Discussion of Limited Technologies - CCS for Amine Still Vents

Background

CCS at gas plants has not previously been considered technically or economically achievable. However, due to a unique set of circumstances, namely the purity of the CO_2 in the amine still vent streams and the close proximity of a Kinder Morgan pipeline that has the capacity to take up to 7 MMSCF/D of the CO_2 for use in enhanced oil recovery (EOR) projects, it appears feasible to commit up to 35% of the Ramsey amine still vent stream to CCS. As part of the BACT determination process, Nuevo was asked to consider the possible use of CCS for the remaining 65% of the amine vent streams (approximately 10.83 MSCF/D) instead of routing them to Regenerative Thermal Oxidizers (RTOs).

Potential Options

There are two potential options that were considered:

- Pretreatment and transportation via pipeline to an existing CO_2 pipeline for use in Enhanced Oil Recovery (EOR).
  This is a potential option because there may be some demand for additional CO_2 for use in EOR projects.
- Transportation via pipeline to a reservoir for sequestration in a geological formation
  This is a potential option in the event that there is no current demand for the CO_2.

In addition to any other technical concerns, both these options would involve working with third parties, over whom Nuevo would have no control.

Technical Issues

- ***Pre-treatment and Transportation via pipeline to an existing EOR***
  There are a number of technical issues that have to be overcome to make this a viable option, including: pre-treating the amine still vent stream to remove trace amounts of hydrogen sulfide and other contaminants, finding an end user for the CO_2 and .building compression and a pipeline to get it there. Recent articles in the Oil and Gas Journal (April 7, 2014 and May 5, 2014) described the volumes of CO_2 required for the existing and proposed EOR floods and indicated that supply had already been identified and secured to meet projected demand through 2020.
    - 2014 1.9 BCF/D
    - 2016 2.2 BCF/D
    - 2017 2.8 BCF/D
    - 2020 3.1 BCF/D

  Not only does it appear that there is no short term need for additional CO_2 in the area, but, even if there was, the Nuevo stream of 10.83 MMSCF/D, would only be approximately 0.57% of the 2014 required volume and 0.35% of that for 2020. In fact the Annual Rate is too low to qualify for IRS Section 45Q tax credit.

The best chance for selling the CO_2 would be to get it to a hub where the demand is higher. The closest hub to Ramsey is in Andrews County, southwest of Andrews (located at approximately 32^0 13' 15.74"N and -120^0 41' 26.00"W). This would involve laying an approximately 89 mile, 8-inch diameter pipeline.

- ***Pre-treatment and Transportation via pipeline to a reservoir for storage in a geological formation***

  The other option that was considered was to store the CO_2 in an existing reservoir. There are a number of factors that have to be addressed to successfully store CO_2. These include:
  - Locating a suitable reservoir that could be used for storage
  - Acquiring the rights to store the CO_2 in the reservoir
  - The status of pressure in the reservoir
  - Competent injection well(s) to use or drilling new wells
  - The presence of a pipeline to get the CO_2 to the field for injection
  - Pretreating the amine still vent stream to remove hydrogen sulfide and other contaminants and compression facilities

  The Ramsey plant is located near several previously CO_2 flooded fields in the Delaware and Permian Basins. Among these are four that are closest to the Plant, none of which have active CO_2 floods:
  - Ford Geraldine (average well depth 2,680 ft)
    CO_2 flood started 1981, discontinued for technical reasons.
  - E Ford (average well depth 2,580 ft)
    CO_2 flood started 1995, but was discontinued because of low economic returns.
  - Two Freds (average well depth 4,900 ft)
    CO_2 flood started 1974 and ended in the 1980s.
  - N. Elmar (average well depth 4,500 ft)
    CO_2 flood started 1994. It was unsuccessful and discontinued after a few years.

  Given the age of the reservoirs and the wells, it would be more cost effective to drill new wells. A reservoir study would need to be undertaken to determine the exact number of injections wells that would be needed, but, based on the volumes involved and the type of reservoirs, the number has been estimated at 27.

  Potential environmental impacts resulting from CO_2 injection are a second factor that removes sequestration in a geological formation from consideration. Potential environmental impacts resulting from CO_2 injection that still require assessment before CCS technology can be considered feasible include:
  - The long-term impacts of dissolving CO_2 into brine,
  - The risk of brine displacement caused by large-scale CO_2 injection, including the risk that increased formation pressure could cause brine to leak into underground drinking water sources and/or surface water, and
  - Potential effects on wildlife.

These potential impacts have serious ramifications, and would likely prevent or delay approval of a geologic sequestration facility until they were addressed. The Department of Energy has recognized the current infeasibility of geologic sequestration. According to the DOE-NETL, Carbon Sequestration Program: Technical Program Plan, published in 2011:

> "The overall objective of the Carbon Sequestration Program is to develop and advance CCS technologies that will be ready for widespread commercial deployment by 2020.
> To accomplish widespread deployment, four program goals have been established:
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> (1) Develop technologies that can separate, capture, transport, and store CO_2 using either direct or indirect systems that result in a less than 10 percent increase in the cost of energy by 2015;
> (2) Develop technologies that will support industries' ability to predict CO_2 storage capacity in geologic formations to within ±30 percent by 2015;
> (3) Develop technologies to demonstrate that 99 percent of injected CO_2 remains in the injection zones by 2015;
> (4) Complete Best Practices Manuals (BPMs) for site selection, characterization, site operations, and closure practices by 2020. Only by accomplishing these goals will CCS technologies be ready for safe, effective commercial deployment both domestically and abroad beginning in 2020 and through the next several decades."

The DOE concludes that geologic sequestration will not meet the BACT definition of technically feasible until 2020 at the earliest. It is therefore not technically feasible to construct a site-specific geologic sequestration facility for the Ramsey Plant project.

Legal Issues

In addition to being infeasible, construction of a geologic sequestration facility cannot be required under the PSD BACT process. Such a facility would be an independent operation, and a separate source of air emissions, contamination liabilities and other environmental impacts. It would represent a huge change in the scope of the Ramsey Project, in effect a new venture entirely outside the goals, objectives, purpose, and basic design proposed by Nuevo for the Ramsey Plant. According the EPA Environmental Appeals Board, a proponent cannot be required to undertake such a scope change or new venture by the BACT process. This is stated on page 23 of *In Re Prairie State Generating Company*, PSD Appeal No. 05-05, decided August 24, 2006

> "Looking in the first instance to how the permit applicant defines the proposed facility's purpose or basic design in its application not only harmonizes the BACT definition with the permit application process in which the definition must be applied, but also is consistent with the Agency's long-standing policy against redefining the proposed facility. When the Administrator first developed this policy in Pennsauken, the

> Administrator concluded that permit conditions defining the emissions control systems "are imposed on the source as the applicant has defined it" and that "the source itself is not a condition of the permit." In re Pennsauken County, N.J., Res. Recovery Facility, 2 E.A.D. 667, 673 (Adm'r 1988) (emphasis added); see also In re Old Dominion Elec. Coop., 3 E.A.D. 779, 793 n.38 (Adm'r 1992) ("Traditionally, EPA has not required a PSD applicant to change the fundamental scope of its project."); In re Spokane Reg'l Waste-to-Energy, 2 E.A.D. 809, 811 n.7 (Adm'r 1989) (same).
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> For these reasons, we conclude that the permit issuer appropriately looks to how the applicant, in proposing the facility, defines the goals, objectives, purpose, or basic design for the proposed facility. Thus, the permit issuer must be mindful that BACT, in most cases, should not be applied to regulate the applicant's objective or purpose for the proposed facility, and therefore, the permit issuer must discern which design elements are inherent to that purpose, articulated for reasons independent of air quality permitting, and which design elements may be changed to achieve pollutant emissions reductions without disrupting the applicant's basic business purpose for the proposed facility."

This EAB decision was upheld by the U.S. Court of Appeals for the Seventh Circuit. Nuevo agrees with the EAB that installation of a geologic sequestration facility cannot be required under BACT. These same arguments apply to prohibit a requirement to construction of a CO_2 treatment facility and pipeline under PSD BACT.

Cost Analysis

For the reasons explained above, there are significant technical and legal issues that would preclude selecting either of the potential options. However, in the event that it was possible to overcome these barriers, a cost analysis was undertaken to determine if they were economically feasible.

- ***Pre-treatment and Transportation via pipeline to an existing EOR***

The net annualized cost for this option is estimated to be $14,200,000, which is 46% of the overall annualized costs of the Ramsey Expansion. The first year costs for this option would be $97,800,000, which equates to 33% of the Ramsey Expansion costs. This estimated net annualized cost is equivalent to $66.37 per ton of CO_2 removed.

- ***Pre-treatment and Transportation via pipeline to a reservoir for storage in a geological formation***

The total annualized cost for this option is estimated to be $16,200,000, which is 53% of the overall annualized costs of the Ramsey Expansion. The first year costs for this option would be $79,400,000, which equates to 26.5% of the Ramsey Expansion costs. This estimated annualized cost is equivalent to $75.66 per ton of CO_2 removed.

Conclusion

Based on the information available, CCS of amounts of CO_2 exceeding 7 MMSCF/D is not economically feasible.