

Accepted Manuscript

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PII: S1875-5100(18)30170-7

DOI: [10.1016/j.jngse.2018.04.014](https://doi.org/10.1016/j.jngse.2018.04.014)

Reference: JNGSE 2536

To appear in: *Journal of Natural Gas Science and Engineering*

Received Date: 24 October 2017

Revised Date: 10 April 2018

Accepted Date: 11 April 2018

Please cite this article as: Li, X., Ventura, J.A., Ayala, L.F., Carbon dioxide source selection and supply planning for fracking operations in shale gas and oil wells, *Journal of Natural Gas Science & Engineering* (2018), doi: 10.1016/j.jngse.2018.04.014.

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Carbon Dioxide Source Selection and Supply Planning for Fracking Operations in Shale Gas and Oil Wells

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Abstract

As a promising alternative approach for shale gas and oil withdrawal, fracking using CO₂ instead of water has been proved to be not only technically feasible but also environmentally friendly. This paper aims at evaluating CO₂ fracking from an economic perspective by considering the collection, supply, transportation, and storage of CO₂. More specifically, a CO₂ source selection and supply planning problem is defined and discussed from three aspects: CO₂ collection and storage at sources, CO₂ transportation, and CO₂ storage and usage at well pads. Cost models for the three aspects are built, based on which, a mixed-integer nonlinear programming model is developed to determine the optimal set of sources, the corresponding supply and transportation plan, and the investment in associated facilities and equipment. A two-stage algorithm is proposed, which decomposes the original model into a large set of simple sub-problems and a mixed-integer linear problem. A case study for three emerging well pads in North Dakota is presented to illustrate the implementation of the mathematical model and algorithm, and a sensitivity analysis is conducted to analyze the influences of four key parameters over the cost of using CO₂.

Keywords: CO₂ fracking; source selection; supply planning; mathematical model; two-stage algorithm; sensitivity analysis.

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