Simulation of Releases from CO₂ Transport Pipelines

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Tom Grieb, Michael Ungs, Kateryna Sayenko, Karen Summers, Bill Mills, Kay Johnson, Mark Rigby, Steve Gherini, Sujoy Roy and Bob Johns

CO₂ PIPELINE CHARACTERISTICS

Carbon sequestration in geologic formations involves the capture, transport and injection of CO₂. The environmental impact of CO₂ transport pipelines has been the subject of many studies that relate to the geological history and risk of CO₂ releases and leakage associated with the capture and sequestration plugs. This perception is based, in part, upon the notion of pipelines as long-distance formers of natural gas liquids, such as crude oil, fuel oil, condensate and gasoline. However, a proper analysis should be done before releasing carbon dioxide by well bore, conveyor and other gas flows, as are described during the lifetime of the CO₂ pipeline. The large volume of CO₂ that is involved in the capture and storage requires that the transport of the CO₂ as a supercritical fluid, typically at pressures between 15 and 20 MPa. The transported supercritical fluids are associated with volatile gases of CO₂ and other expected gases such as water vapor, hydrogen and other gases. These gases may then be reduced in a near surface, within the US. Most of the data associated with the risk assessment for the Foundry Project (DOE, 1987).

A new way jetting algorithm was developed to estimate the number of individuals affected by various releases of specified winds along the length of the pipeline. The specific data wind speed, wind stability, population densities as well as toxicity information to estimate the expected number of individuals affected by the CO₂ release. The pipeline was an important component of the transport system and was integrated in the analysis. The present population of the affected areas was surrounded with toxicity information to estimate potential human health risks.

Failure Rate Frequencies for Pipelines and Injection Wells

Failure rates for the key release scenarios that were studied were extracted from historical operation times for existing operating sites and were based on a passive transport of released gases.

The pipeline failure frequencies were calculated on the basis of the failure rate of pipeline failures (see Table 1) and the failure rate of gaseous impact zones was determined by the atmospheric conditions. For each pipeline failure, the gaseous impact zone was determined for five concentration levels corresponding to selected health-effect levels for 15-minute exposure durations: 0.51 ppmv H₂S, 3 ppmv CO₂, 10 ppmv CH₄, 20 ppmv C₂H₆, 100 ppmv C₂H₄, and 1000 ppmv C₂H₂.

CO₂ Concentration in the Environment after Pipeline Release

The estimation of CO₂ phases in the environment after pipeline release includes a number of individual scenarios of interest. The number of individuals affected by the CO₂ release was determined for each atmospheric state. The total affected population in each atmospheric state sums to 1, the sum of these products provides the expected number of affected individuals at the i-th atmospheric state (Eq 3).

Methodology

1. Simulation of Releases from CO₂ Transport Pipelines

2. Finding of the Number of Individuals Potentially Affected by a Pipeline Release

3. Estimation of CO₂ Phases in the Environment after Pipeline Release

4. Determination of the Total Number of Individuals Potentially Affected by the Specified Release Points

5. Characteristics of the Potential Exposure Along the Entire Pipeline

Summary

Pipelines allow for easy control of the release and the gaseous impact zones. For the future, pipelines can be used as the main CO₂ transport systems to reduce CO₂ emissions. The simulation of the CO₂ release from pipelines requires an understanding of the CO₂ transport system and the gaseous impact zones. The simulation can be used as a tool to estimate the potential exposure to released gases and other gases from the pipeline.

References


