NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Storage/Disposal Coal Mine Tailings

Reference Flow: 1 kg of coal mine tailings

Brief Description: Storage/Disposal Coal Mine Tailings in Pond, Piles, or Backfill

Section I: Meta Data

Geographical Coverage: Global **Region:** N/A

Year Data Best Represents: 2000-2009

Process Type: Waste Treatment Process (WT)

Process Scope: Gate-to-Grave (End-of-Life) Process (GE)

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	☐ Organic Emissions	☐ Other

Adjustable Process Parameters:

disposal_time	*[dimensionless] 0 - Short-Term, 1 - Long-Term*
waste_to_env	*[kg/kg] kg of leachate that is emitted to fresh water per kg of total leachate*

Tracked Input Flows:

Coal Mine tailings, for storage and disposal	*Reference Flow*

Tracked Output Flows:

None.

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Coal_Tailings_Disposal_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

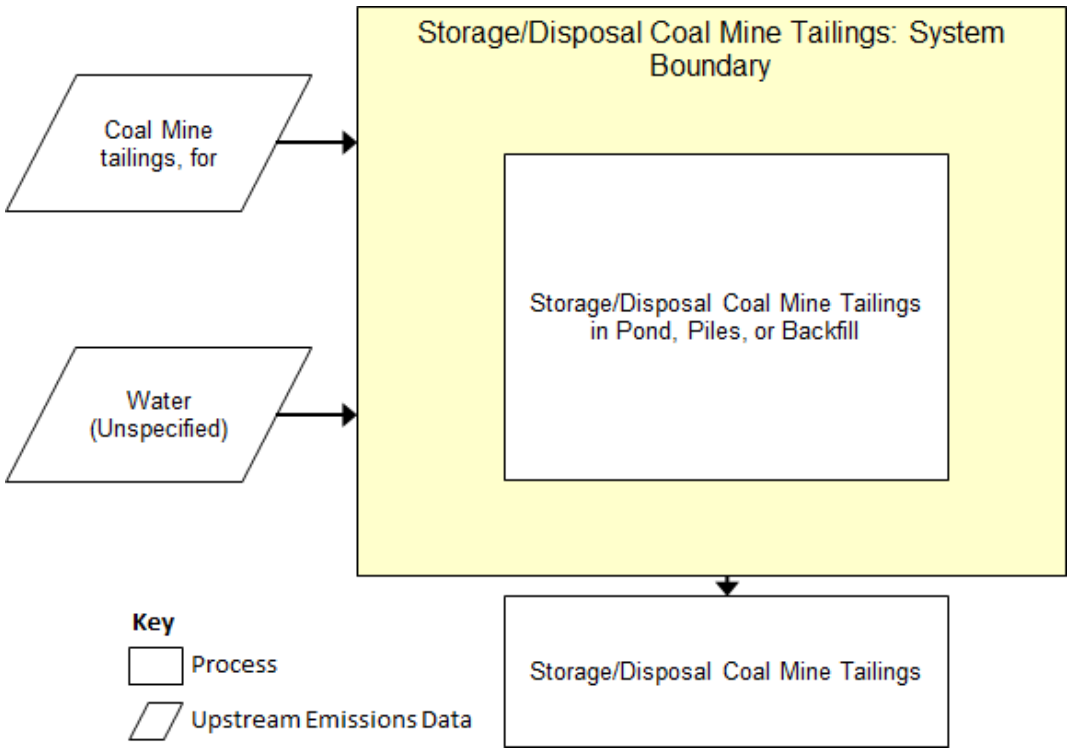
Goal and Scope

This unit process provides a summary of relevant input and output flows associated with disposing or storing coal mine tailings in an impoundment (pond), piles (landfill), or backfill. The process accounts for the leachate incurred during storage process in the short-term (0-100 years) and long-term (0-60,000 years). The reference flow of this unit process is: 1 kg of coal mine tailings.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process.

Figure 1: Unit Process Scope and Boundary



Coal mine tailings are the waste portions of mined coal that are separated from the target mineral(s) during beneficiation (EPA, 2000). Tailings disposal is a significant portion of the overall portion of the overall waste management process at coal mining operations (EPA, 2000). The physical and chemical nature of the tailings is a function of the coal being processed and the operations used for beneficiation (EPA, 2000). In the United States, tailings are managed wet or thickened in tailings impoundments; dry in disposal piles; or slurried and used as backfill into underground mines (EPA, 2000).

Data for coal tailings composition and leachate concentrations were collected by a literature survey (Doka, 2009). Over 1,300 data points were analyzed to derive a landfill model specific to the observed behavior of coal tailings (Doka, 2009). The model serves as a generic coal mine tailings disposal/storage process applicable to tailings impoundments, backfills, or heaps (Doka, 2009).

When coal tailings are placed into a landfill, an impoundment or used for backfill, the resulting leachate depends on climate, water availability, aquifer depths and characteristics, landscape, disposal site size, coal/mineral composition, and geographic location (Doka, 2009). It is not possible to quantify all of these factors in a generic model, and this approach should yield conservative estimates (Doka, 2009). When possible, global data was used (Doka, 2009).

Hydrocarbon concentrations and radioactive pollutants are not included in the emissions inventory due to lack of available data and low toxicity relevance compared to the inorganic pollutants in coal tailings leachate (Doka, 2009; WV, 2009).

In the model pollutants are transported only by water directly infiltrating from the surface (Doka, 2009). Groundwater in-flow and flow-through across the deposit and resulting pollutant removal is not considered (Doka, 2009).

For tin, scandium, thallium, and tungsten data from coal tailings is missing to calculate transfer coefficients so leachate data from lignite spoil was used for the calculation. For bromine and iodine the transfer coefficients of fluorine were assumed (Doka, 2009). For the inventory S, N, P are converted to the appropriate weights of sulfate (SO_4^{2-}), nitrate (NO_3^-), phosphate (PO_4^{3-}) (Doka, 2009). Chromium is inventoried as the soluble species (CrVI) (Doka, 2009). All emissions are inventoried as emissions to groundwater.

As an intermediate result of the modelling, Doka calculated transfer coefficients to indicate how much of each chemical will leach out of the landfill over time (Doka, 2009). Two separate sets of transfer coefficients were produced: a 100 year time (short-term) and the transfer coefficients for the full 60,000 year modelling period (Doka, 2009).

The inventoried emissions were obtained by multiplying the solids composition with the transfer coefficients for each element (Doka, 2009). The long-term emissions numbers used the long-term transfer coefficients and the short-term emissions numbers used the short-term emissions values.

Because industrial waste storage facilities like landfills may be required to control emissions by treating leachate water prior to discharge, a parameter was added to provide the ability to divert flows as simply deposited waste rather than being discharged to fresh water. This method discounts any energy required to process leach water and is also applied to all of the leachates when it may be possible to treat for only specific flows.

Table 1 shows the input and output flows of this unit process. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS sheet.

Table 1: Unit Process Input and Output Flows

Flow Name	Short-term	Long-term	Units (Per Reference Flow)
Inputs			
Coal Mine tailings, for storage and disposal	1.00E+00	1.00E+00	kg
Water (Unspecified) [Water]	4.97E-03	4.97E-03	L/kg
Outputs			
Sulfate (water), water	6.42E-04	1.67E-02	kg/kg
Nitrate (water), water	1.32E-05	1.89E-04	kg/kg
Phosphate (water), water	1.12E-07	6.72E-05	kg/kg
Chloride (water), water	1.49E-04	4.45E-04	kg/kg
Fluoride (water), water	6.23E-07	1.86E-06	kg/kg
Silver, ion (water), water	2.45E-09	3.54E-09	kg/kg
Arsenic, ion (water), water	8.99E-09	3.13E-06	kg/kg
Barium (water), water	8.39E-08	5.05E-05	kg/kg
Cadmium, ion (water), water	1.86E-08	6.40E-07	kg/kg
Cobalt (water), water	3.81E-08	3.43E-06	kg/kg
Chromium VI (water), water	8.76E-09	4.75E-06	kg/kg
Copper, ion (water), water	1.87E-08	1.12E-05	kg/kg
Mercury (water), water	5.88E-10	4.86E-08	kg/kg
Manganese (water), water	3.71E-06	7.25E-05	kg/kg
Molybdenum (water), water	2.27E-08	1.34E-06	kg/kg
Nickel, ion (water), water	1.78E-07	1.63E-05	kg/kg
Lead (water), water	1.50E-09	8.97E-07	kg/kg
Antimony (water), water	2.23E-09	1.28E-07	kg/kg
Selenium (water), water	8.36E-09	7.46E-07	kg/kg
Tin, ion (water), water	1.68E-07	1.71E-05	kg/kg
Vanadium, ion (water), water	2.42E-09	1.34E-06	kg/kg
Zinc, ion (water), water	3.72E-07	5.43E-05	kg/kg
Beryllium (water), water	1.34E-08	5.93E-07	kg/kg
Scandium (water), water	2.87E-09	2.84E-07	kg/kg
Strontium (water), water	6.20E-07	1.94E-05	kg/kg
Titanium, ion (water), water	5.52E-09	3.31E-06	kg/kg
Thallium (water), water	1.26E-10	1.28E-08	kg/kg
Tungsten (water), water	2.61E-10	1.87E-08	kg/kg
Silicon (water), water	1.43E-06	2.39E-04	kg/kg
Iron, ion (water), water	2.52E-06	1.51E-03	kg/kg
Calcium, ion (water), water	8.71E-05	1.10E-03	kg/kg
Aluminum (water), water	6.73E-07	4.04E-04	kg/kg
Potassium, ion (water), water	1.31E-03	1.31E-03	kg/kg
Magnesium (water), water	4.22E-05	8.59E-04	kg/kg
Sodium, ion (water), water	1.09E-04	6.86E-04	kg/kg

Sulfate (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Nitrate (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Phosphate (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Chloride (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Fluoride (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Silver, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Arsenic, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Barium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Cadmium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Cobalt (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Chromium VI (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Copper, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Mercury (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Manganese (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Molybdenum (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Nickel, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Lead (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Antimony (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Selenium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Tin, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Vanadium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Zinc, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Beryllium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Scandium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Strontium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Titanium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Thallium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Tungsten (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Silicon (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Iron, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Calcium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Aluminum (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Potassium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Magnesium (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg
Sodium, ion (water) [Deposited goods]	0.00E+00	0.00E+00	kg/kg

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

Embedded Unit Processes

None.

References

Doka 2009	Doka G. (2009) Life Cycle Inventory of the disposal of lignite spoil, coal spoil and coal tailings. Doka Life Cycle Assessments, Zurich. Commissioned by the Swiss Centre for Life Cycle Inventories ecoinvent Centre. Retrieved April 28, 2014 from http://www.doka.ch/DokaCoalTailings.pdf
EPA 2000	U.S. Environmental Protection Agency (EPA) (2000). *Abandoned Mine Site Characterization and Cleanup Handbook, Chapter 2: Overview of Mining and Mineral Processing Operations.* EPA 910-B-00-001. Accessed May 23, 2014 from http://water.epa.gov/polwaste/nps/upload/2000_08_pdfs_amscch.pdf
WVDEP 2009	West Virginia Department of Environmental Protection (WVDEP) (2009). An Evaluation of the Underground Injection of Coal Slurry in West Virginia -Phase I: Environmental Investigation. Senate Concurrent Resolution-15. Accessed May 15 from https://www.wvdhhr.org/oehs/documents/DEP.Coal.Slurry.Report.pdf

Section III: Document Control Information

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