

CCUS Conference 2023

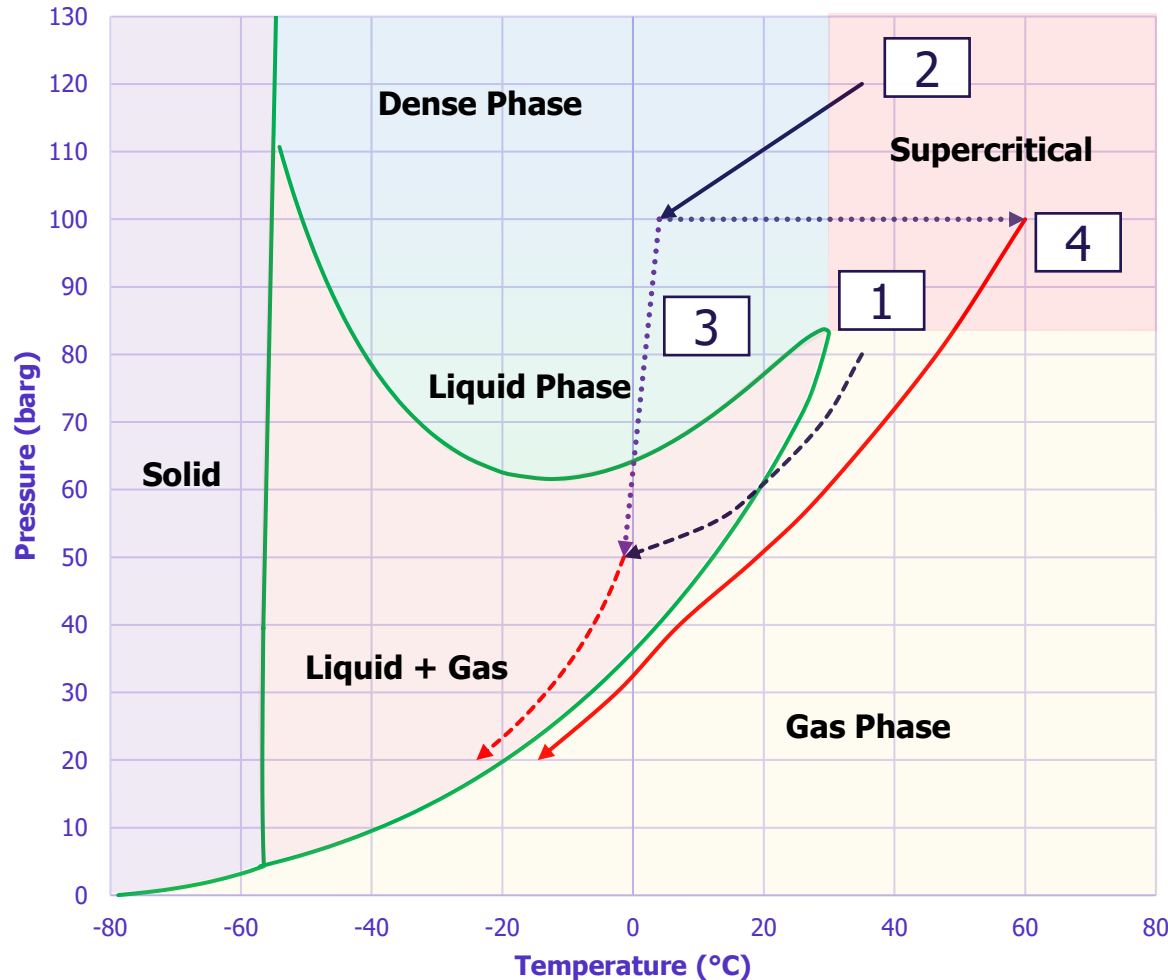
There and Back Again: CO₂ Injection into Depleted Gas Reservoirs

05/10/23

Introduction

- ❖ CCUS is likely to be a key tool in reducing CO₂ emissions as not all emissions can be eliminated completely
- ❖ Depleted gas reservoirs offer a number of advantages for CO₂ storage such as:
 - ❖ Prior knowledge of reservoir and its barriers
 - ❖ Availability of existing infrastructure
- ❖ However the low reservoir pressures present a range of challenges
- ❖ Flow assurance challenges include:
 - ❖ Multiphase flow
 - ❖ Low temperatures
 - ❖ Water dropout / hydrate formation

Injection to Depleted Gas Reservoirs



- ❖ Can operate below the dewpoint curve in gas phase – but if injection rates increase, system pressures can force fluid into liquid / dense phase
- ❖ There are various ways to operate CO₂ transportation and injection systems at higher pressures:
 1. Operating pipelines at pressures above ~35-40 barg can result in multiphase flow in the pipeline / wells
 2. Pipeline can be operated in dense phase at high pressures
 3. Dropping the pressure at well chokes results in multiphase flow in wells
 4. Alternatively heat can be applied to vapourise the CO₂ before injection into the wells

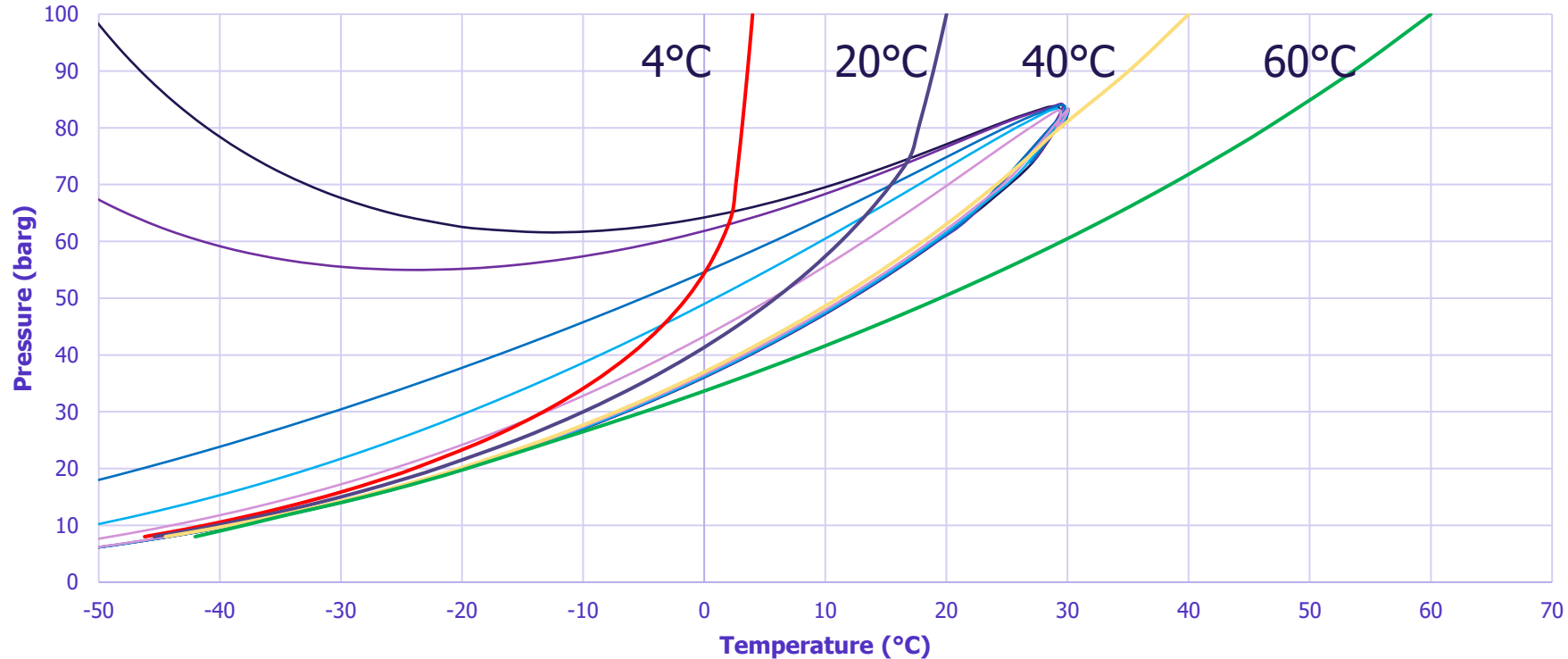
Multiphase Flow Risks

- ❖ There are a number of issues around operating pipelines/ wells in multiphase flow conditions:
 - ❖ Slugging
 - ❖ Impurities partitioning between phases
 - ❖ Meter Accuracy
 - ❖ Low Temperatures
 - ❖ High Velocities

- ❖ These risks may depend on whether multiphase flow occurs in the wells or pipelines

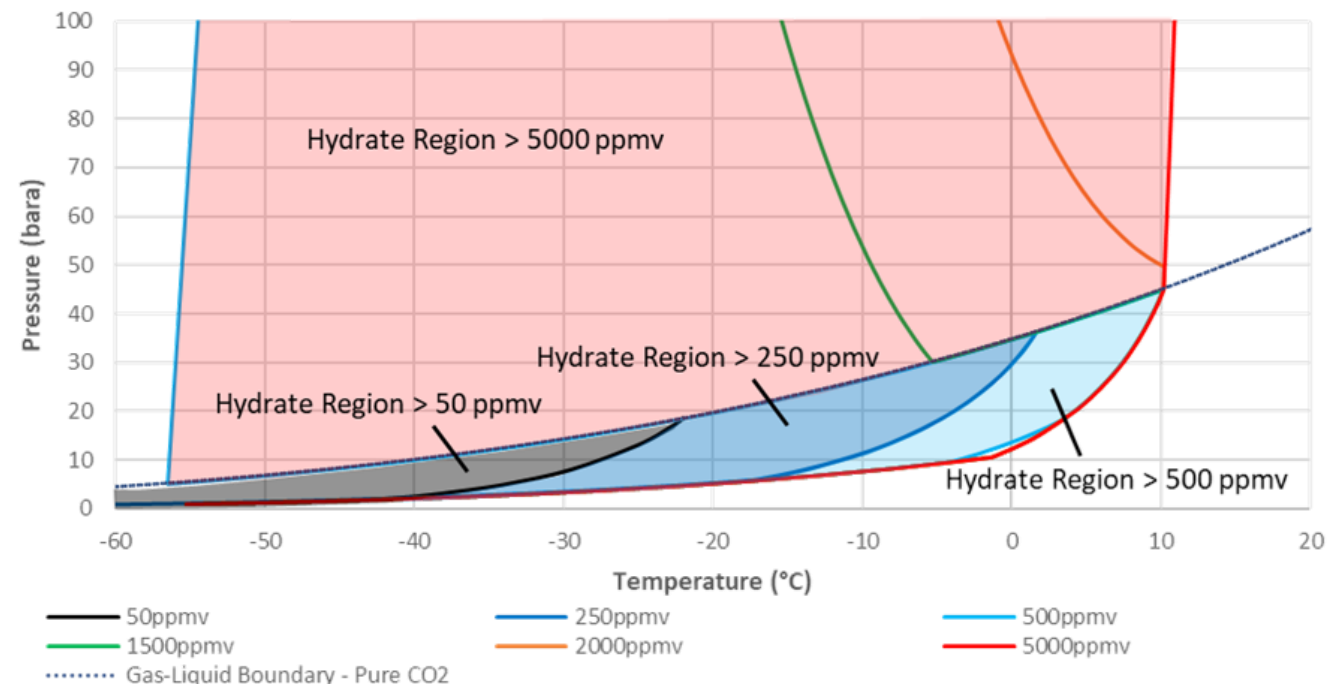
Low Temperature Risk of CO₂

- ❖ As the pressure of CO₂ falls, the temperature also falls
 - ❖ This effect is more significant in multiphase and gas phase fluids than in liquid phase.
- ❖ Isenthalpic depressurisation curves shown below:



CO₂ Hydrate Risks

- ❖ Dehydration will be the primary defence against water condensation / hydrate formation
- ❖ CO₂'s hydrate behaviour at low water contents is affected by the Gas-Liquid phase boundary due to different water saturation levels of gaseous / liquid CO₂
 - ❖ Water condensation much more likely when operating in gas phase CO₂
- ❖ Also need to be aware of hydrate risk for the free water in the reservoir



Locations / Operations of Focus

- ❖ Areas to check for multiphase flow, hydrate / water dropout, or low temperatures:
 - ❖ Shutdown:
 - ❖ Pipelines (Gas Phase): Liquid dropout on packing
 - ❖ Pipelines (Dense Phase): Vapour flashing on cooldown
 - ❖ Wells: Pressure drop as excess pressure dissipates to reservoir
 - ❖ Start-up / Restart:
 - ❖ Pipelines (Multiphase): Liquid arrival at outlet
 - ❖ Wells: Pressure drop across choke causing low temperatures
- ❖ Depressurisation / Venting: Low temperatures, hydrates, solid CO₂ formation



THANK YOU