Can oil & gas pipelines be re-used for CO₂ transportation?

Purpose

As oil and gas fields come to the end of their lives and infrastructure is no longer required for its original use, what opportunity is there to re-use infrastructure for carbon dioxide transport and storage? This factsheet considers the potential for re-using oil and gas pipelines to transport CO₂ as part of a carbon capture and storage (CCS) project.

Summary

- Pipelines that have not been exposed to hydrocarbon production for long periods of time are most likely to be suitable for transporting dry CO₂ in dense phase.
- The costs to re-purpose a hydrocarbon pipeline for CO₂ transportation are likely to be very low.
- The condition of redundant pipelines is often uncertain and would require assessment and potentially remedial intervention before re-use, which would likely be at a modest cost.
Potential opportunity

The extensive hydrocarbon pipeline network in the North Sea is over 45,000km in length. Pipelines can be either rigid or flexible, with a variety of sizes between 2-44 inches in diameter. Some of these pipelines are suitable for the transport of CO$_2$ to secure geological sites for sequestration or oil fields for enhanced oil recovery (EOR) activities.

In the UK and Norwegian sectors, 850 pipelines with a combined length of 7,500km are planned to be decommissioned during the next decade. This activity is estimated to cost £867 million.

Re-using an existing oil or gas pipeline for CO$_2$ transportation in a CCS project may cost 1-10% of the cost of building and installing a new pipeline. In light of the renewed momentum for CCS, there is now a significant opportunity to not only deliver additional value to these existing assets, which would otherwise be decommissioned, but also to help overcome the initial cost hurdle faced by many CCS projects to date, by reducing the initial capital requirement and the project's risk.

General considerations

- As part of an overall system, the potential to re-use a pipeline is only of interest if it is proximal to a depleted oil or gas field (or connected aquifer), which is suitable for CO$_2$ storage.

- The suitability of the subsurface reservoir should be considered first and include considerations of:
  - capacity (is the reservoir an appropriate size for the project?)
  - integrity (can the CO$_2$ be safely stored at this location?) and
  - injectivity (can the CO$_2$ be injected at a rate which fits with the need?)

- The age, condition and pressure rating of the pipeline are key factors in assessing its suitability. Old pipelines, or those that have experienced harsh production environments, may have issues with corrosion or other integrity concerns.
Commercial considerations

In many circumstances it is likely that dry CO$_2$ in dense phase will be transported in pipelines at high pressure so that the fluid can be fed directly to the wells without any additional pumping or compression required offshore. This is likely to require an operating pressure of at least 110-120 bar. For injection into depleted gas fields, operators may elect to transport CO$_2$ at low pressure in gaseous phase, and in these situations the CO$_2$ should still be dehydrated to minimise corrosion and the cost of pipeline repairs.

Assuming that the location is suitable for CO$_2$ storage, the key commercial considerations for pipeline re-use are cost and risk. The costs associated with the reuse of pipelines are principally associated with implementing any remedial action (such as installing additional concrete mattresses) resulting from analysis of the surveys to confirm suitability.

The main risk associated with reusing a pipeline is in not identifying areas of high corrosion and/or particularly thin walls and overestimating the integrity of the pipeline for its new duty of transporting CO$_2$.

Technical considerations

Key technical issues that need to be considered when assessing the suitability of a pipeline for preservation include:

- Phase behaviour of CO$_2$ is the primary technical and operational concern, with other risks (i.e. corrosion, ductile fracture) being potentially manageable dependent on the pipeline.

- Impact of corrosion on design life and operating pressure. This includes assessment of the materials, operating life, fluids transported during operations, initial wall thickness, corrosion allowance and topography (i.e. the prevalence of low points along the pipeline that may cause hot spots of corrosion).

- Outer diameter. This indicates the potential CO$_2$ throughput rate, when combined with the maximum operating pressure of the pipeline.

- Installation condition. This includes the current degree of burial, exposure, free-spans, damage (e.g. from trawlers).

- Design temperature range.

- Availability of data from internal and external surveys.

In general, a greater initial wall thickness represents a lower risk of running ductile fracture and a lower impact from corrosion due to transporting hydrocarbons and water. Key operational considerations for re-purposing include condition assessment, external inspections and CO$_2$ phase behaviour.
Regulatory considerations

In the UK, the Petroleum Act 1998 provides a framework for the orderly decommissioning of both offshore installations and offshore pipelines. The Pipeline Safety Regulations 1996, administered by the Health and Safety Executive, provide requirements for the safe decommissioning of pipelines. The Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) within the Department for Business, Energy and Industrial Strategy (BEIS) regulates the decommissioning of offshore oil and gas pipelines. A number of other statutory bodies are also involved in assessing pipeline decommissioning, including The Crown Estate, Crown Estate Scotland and Marine Scotland.

Decommissioning obligations arise when the Secretary of State serves the operator/owner of the pipeline a Section 29 notice under the aforementioned act. In general, once it has been determined that no reuse potential exists, a pipeline can be decommissioned either in-situ or by removal. Any removal or part removal of a pipeline must be performed in such a way as to cause no significant adverse effects upon the marine environment. If a pipeline is to be decommissioned in-situ then an impact assessment of the future decay, burial and exposure of the pipeline must be completed.

As a general rule, small diameter pipelines, umbilicals and flexible flowlines, which are neither trenched nor buried, are likely to be removed. Protection and support equipment, such as concrete mattresses, are also normally removed. Pipelines that are adequately buried or trenched, or could reasonably be expected to “self-bury” over time, will normally be allowed to be decommissioned in-situ.

If a pipeline was transferred from one party to another, the acquiring party would also have to accept the decommissioning obligations as outlined earlier.