Moonie Oil Field CO_2 EOR Project

Initial Injection Plan 2021

Chapter 14: Assessment of Impact: Operations

Commercial in Confidence

The Moonie Oil Well 27 (M27)

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14.0 Summary

The purpose of this chapter is to review the site CO_2 operations and make an environmental assessment of potential impacts of site operations and then propose mitigating actions to control the impact to ALARP and Best Industry Practice.

The Site Operations assessed include:

1. Delivery of the CO_2 to site,
2. Storage of CO_2 at site,
3. Surface adjustment of the liquid CO_2 state prior (potential preheat) to injection,
4. The CO_2 injection and pumping process,
5. Operation of the production/monitoring (PM) wells,
6. The surface oil and gas separation and future recycling, and
7. Monitoring on the PM wells as detailed in Chapter 5.

Bridgeport's "Operations team" will prepare the scope, the basis of design, and the detailed design process, which will include risk assessment workshops and the preparation of operation and equipment maintenance procedures. All of this will be applied under the existing environmental management plan (EMP) and under the existing safety management system (SMS) and in accordance with Bridgeport authorised policies. This will see the continuing use of the site Job Safety Analysis (JSA) and Safe Operating Procedure (SOP) prior to all operational tasks being implemented.

14.1 Introduction

This is an assessment of CO_2 Operations during delivery, storage, injection and monitoring operational activities.

14.1.1 CO_2 Delivery to Site.

In this initial CO_2 project, the CO_2 will be delivered by truck, using existing industry certified ISO liquid CO_2 containers on transport trucks. Later projects with higher volumes will anticipate the use of a dedicated pipeline from Milmerran to the Moonie field.

14.1.1.1 Assessment of environmental impacts: CO_2 Delivery

If CO_2 is released to the atmosphere during the delivery process, depending on the amount, negligible impact will occur as the CO_2 will dissipate immediately. A safety zone will be determined during the design phase by considering the project risk assessment, and industry specifications. For example, an initial safety zone of 3m from the injection well CO_2 infrastructure will be established, signposted and regular monitoring of gas levels in and around the injection site will be undertaken. Safe workplace thresholds for gaseousCO_2 being used will be at levels of CO_2 concentration greater than 35ppm within the working envelope and will preclude any ongoing work without breathing apparatus. As minor levels of hydrogen sulphide are present in the injection fluid stream the workplace exposure limit threshold will similarly be set at levels consistent with industry standards, e.g., within the 3m working envelope of the well and in the PM well cellars.

A windsock and signposted muster points will be mounted in the vicinity of CO_2 surface injection operations.

14.1.2 CO2 Storage

The liquid cooled CO_2 will be stored in an appropriate industrial certified liquid CO_2 storage vessel. This vessel will have a venting mechanism for emergency release, with the actual vent discharging away from the facility via the onsite flare tower or with its own dedicated vertical vent.

14.1.2.1 Assessment of environmental impacts: CO_2 Storage

If the Bridgeport storage process and procedure utilising standard practices for handling liquid CO_2 are implemented, no CO_2 will be directly released to the atmosphere during the storage process.

14.1.3 CO_2 Injection

The liquid CO_2 will be pumped from the storage tank via a small heat exchanger (subject to detailed design requirements) to slightly warm the CO_2 prior to surface injection into the M27 injection well. The heat exchanger warms the liquid CO_2 to the ideal temperature for injecting downhole into the formation. The liquid CO_2 is injected by cryogenic high pressure liquid CO_2 pumps. The heat and pressure at surface is in part governed by the tubing and wellhead material strengths and in part by the desired bottom hole pressure and temperature to minimise impact at the sandface and ensure the CO_2 is close to supercritical when it enters the reservoir.

14.1.3.1 Assessment of environmental impacts: CO_2 Injection

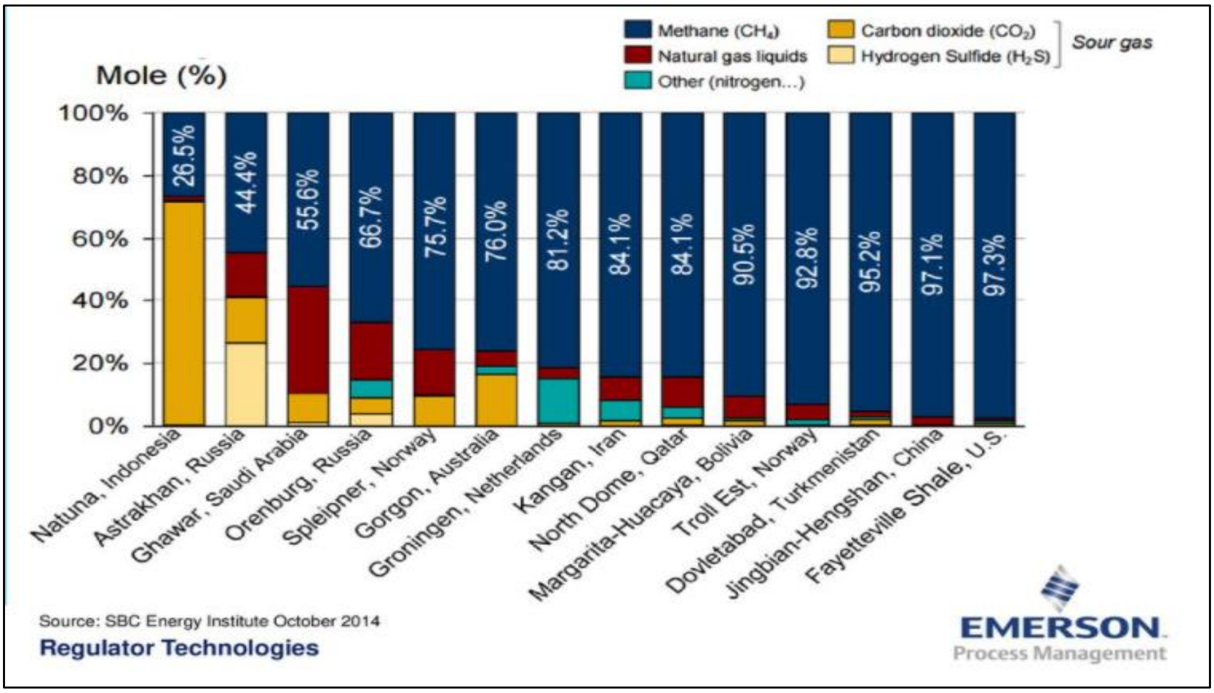
CO_2 forms 3.14-4 % of the Earth's atmosphere. The release of trace amounts of CO_2 will have no significant environmental impact, however, a safety zone subject to design, for example, of 3m around the infrastructure and regular gas leak detection surveys to ensure the detection of any leaking gas, together with an emergency vent system will be instigated.

14.1.3.2 Carbon Dioxide Injection Well Blowout

Bridgeport has no history of a blow-out on any exploration or production well, and all Moonie wells will be managed as per the Bridgeport well integrity management system (WIMS), which honours the QLD Code of Practice.

A CO_2 injection well blow out is an incident where the CO_2 injection well fails, and CO_2 is liberated at the well head under high pressure. A well blowout is an inherent risk for all petroleum wells, and it is safely managed by established design processes and the selection of material based upon industry standards and regulatory requirements. High CO_2 content is not unique in the petroleum industry and there are many large gas projects throughout the world that competently manage these fluids. Some of these large projects are presented in Table 14.1 below.

Figure 14.1 Worldwide LNG projects with the % of CO_2 produced



14.1.3.3 Volume of CO_2 injection is insufficient to cause overpressure.

It is important to note that at no point is it possible to overpressure the currently depleted under pressure reservoir during this initial stage project using the specified injection pressures (Chapter 3) and simply because the rate and volume of CO_2 injection is insufficient to cause overpressure conditions at either the Injection well or the Production Monitoring wells. The PM wells in particular by virtue of producing with the artificial lift installed, act as a reservoir pressure sink at the offtake points. This design feature of the project alone ensures there is no possibility of locked or trapped pressure events in the reservoir. This does not mean that BEL will be complacent, and it will continue to apply its standards and procedures via its authorised WIMS through monitoring the production casing annuli on all its wells, a standard it already undertakes.

14.1.3.4 Corrosion Management, Monitoring and Corrosion Coupons.

The additional well control risk introduced by CO_2 is the potential risk of corrosion. The CO_2 corrosion rate of steel is dependent upon the chemistry of the received fluids (discussed in Chapter 8) and the partial pressure of CO_2. For the producing wells the bottom hole flowing pressures (500 – 1,000psi) are very low due to the artificial pumps being utilised so there is negligible CO_2 corrosion at the existing CO_2 content of 5%. During the project the CO_2 content in the producing wells will need to increase by several multiples before the corrosion rate becomes a concern.

At the wellhead, where an integrity breach could result in a surface blow-out, much higher percentages of CO_2 are required to become corrosive, as the flowing pressures are even lower than the flowing bottom hole pressures (100 – 200 psi). The producing wells will be monitored for CO_2 percentage and the level of pH and shut-in and reassessed when they reach 15% CO_2 concentration, or a consistent pH concentration considered to precipitate excessive corrosion. In any event corrosion coupons will be inserted in the wellheads and surface flow lines and monitored on a regular basis. Excessive corrosion will trigger the shut-in process and subsequent upgrades. The well will then be worked over to replace any steel components that are wetted by produced fluids with corrosion resistant components prior to placing the well back onto production.

Any shut-in or suspended (temporarily abandoned) wells in the field will be monitored for changes in pressure as per the Bridgeport WIMS. If a material pressure change is detected, it will be investigated, and contingency plans activated to mitigate the risk and re-instate the well's integrity so it's acceptable to the WIMS and the Code of Practice.

It is noted from available public information, that in 2011 a major release of CO_2 occurred at the Tinsley Field which was operated by Denbury Resources. It was reported as a “well blowout” when it was actually caused by an excavator accidently digging up the 8” CO_2 injection pipeline owned by the CO_2 delivery company. Bridgeport will avoid a similar incident by designing and installing any pipelines in designated pipeline corridors which are clearly marked, and sign posted as per Australia standards for pipelines and the Bridgeport Pipeline Integrity Management Plan. Also, isolation valves will be installed at CO_2 storage tanks, injection lines and on the wellhead and an isolation valve (DHSV) or XN profile for a downhole plug in the subsurface completion string. The injection well string design will be finalised during the detailed design process, but fundamentally the planned CRA tubulars, downhole production casing isolation packer and the CRA wellhead provide the basis for a sound failsafe design.

14.1.4 All Well Operations

The CO_2 will remain contained within the wells during Operations based upon the existing process, industry standards and regulations for managing well integrity. Bridgeport applies these systems by its WIMS which honours the QLD Code of Practice (see Chapter 3). The aim of well head monitoring (see Chapter 5, Monitoring Plan and Schedule) is to validate that the injected CO_2 is contained within the formation and inside the PM well areas as modelled (no detectable leaks beyond allowable limits), and there is negligible risk of future CO_2 leakage, or formation fluid displacement which could have a negative impact on human health or the environment.

The wells’ casing, cement, wellheads and completion string will meet industry regulatory requirements (refer to Chapter 3 for full detail). As such it is unlikely that any CO_2 will escape the confines of the formation. However, to validate this regular CO_2 monitoring at the wellhead on the injection well and PM wells production casing annuli will be undertaken as is current practice in the BEL WIMS. A mass balance calculation, as detailed in the Chapter 5 Monitoring Plan, will also be used to detect anomalies.

14.1.4.1. Assessment of environmental impacts: Well Operations

During well Operations, surface and production casing annuli will be monitored to detect any adverse conditions above the thresholds developed in Chapter 5: Monitoring Plan and Schedule. Should CO_2 levels exceed the monitoring threshold limits, the affected well operation will be shut down, reassessed and depending on the type of incident, contingency plans detailed in Chapter 3 implemented.