Pipeline Safety: Safety Valves on CO₂ Pipeline Systems

All of the Denbury carbon dioxide (CO₂) pipeline systems utilize valves to control flow and relieve pressure within the pipelines. Valves are one method by which Denbury and other Operators are able to safely maintain and control the transportation of CO₂ by pipeline.

An automated valve is one that can be opened or closed using an electronic or pneumatic signal that causes a valve actuator to physically change the position of the valve (Open/Close). Denbury uses automated valves to isolate segments of their pipeline for maintenance, to control conditions along their pipeline systems and to protect their pipelines from operating outside of their design parameters. Automated valves can be operated remotely or locally or they can be designed to control conditions without any human intervention (i.e. Control Valves). Remotely controlled valves are operated from a remote location such as a central control center or field location. Valves in highly sensitive areas or remote locations are more likely to be remotely operated. Automated valves can also be operated locally, directly by Pipeline Operators who have the ability to isolate segments of the pipeline for maintenance activities and in order to maintain safe and efficient operating conditions. A control valve is a special category of automated valves designed to keep pipeline conditions as close as possible to a desired set point without any human intervention. These valves utilize complex control systems to sense pressure or flow conditions and automatically make corrections to keep the desired set point within a safe range.

Pressure relief valves and thermal relief valves are another category of valve, designed to prevent the internal pressure of the pipeline from reaching an established upper limit during operations (set point). This is accomplished by setting parameters on the valve that will allow the pressurized fluid to flow out of the system at the desired set point.

In the unlikely event of a CO₂ pipeline leak, a significant change in pipeline pressure would trigger an alarm at Denbury’s Gas Control Center (24/7 Operation) at which time a Pipeline Controller will initiate a command to close the upstream and downstream valves in order to isolate the affected pipeline segment. The benefits of monitoring the pipeline system conditions from a centralized 24/7 control center is that leaks can be detected quickly, the size of a subsequent release can be minimized, safety is enhanced along the pipelines and the downstream pipeline system is protected in the event of an operational upset. Other operating practices such as use of the One-Call system (811 Call Before you Dig), aerial patrol of the pipeline and
personnel surveillance of the pipeline are additional tools that Denbury uses to keep our pipelines safe and leak-free.

Training Opportunity: Emergency Response Scenario for a CO₂ Pipeline

An example of an emergency response scenario for a CO₂ pipeline: It’s 4:30 p.m. on a Friday afternoon. A road construction contractor is conducting grading and drainage improvements in advance of a roadway resurfacing project on Highway 44. The crew foreman is pushing the track hoe operator to finish digging before a pending thunderstorm brings significant rainfall to the area.

As the track hoe bucket reaches for one more load of soil, the CO₂ pipeline is damaged; subsequently a loud roaring noise is heard followed by the initial development of a white vapor cloud in the excavation.

Shortly thereafter, the traffic on Highway 44 has increased and in some areas has come to a standstill. Onlookers have gathered in proximity to the rupture site and are taking pictures to post on social media sites.

A reporter and camera crew from 26 Eyewitness News has arrived on site and is requesting information from emergency responders and pipeline personnel.

Scenario Discussion Questions

- What are the strategic and tactical response priorities?
- What might the Incident Command System structure look like for this incident?
- What are the physical properties and hazards associated with the product being released?
- How are the public sector responders coordinating with the pipeline operator to respond to the incident?
- How is the traffic congestion and request from the news media personnel addressed?

This scenario can be used for discussion during a roll call or crew safety meeting. Are you familiar with how to handle a response to a CO₂ pipeline incident? Pipeline operators are eager to meet with public sector responders and discuss their operations and how to work together in the unlikely event.
Pipeline Highlight: Greencore Pipeline

Denbury’s first CO₂ pipeline in the Rocky Mountain Region was the 232-mile Greencore Pipeline completed in 2012. This 20-inch CO₂ pipeline begins at the ConocoPhillips Lost Cabin Gas Plant in Fremont County, Wyoming, and terminates at Denbury’s Bell Creek Field in Powder River County, Montana. The purpose of the Greencore Pipeline is to transport CO₂ to petroleum reservoirs for enhanced oil recovery in Denbury’s Rocky Mountain region.

Enhanced oil recovery efforts such as Denbury’s operations result in the development of significant and otherwise stranded reserves of American oil from depleted reservoirs. This incremental production is extending the economic life and increasing the overall value of mature oil fields while providing considerable economic and environmental benefits. For more information on the Greencore Pipeline Project, please click here.

Synonyms: Carbonic acid gas, dry ice, carbonic anhydride

<table>
<thead>
<tr>
<th>Synonyms: Carbonic acid gas, dry ice, carbonic anhydride</th>
<th>Colorless gas-white when in solid form</th>
<th>Initial Boiling Point: -133.8 degrees Fahrenheit</th>
<th>pH: 3.2-3.7</th>
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</thead>
<tbody>
<tr>
<td>Odorless</td>
<td>Displaces oxygen in high concentrations</td>
<td>Melting/freezing point: -109.3 degrees Fahrenheit</td>
<td>Vapor Density: 1.5 @ 78.2 degrees Celsius</td>
</tr>
<tr>
<td>Pressurized Gas – cylinder may rupture if heated</td>
<td>NFPA 704 Hazard Class</td>
<td>Vapor pressure: 58.5 bar</td>
<td>Solubility in water: dissolves</td>
</tr>
</tbody>
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Carbon Dioxide Safety Data Sheet Quick Reference

Odorless
Displaces oxygen in high concentrations
Melting/freezing point: -109.3 degrees Fahrenheit
Vapor Density: 1.5 @ 78.2 degrees Celsius

Pressurized Gas – cylinder may rupture if heated
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