IMPACTS TOOLBOX

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TNO innovation for life

IMPACTS TOOLBOX

IMPACTS Technical Knowledge Base

IMPACTS Toolbox

Collection of the primary results of the IMPACTS project:

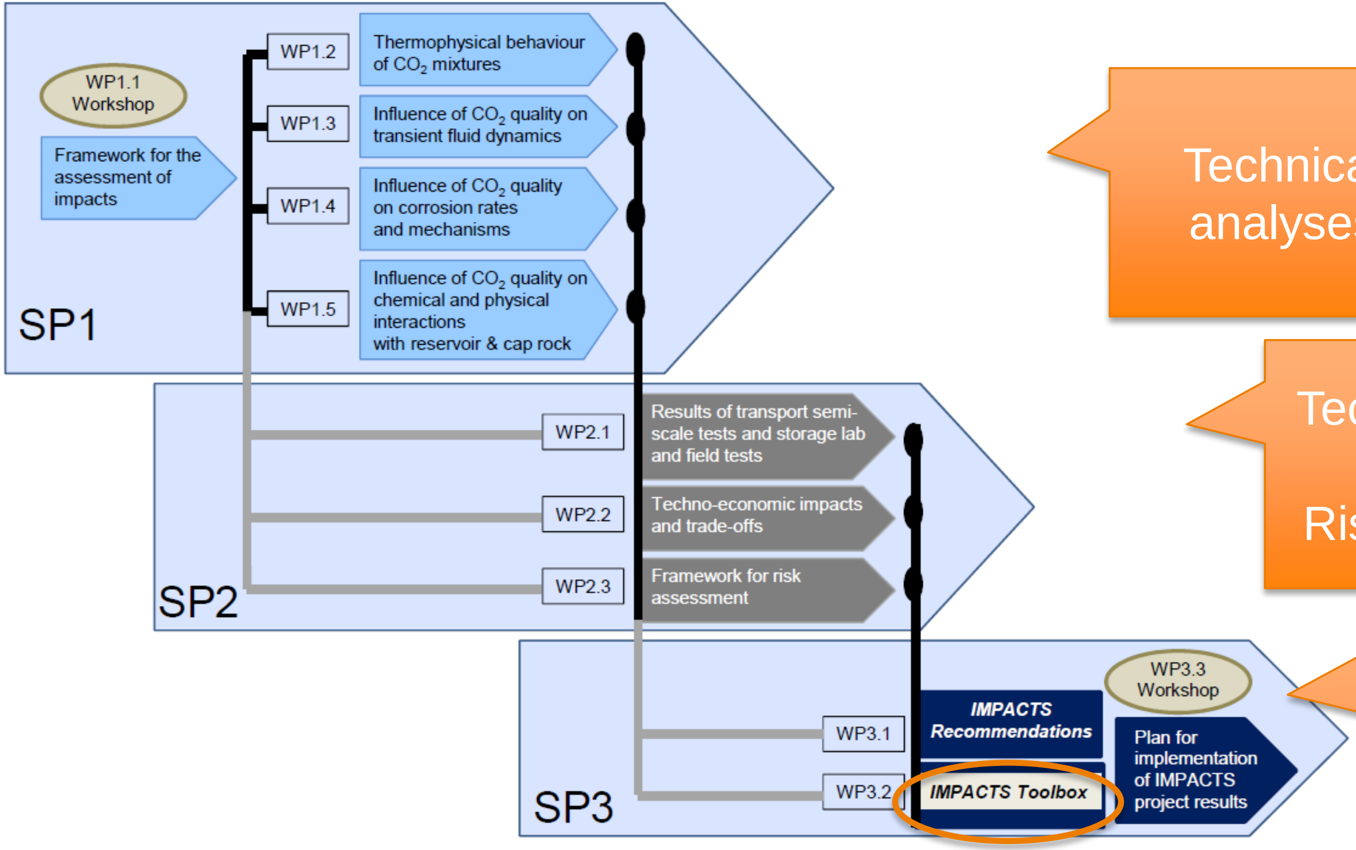
a) Changes in fundamental properties of CO_2 stream due to impurities
b) Operational and material impacts of CO_2 impurities

IMPACTS Recommendations

Secondary results of the IMPACTS project- Recommendations and guidelines derived from the assessed changes in CO_2 stream properties and impacts of impurities on transport and storage

This presentation

Previous presentation



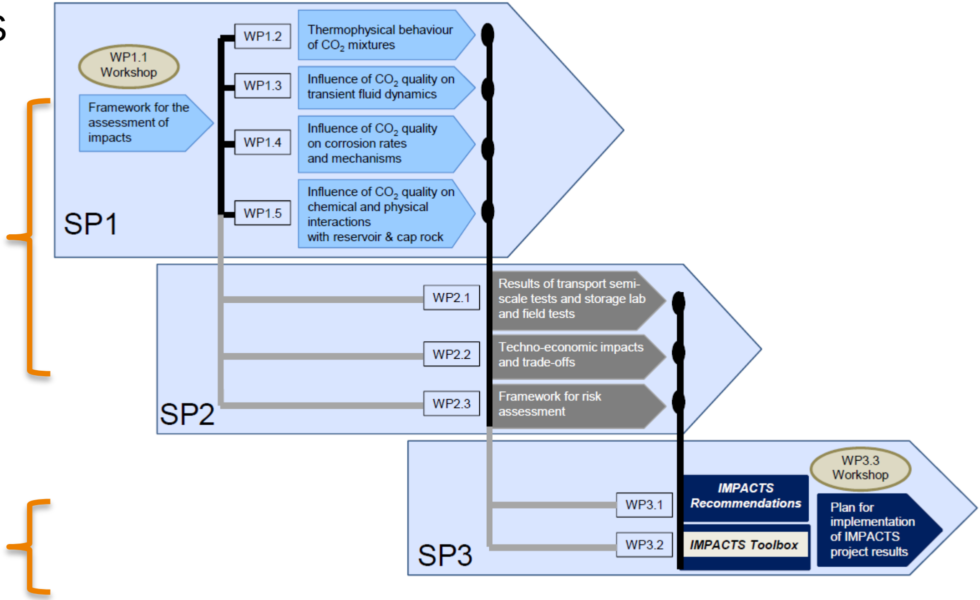
Technical analyses

Techno-economic analyses
Risk assessment

Recommendations
Toolbox

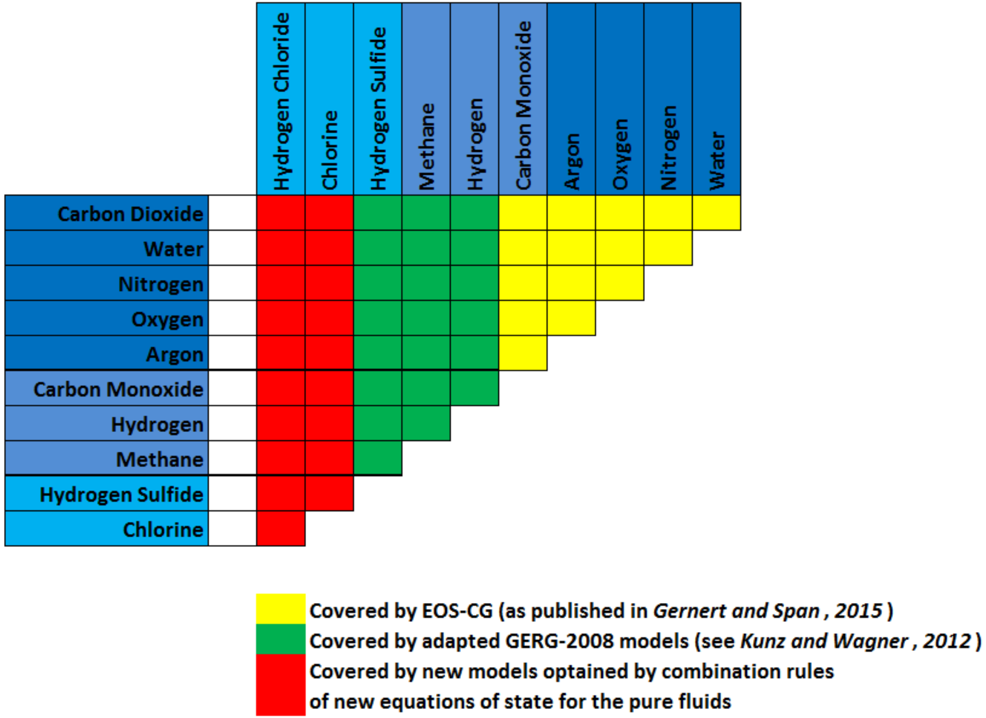
IMPACTS TOOLBOX

- Objective
  - Provide results, tools, models from IMPACTS project to public
  - Cover all areas of IMPACTS research
    - Mixture properties
    - Fluid flow, transport
    - Corrosion
    - Storage
    - Techno-economic assessment of CO_2 mixtures in the CCS chain
    - Risk analysis
  - Include recommendations from IMPACTS



TOOLBOX HIGHLIGHTS TREND 2.0

- TREND 2.0
  - Model for thermodynamic properties of CO_2 rich mixtures
  - Excel tool provided as interface
- See presentation by Roland Span, Thursday 17th, 12:30



TOOLBOX HIGHLIGHTS
CO_2 PURITY

- Reference data for CO_2 purity (next slide)

TYPICAL IMPURITY LEVELS
BEFORE (LEFT), AFTER COMPRESSION (RIGHT)

CO2 source	Capture process	#s	P	T	CO2 min	H2O	N2	O2	Ar	NOx	SOx	#s	P	T	CO2 min	H2O	N2	O2	Ar	NOx	SOx
Coal-fired power plant	CO2/N2 separation	11	40	50	94.0%	6.0%	2500	200	300	100	10	12	200	70	99.0%	1500	2500	300	300	100	20
Coal-fired power plant	CO2/HC separation	2	0	0	95.6%	1400	300		500			8	200	51	95.0%	1600	9000	1	1100	10	10
Coal-fired power plant	O2/N2 separation	11	1	100	70.0%	15.2%	15.0%	12.0%	6000	2500	1.5%	13	153	70	83.6%	500	12.6%	4.7%	5000	2500	2.5%
Gas-fired power plant	CO2/N2 separation	1	2	21	98.6%	1.4%						2	153	51	99.9%		100	100			
Gas-fired power plant	O2/N2 separation	1	1	10	70.1%	4800	19.3%	6.3%	3.9%			1	120	36	97.3%		1.6%	7100	3900		
Cement & lime production	CO2/N2 separation	1	1		99.8%	640	890	35	11			0									
Cement & lime production	O2/N2 separation	1	1	15	83.0%	1.0%	10.9%	3.5%	1.5%			0									
Steel & Iron production	CO2/HC separation	5			86.5%	6.0%	4.1%					0									
Refineries	CO2/N2 separation	1	1		99.6%	640	2900	120	38	3	1	0									
Refineries	CO2/HC separation	2	2	35	95.0%	4.0%	60		50			1			100.0%	400					
(S)NG processing	CO2/HC separation	4	2	35	95.0%	1.2%	30	5				8	150	24	95.0%	1200	4.0%	10			
Overall	Overall	40	40	100	70.0%	15.2%	19.3%	12.0%	6.0%	2500	1.5%	45	200	70	83.6%	1600	12.6%	4.7%	5.0%	2500	2.5%

@ of hits in lierature

Concentrations in ppm, or in %

WORST COMBINATIONS

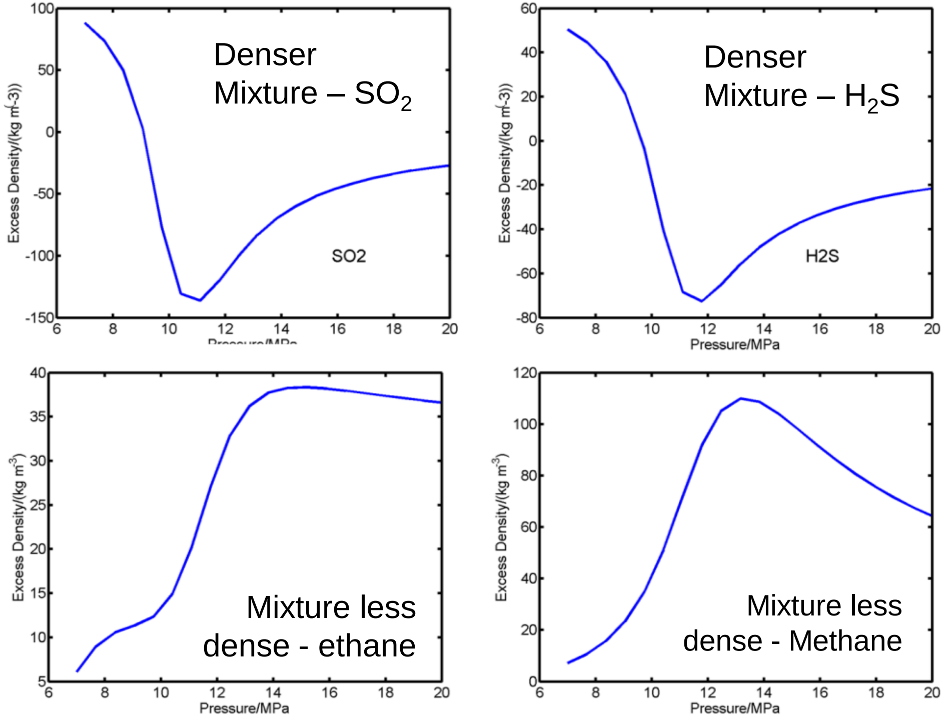
- Six combinations that produce the highest levels of impurities
  - [CO_2] above 95%
- Water content not included
  - Defined by customer, not by capture process
- Desulphurisation included

CO_2 source Capture technology	Coal-fired power plant Amine-based absorption	Coal-fired power plant Ammonia-based absorption	Coal-fired power plant Selexol-based absorption	Coal-fired power plant Oxyfuel combustion	Natural gas processing Amine-based absorption	Synthesis gas processing Rectisol-based absorption
CO_2	99.8%	99.8%	98.2%	95.3%	95.0%	96.7%
N_2	2000	2000	6000	2.5%	5000	30
O_2	200	200	1	1.6%		5
Ar	100	100	500	6000		
NO_x	50	50		100		
SO_x	10	10		100		
CO	10	10	400	50		1000
H_2S			100		200	9000
H_2			1.0%			500
CH_4			1000		4.0%	7000
C_2+					5000	1.5%
NH_3	1	100				
Amine	1					
	Post	Post	Pre	Oxy	Amine	Amine

TOOLBOX HIGHLIGHTS
CO_2 MIXTURE PROPERTIES

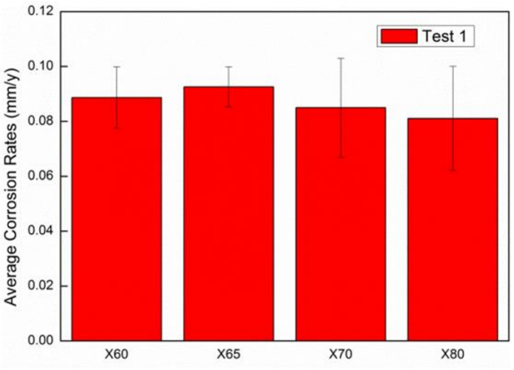
- Insights into effects of various impurities on mixture properties. Example: density

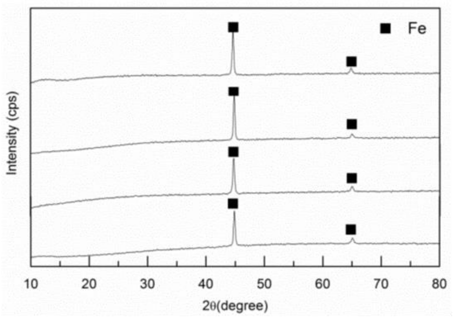
  - Effect on density
    - 'Excess density' curves show change in density of mixture when 10% impurity is added
    - Positive values (for ethane, methane) indicate decreasing density of mixture
    - Negative value (SO_2, H_2S) indicate that adding these to the CO_2 *increases* the density
      - Smaller compressors…
      - Larger storage capacity…

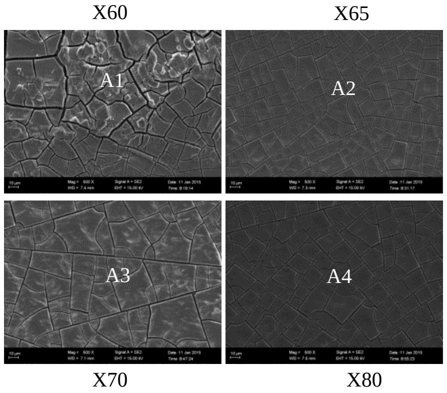


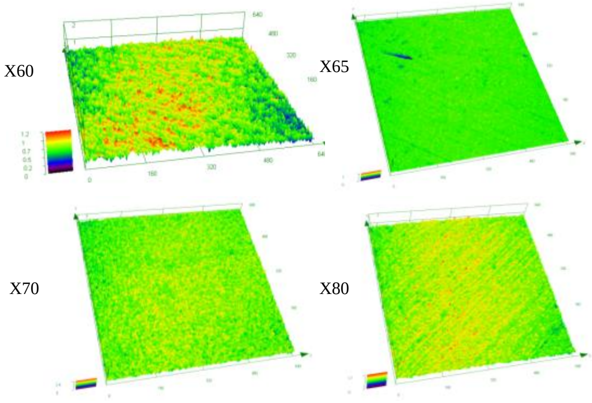
TOOLBOX HIGHLIGHTS CORROSION

- Examples of results from corrosion experiments
  - This examples shows corrosion rates for several steel grades
  - Link to detailed report provided









TOOLBOX HIGHLIGHTS STORAGE CAPACITY

- Example shows effect mixture properties on storage capacity
  - Several real (!) mixtures
  - Effects can be significant

Depth (m) reservoir ↓	Coal-fired power station Amine based adsorption			Coal-fired power station Post combustion ammonia			Coal-fired power station Selexol based adsorption		
	Oil field Storage capacity (Mt)			Aquifer Storage capacity (Mt)			Oil field Storage capacity (Mt)		
	Pure	Mixture	Diff (%)	Pure	Mixture	Diff (%)	Pure	Mixture	Diff (%)
800	6.0	4.1	-32	14.1	13.9	-1	6.0	3.5	-42
900	5.8	5.1	-12	15.9	15.7	-1	5.8	4.5	-22
2000	5.8	5.7	-2	34.4	34.2	-1	5.8	5.6	-4
3400	4.8	4.8	0	57.0	56.8	0	4.8	4.7	-2
	Coal-fired powerstation Oxyfuel			Natural gas processing Amine			Synthetic gas processing		
	Aquifer Storage capacity (Mt)			Chalk oil field Storage capacity (Mt)			Oil field Storage capacity (Mt)		
	Pure	Mixture	Diff (%)	Pure	Mixture	Diff (%)	Pure	Mixture	Diff (%)
800	14.1	7.8	-45	6.0	3.1	-48	6.0	3.5	-42
900	15.9	11.0	-31	5.8	3.2	-45	5.8	4.4	-24
2000	34.4	30.7	-11	5.8	5.3	-9	5.8	5.5	-5
3400	57.0	52.5	-8	4.8	4.6	-4	4.8	4.7	-2
	Cement Industry			Aquifer injection (+5% SO_2)					
	Aquifer Storage capacity (Mt)			Aquifer Storage capacity (Mt)					
	Pure	Mixture	Diff (%)	Pure	Mixture	Diff (%)			
800	14.1	4.3	-70	14.1	13.6	-4			
900	15.9	5.6	-65	15.9	15.2	-4			
2000	34.4	22.4	-35	34.4	32.2	-7			
3400	57.0	42.0	-26	57.0	53.0	-7			

WRAP-UP

- IMPACTS Toolbox
  - Provides overview of IMPACTS results, tools, recommendations, …
  - Quick introduction into areas covered by IMPACTS project
  - Provides links to IMPACTS reports on each topic or highlight
- Implementation: pdf file
  - Internal links – between research areas
  - External links – to IMPACTS reports, for details and background
- Available on IMPACTS website - *coming soon!*
  - *www.sintef.no/projectweb/impacts*

CO_2? RISKY?

CO_2 leaking from truck
Netherlands, 1960s

THANK YOU FOR YOUR ATTENTION

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