 2 (≥99,97 Mol.-%)
Technical requirements	O_2	corrosion	x	x	x			x	continuously	x	x	10 ppm	10 ppm		5 ppm
	Glykol	hydrat inhibation	x	x		x		(x)	sampling						
	Methanol*	hydrat inhibation	x	x		x		(x)	sampling	x	(x)				2 ppm
	Bactericidal	Microbiological problems		x	x		rare		none						
	Anti-corrosive agents	corrosion	x	x	x		rare		none						
	acids	Microbiological problems around the borehole		x	x		rare		none						
	higher Hydrocarbon	blanket - Oil for the separation of gas and water phases	x			x	partially		none		x				2 ppm
	higher Hydrocarbon	compressor oil	x	x	x	(sometimes)			none		x				2 ppm
	oils, fats	Start of microbiological activity		x	x				none						
	Sulphur componds (input)	Conversion of S components in the underground storage		x	x		some countries	(X)	sampling / continuously	x					
	Glycol	gas drying -Desiccant in absorption processes	x	x		x	standard process		none		x				2 ppm
Gas quality measurements	O_2	corrosion	x	x		x		x	continuously	x	x	10 ppm	10 ppm	10 ppm	5 ppm
	H_2	applications	x	x		x		x	continuously PGC	x	x	0 - 20 Mol.-%	1 - 98 Mol.-%	98 -100 Mol.-% or rest	Measurement rest
	H_2O	Prevention of condensation components in UGS	x	x		x		x	continuously	x	x	50 mg/m³	50 mg/m³	50 mg/m³	5 ppm
	S total*		x	x		x			none		x	6 mg/m³	6 mg/m³	6 mg/m³	4 ppb
	H_2S + COS		x	x		x		x	continuously/ sampling	x	x	5 mg/m³	5 mg/m³	5 mg/m³	4 ppb
	Mercaptans		x	x		x		(x)	sampling	x	x	6 mg/m³	6 mg/m³	6 mg/m³	4 ppb
	HC Dewpoint	Prevention of condensation		x		x		(x)	continuously	x		< -2°C (0 - 70 bara)	< -2°C (0 - 70 bara)		
	Hydrocarbon (trace)		x	x		x			none		x				2 ppm
	Methane (trace)			x		x			none		x				100 ppm
	CO					x			none		(x)				0,2 ppm
	NH_3 - Amins	Amine for CO_2-Treatment		x		x			sampling	(x)		< 10 mg/m³	< 10 mg/m³	< 10 mg/m³	0,1 ppm
	Halogens*		x			x			none		(x) ?			≤ 0,05 ppm	≤ 0,05 ppm
	Dust,		x	x		x			none			technical free	technical free	technical free	1 mg/m³
	Silizium*				x				none		(x) ?	0,3 mg/m³			x
	N_2			x		x		x	continuously PGC	x	x	0 - 20 Mol.-%	0 - 20 Mol.-%	0 - 2 Mol.-%	0,03 Mol.-%
	CO_2								continuously PGC	x	x	2,5 - 4 Mol.-%	2,5 - 4 Mol.-%	?	2 ppm
	non H_2-Gases (He, Ar)								continuously PGC	(x)	x				≤ 300 ppm
Gas Quality Measurements for billing	gas composition	billing	x	x	x	x		x	continuously PGC	x	x				
	flow Measurement	billing	x	x	x	x		x	continuously	x	x				
	physical propoerties	billing	x	x	x	x		calculation	continuously PGC	x	(x) ?				

Table 1: Currently discussed analytical requirements for UGS H_2 technology

References

[1] http://www.gazprominfo.com/articles/gas-storage/

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