High pressure CO_2 - Study of the influence of contaminants on corrosion and definition of new testing methodologies

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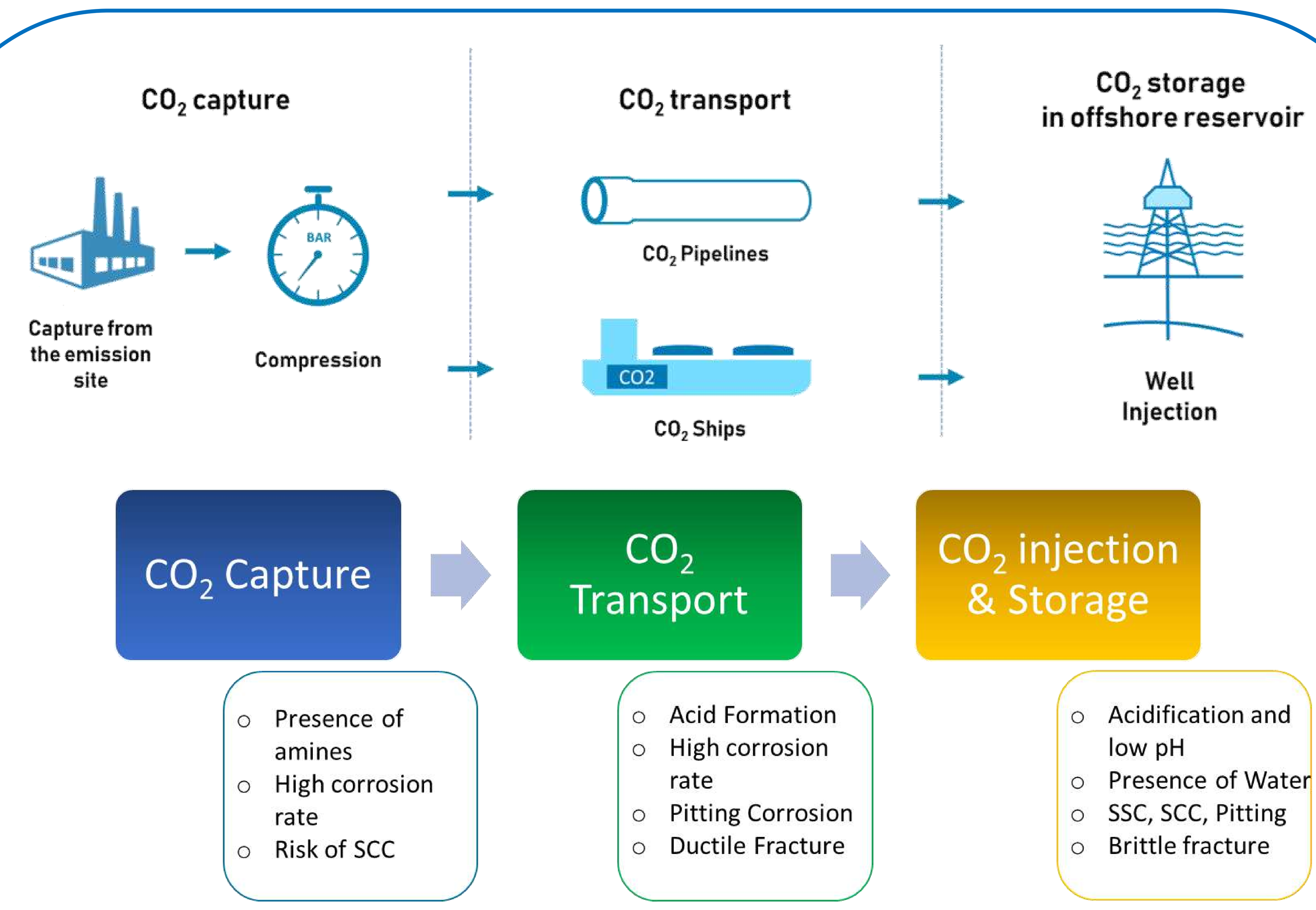
Introduction

Global warming and climate change have been the driving force behind research and technological development used to reduce carbon dioxide (CO_2) emissions in the atmosphere. in the last 200 years but mainly the last 70 years the CO_2 concentration in atmospheric and the CO_2 emissions are rinsing mostly[1]. So, the issue of CO_2 emissions management has become very important. To minimize the carbon dioxide impact, a series of measures such as energy structure optimization, electrification, unnecessary energy consumption reduction, and carbon sequestration can be taken.

To minimize the CO_2 impact two methods were studied for reducing emissions and to combat climate change[2,3]:

1. Carbon capture and storage (CCS): CCS is necessary on the way to reach large-scale reduction of CO_2 emissions as quickly as possible.
2. Carbon capture utilization Captured CO_2 (CCU): CCU is an integral part of the long-term vision.

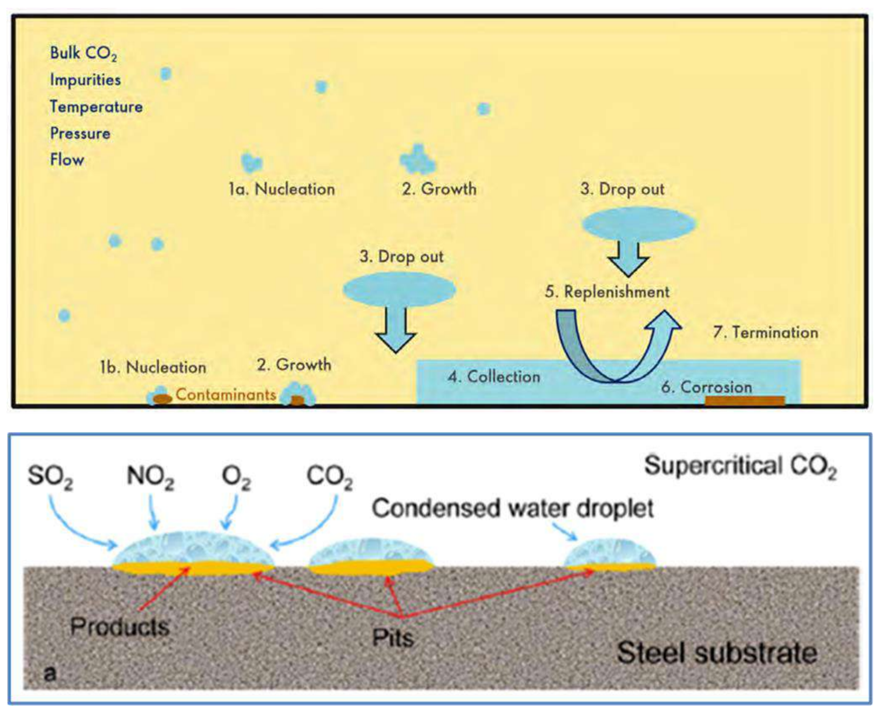
Background and Scope of work



The source of CO_2 can originate from a range of industrial sources (emitters). The impurities include those present in the gas source (e.g. H_2O, NO_x, SO_x, O_2, CO, H_2, etc.), as well as those present from the cleaning process (e.g. glycol, amines), or other project specific impurities (e.g. NH_3, methanol, glycol, etc.)[4,5].

The objective of the following doctoral work is the definition of a methodology that allows us to evaluate the behavior of the material in an environment of captured-transported-stored CO_2 and the study of the contribution of pollutants in corrosion.

Liquids Drop out from dense phase CO_2[6,7]



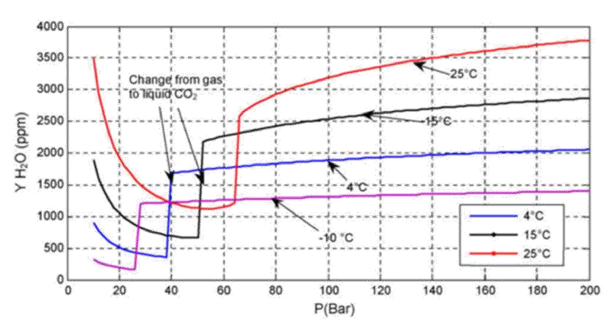
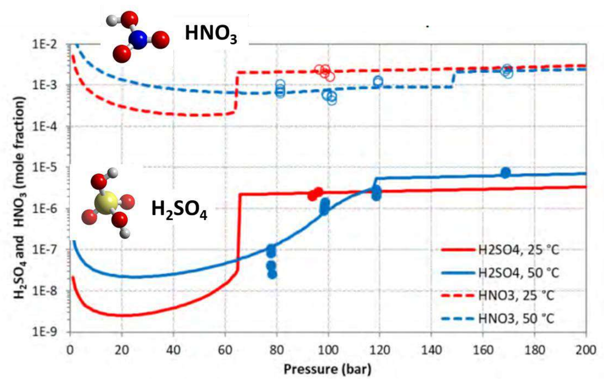
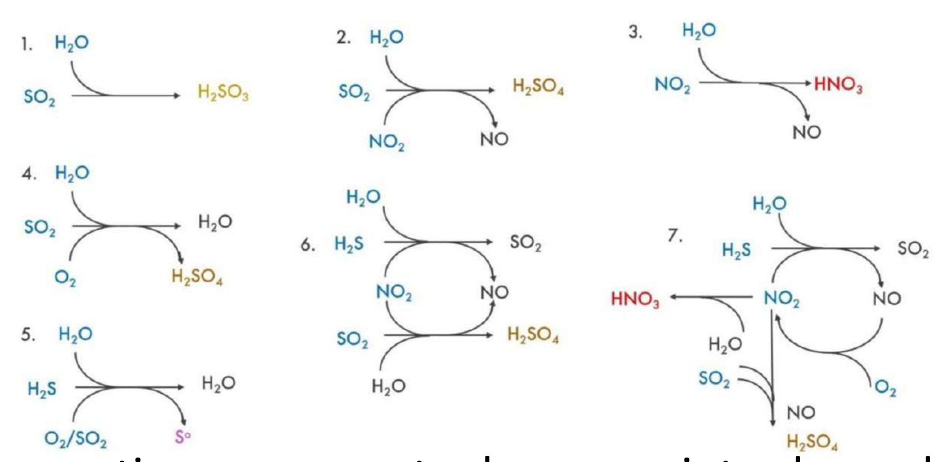


Figure 3: Water solubility in pure CO_2 for varying temperatures as a function of pressure - Figure from de Visser et al.[16] as part of the DYNAMIS report



Chemical Reactions in Impure CO_2



The chemical reactions appear to have an interdependence between the formation of a separate (aqueous) phase and the reactions that take place. In the chemical interaction the impurities trigger the formation of a separate phase (nucleation). This nucleation process depends on concentration of the impurities (solubility), kinetics, presence of catalyst materials and process conditions (pressure, temperature, and flow)[8].

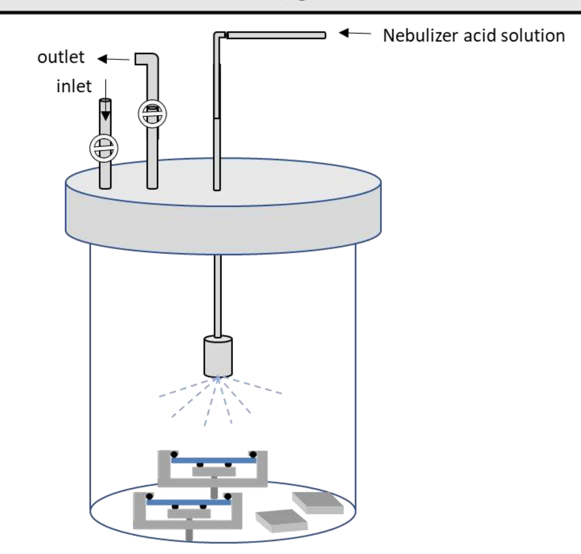
Testing methodologies review

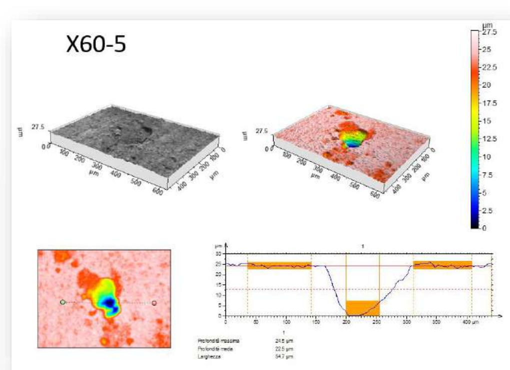
Experimental Setup	Advantages	Disadvantages
Static autoclave	1 Simple Design	1 Flow conditions cannot be easily related those in service
	2 Low maintenance cost	2 Flow conditions vary with the specimen location in the autoclave
	3 Bulk specimens ca be used	3 Modelling is required to understand flow condition
	4 Can perform SCC/SSC and electrochemical tests	
	5 Specimen configuration may be related to top, side, or bottom location of a pipeline	
Rotating/Rocking autoclave	1 Simple geometry and low initial cost	1 Cannot use bulk specimens
	2 Several tests with different test environments can be run in parallel	2 Generates noise
	3 Requires less laboratory space	3 Cannot perform SCC/SSC or electrochemical tests
		4 flow conditions cannot be easily controlled and cannot represent the flow conditions in service
		5 Mechanical impact of specimens may influence the corrosion rate
Flow Loop	1 Generates service flow conditions with sophisticated loop design	1 Complex design
	2 Measured corrosion rates can be related to top, side, or bottom location of pipeline	2 High running and maintenance cost
	3 Can perform SCC/SSC and electrochemical tests	3 Requires more laboratory space

New Testing methodologies approach

Testing program to study the effect of acid droplet at low and high pressure of CO_2

TEST	P (bar)	CO_2	pH (OLI)	Acid Solution
1	1	bubbling	simulation	H_2SO_4





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