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Disposal of brackish water concentrate into depleted oil and gas fields: a Texas study

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Abstract

Disposal of concentrate from brackish water desalination plants by deep well injection into oil and gas fields is an attractive option in Texas. Underpressured depleted oil and gas reservoirs cover large areas of the state. Six areas were selected from across Texas for detailed analysis. These sites were characterized by abundant brackish groundwater, a projected shortage of freshwater, depleted oil and gas fields, and shallow injection wells. Information was collected on formation mineralogy, pressure history, geochemical attributes and flow parameters. Numerical modeling using SOLMINEQ, combined with a statistical approach, was used to assess the results of mixing desalination concentrate with formation water. Issues addressed include injection pressures required, the impact of down-hole conditions on mineral precipitation, and mobilisation of formation fines and clays. Numerical modeling found no technical problems outside the range commonly dealt with by the oil and gas industry. In addition, historically, most of the fields have received considerable volume of fresh and/or brackish waters. From a technological standpoint, injection of desalination concentrates into depleted oil or gas fields using existing wells is a highly feasible alternative. A brief look at the economics also suggests that this opportunity is highly advantageous.

Keywords: Concentrate; Oil and gas fields; Disposal; Scaling; Clay sensitivity

1. Introduction and background

Demand for fresh water in Texas will increase in the future owing to population growth. Because conventional sources will be insufficient to cover needs, desalination of brackish water is an alternative being actively pursued by the State. A promising possibility for disposing of concentrates is deep well injection. Formation pressures in reservoirs have been greatly lowered because of past oil and gas production, creating an opportunity for injecting a large volume of foreign fluids

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at lower cost. Legal and, to a lesser degree, technical issues can nevertheless arise [1]. This paper focuses on the technical issues. Injection of concentrate into the subsurface can potentially lead to formation damage because of scaling and clay mobilization. When concentrate is injected into the subsurface, it is subject to an increase in temperature and pressure. It mixes with the resident formation water as well, and both processes can lead to scaling. Another relevant concern is clay sensitivity to fresher water injection. Clayey material and fines can be mobilized and plug pores when they come in contact with a water of lower ionic strength and/or different ionic makeup. A third concern is the possible upper limit on the injection rate at which a formation is able to accept the concentrate stream.

Oil fields are plentiful in Texas (Fig. 1), with a cumulative production of approximately 60 billions barrels (9.5×10^{12} m^3) since the late 19th

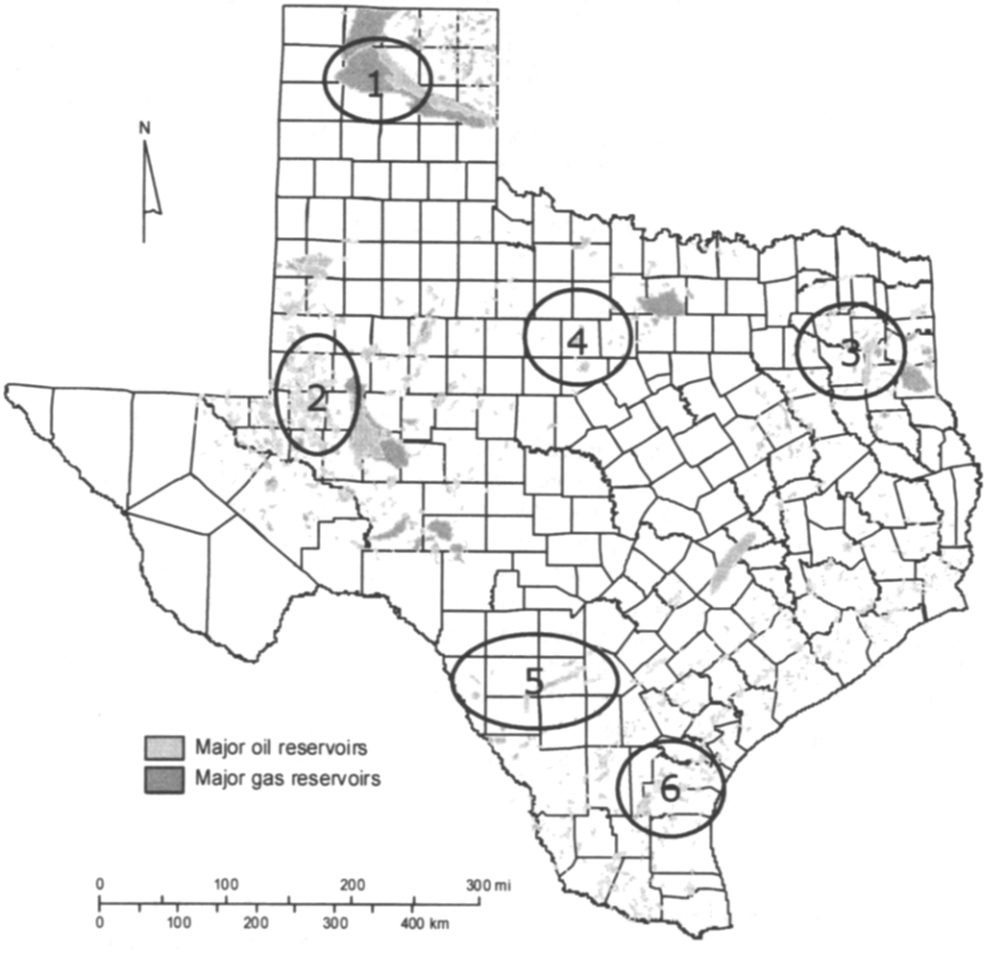

Fig. 1. Map of major oil and gas fields in Texas. Analysis areas are numbered: 1. Anadarko Basin, 2. Permian Basin, 3. East Texas Basin, 4. Fort Worth Basin, 5. Maverick Basin, and 6. Southern Gulf Coast Basin. The threshold value for a reservoir to be mapped is 10 million barrels (15.9×10^6 m^3) of cumulative production of oil or 30 billions ft^3 (850×10^6 m^3) of gas.