# NETL Life Cycle Inventory Data
# Process Documentation File

| | |
|---|---|
| **Process Name:** | Brine Water Management for Saline Aquifer CO2 Sequestration, Operations |
| **Reference Flow:** | 1 kg of Brine |
| **Brief Description:** | This unit process models the treatment and/or reinjection of brine water produced as a result of CO2 sequestration operations in saline aquifers. |

## Section I: Meta Data

**Geographical Coverage:** United States **Region:** United States

**Year Data Best Represents:** 2009

**Process Type:** Waste Treatment Process (WT)

**Process Scope:** Gate-to-Gate Process (GG)

**Allocation Applied:** No

**Completeness:** All Relevant Flows Captured

**Flows Aggregated in Data Set:**

☑ Process ☑ Energy Use ☐ Energy P&D ☐ Material P&D

**Relevant Output Flows Included in Data Set:**

| | | | |
|---|---|---|---|
| Releases to Air: | ☐ Greenhouse Gases | ☑ Criteria Air | ☐ Other |
| Releases to Water: | ☐ Inorganic | ☐ Organic Emissions | ☐ Other |
| Water Usage: | ☐ Water Consumption | ☑ Water Demand (throughput) | |
| Releases to Soil: | ☐ Inorganic Releases | ☐ Organic Releases | ☐ Other |

**Adjustable Process Parameters:**

| | |
|---|---|
| Treat_or_inj | *[dimensionless] 0 = reinjection; 1 = on-site treatment* |
| Reinj_or_truck | *[dimensionless] 0 = reinjection; 1 = truck transport to offsite waste management* |

| | |
|---|---|
| Brine_TDS | *[mg/L] Total dissolved solids content in the brine that is produced* |
| Treat_type | *[dimensionless] 0 = reverse osmosis.; 1 = distillation; treatment type based on TDS contained in brine* |
| RO_Power | *[kWh/kg] Power requirements for reverse osmosis treatment per kg of brine influent* |
| Dist_Power | *[kWh/kg] Power requirements for distillation treatment per kg of brine influent* |
| Inj_pump_elec | *[kWh/kg] Power requirements for water injection pump per kg of water injected* |

**Tracked Input Flows:**

| | |
|---|---|
| Power [Electric Power] | *[kWh] Power required by water treatment and/or injection pumps* |
| Brine [Water] | *[kg] Mass of produced brine water from the saline aquifer (Reference flow)* |

**Tracked Output Flows:**

| | |
|---|---|
| Water Potable [Water] | *[kg] Treated water produced* |
| Wastewater | *[kg] Concentrated brine for offsite transport* |

## Section II: Process Description

### Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_Brine_Management_CO2_Seq_2012.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

### Goal and Scope

This unit process provides a summary of relevant input and output flows associated with treatment and/or reinjection of brine water produced as a result of carbon dioxide ($CO_2$) sequestration in a saline aquifer. The inputs to this unit process include brine water and electricity used to power the treatment operations and injection pumps. The concentrated waste stream from brine treatment is either injected underground or shipped offsite for additional processing. Outputs include potable water and wastewater.

The reference flow of this unit process is 1 kg of Brine.

### Boundary and Description

This unit process provides a summary of relevant input and output flows associated with the treatment or reinjection of brine water produced from a saline aquifer that is used to store and sequester $CO_2$. Brine extraction from the formation can be used to control pressure to avoid underground fracturing or seismic events as well as provide additional capacity for $CO_2$ storage. Production of brine from the formation would likely occur away from the $CO_2$ injection well to prevent the migration of the injected $CO_2$ to the surface with the produced brine (ANL, 2011).

The inputs to this unit process include produced brine water and electricity used by one of two treatment processes and/or injection pumps. The unit process is setup such that produced brine can either be treated at a nearby facility to produce potable water or re-injected into a suitable underground formation.

Two water treatment technologies are considered in this unit process: reverse osmosis and vapor compression distillation. In this unit process, the choice of treatment technology is based on the total dissolved solids (TDS) content in the produced brine. Brine water quality, specifically in terms of TDS, is highly variable across the sites that are being considered for large scale $CO_2$ sequestration with values ranging from 5,000 to over 300,000 mg/L (ANL, 2011). Reverse osmosis is effective at handling water with a TDS up to 50,000 mg/L, while distillation is effective at higher TDS concentrations (Colorado School of Mines, 2009). Electricity requirements for the water treatment technologies considered are 11 to 16 kWh/1,000 gallons of untreated water for reverse osmosis and 26.5 kWh/1,000 gallons of untreated water for vapor compression distillation. Product recovery from reverse osmosis treatment is a function of the influent TDS concentration and ranges from 30 to 60 percent. Vapor compression distillation yields a product recovery of 40 percent (Colorado School of Mines, 2009).

Instead of treating the produced brine water at the surface, it may be desirable to instead re-inject the stream into a suitable underground formation nearby the production site. This practice is common in the oil and gas industry for onshore wells (ANL, 2011). In that scenario, this unit process models the pumping requirements for that injected stream. The pump modeled for the re-injection scenario has a rated flow of 250 gallons/minute with a differential head of 2,250 feet and a power demand of 190 kW (Sundyne Corporation, 2012). The pump chosen for this model is compatible with brine and delivers the required head for re-injection. The NETL saline aquifer storage cost model (internal) contains a representative list of possible storage formations in the United States. The injection pressure calculated from the model is used to determine the pumping requirements. The average injection pressure based on the midpoint of the geologic formation was 3,780 psia. The construction of the brine water disposal well is considered in a separate unit process.

The concentrated waste stream produced from water treatment can either be re-injected into a suitable formation or transported offsite for additional processing. The pumping requirements for injection of the concentrated brine are assumed to be the same as those for injection of the original brine stream produced from the aquifer.

The calculations presented for this unit process are based on the reference flow of 1 kg of brine water produced from a saline aquifer. The quantity of electricity consumed by the treatment plant (either reverse osmosis or distillation) and/or by the injection pump is accounted for in this unit process, but the upstream emissions from electricity generation are accounted for by upstream unit processes.

**Figure 1** provides an overview of the boundary of this unit process. Within the boundary of this unit process, brine is either re-injected or treated to produce potable water. If treated, there is an option to transport to the concentrated waste stream offsite for additional processing.

**Figure 1: Unit Process Scope and Boundary**

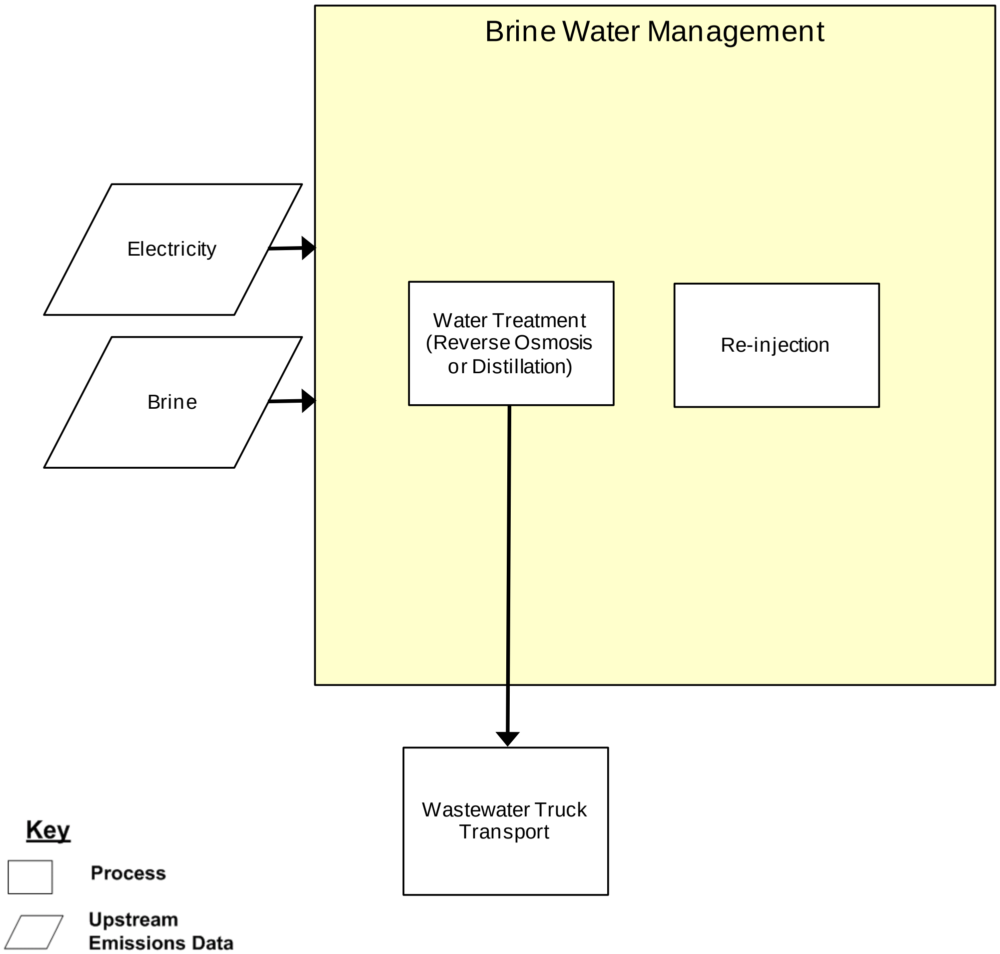


**Table 1** summarizes the electricity requirements and recovery rate parameters for the brine water management unit process. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS.

**Table 1: Parameters for Brine Management**

| Flow Name | Value | Units | Reference |
|---|---|---|---|
| Reverse Osmosis electricity use | 7.16E-04 | kWh/kg water | Colorado School of Mines 2009 |
| Distillation electricity use | 1.41E-03 | kWh/kg water | Colorado School of Mines 2009 |
| Reverse Osmosis recovered potable water | 0.45 | kg/kg brine | Colorado School of Mines 2009 |
| Distillation recovered potable water | 0.40 | kg/kg brine | Colorado School of Mines 2009 |
| Injection pump electricity use | 3.30E-03 | kWh/kg | Sundyne 2012 |

## Table 2: Unit Process Input and Output Flows

| Scenario | Concentrated Brine Handling | Flow Name | Value | Units (Per Reference Flow) |
|---|---|---|---|---|
| Reverse Osmosis Treatment Distillation Treatment | Reinjection | Inputs | | |
| | | Power [Electric Power] | 2.53E-03 | kWh |
| | | Brine [Water] | 1.00 | kg |
| | | Outputs | | |
| | | Water Potable [Water] | 0.45 | kg |
| | | Wastewater | 0 | kg |
| | Truck Transport to Offsite Treatment | Inputs | | |
| | | Power [Electric Power] | 7.16E-04 | kWh |
| | | Brine [Water] | 1.00 | kg |
| | | Outputs | | |
| | | Water Potable [Water] | 0.45 | kg |
| | | Wastewater | 0.55 | kg |
| Distillation Treatment Distillation Treatment | Reinjection | Inputs | | |
| | | Power [Electric Power] | 3.39E-03 | kWh |
| | | Brine [Water] | 1.00 | kg |
| | | Outputs | | |
| | | Water Potable [Water] | 0.40 | kg |
| | | Wastewater | 0 | kg |
| | Truck Transport to Offsite Treatment | Inputs | | |
| | | Power [Electric Power] | 1.41E-03 | kWh |
| | | Brine [Water] | 1.00 | kg |
| | | Outputs | | |
| | | Water Potable [Water] | 0.40 | kg |
| | | Wastewater | 0.60 | kg |
| Reinjection | N/A | Inputs | | |
| | | Power [Electric Power] | 3.30E-03 | kWh |
| | | Brine [Water] | 1.00 | kg |
| | | Outputs | | |
| | | Water Potable [Water] | 0 | kg |
| | | Wastewater | 0 | kg |

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

## Embedded Unit Processes

None.

## References :

ANL. (2011). *Management of Water Extracted from Carbon Sequestration Projects*. (ANL/EVS/R-11/1). Chicago, Illinois: Argonne National Laboratory Retrieved July 25, 2012, from http://www.ipd.anl.gov/anlpubs/2011/03/69386.pdf

Colorado School of Mines. (2009). *An Integrated Framework for Treatment and Management of Produced Water - Technical Assessment of Produced Water Treatment Technologies*. Golden, CO: Retrieved July 25, 2012, from http://aqwatec.mines.edu/produced_water/treat/docs/Tech_Assessment_PW_Treatment_Tech.pdf

Sundyne Corporation. (2012). LMV/BMP-313 Sundyne Centrifugal Pump Retrieved August 15, 2012, from http://www.sundyne.com/Products/Model+Locator/LMV+313

## Section III: Document Control Information

**Date Created:** August 27, 2012

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**Revision History:**

Original/no revisions

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