NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Tribolectrostatic separation of minerals

Reference Flow: 1 kg of rare earth mineral concentrate

Brief Description: The separation of rare earth containing minerals from other gangue material by tribocharging particles and electrostatic plate separation

Section I: Meta Data

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

Year Data Best Represents: 2008

Process Type: Manufacturing Process (MP)

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

Allocation Applied: No

Completeness: Individual 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:

REO_crude	*[kg/kg] kg REO-equivalent per kg of crude ore*
Recovery_rate	*[kg/kg] kg REO-equivalent recovered per kg of REO-equivalent input*
REO_product	*[kg/kg] kg REO-equivalent per kg of rare earth concentrate*

electric_pwr_f — *[kWh/kg] Electricity required to process 1 kg of crude ore*

Tracked Input Flows:

rare earth ore, to beneficiation — *[Technosphere]*
Electricity [Electric power] — *[Technosphere]*

Tracked Output Flows:

rare earth concentrate, from electrostatic — *[Reference flow]*
solid waste [Waste for disposal] — *[Waste to disposal]*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_triboelectrostatic_separation_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

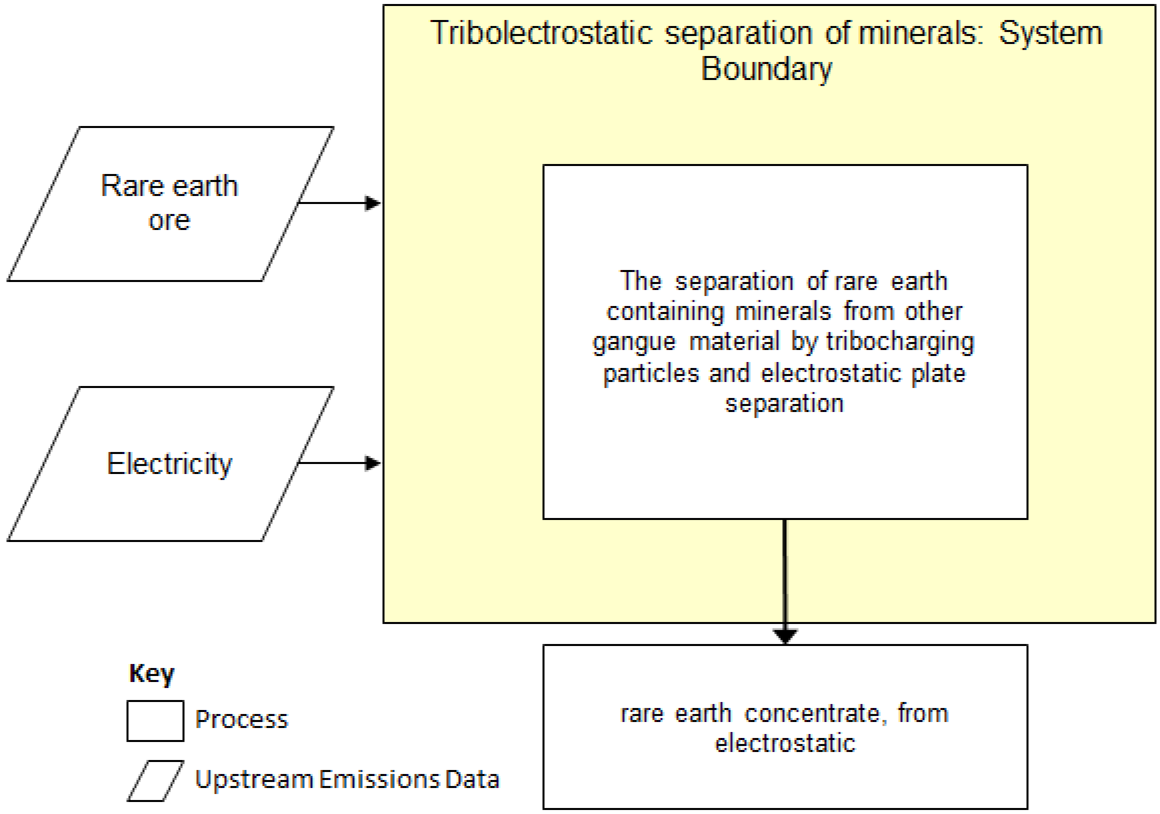
Goal and Scope

This unit process provides a summary of relevant input and output flows associated with separating materials using a triboelectrostatic separation process. The inputs are a dry feed of milled ore containing rare earths (or other valuable materials) and electricity. The outputs are a dry milled product with a higher concentration of rare earths (or other valuable materials) and a solid waste product. The reference flow of this unit process is: 1 kg of rare earth mineral concentrate.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, the upstream emissions from the rare earth ore and electricity are calculated other unit processes. The methods for calculating these operating activities are described below.

Figure 1: Unit Process Scope and Boundary



Triboelectrostatic separation is a function of the ability of two or more dissimilar materials to develop and hold an electric charge. In triboelectrostatic separation, the charge is developed by friction as the dissimilar materials contact each other causing the transfer of electrons. The charged particles are then separated by exploiting the different charges. The default electricity usage is based on a process that uses parallel, oppositely-charged plates to attract the particles into the flow of a high-speed belt that physically separates the particles (Separation Technologies LLC, 2008). Another way to separate the particles is through the use of charged drums, which can either attract charged particles or cause more conductive materials to lose their charge while less conductive materials are repelled by the charge on the drum and attracted to a charged line away from the drum (Wei and Realff, 2005). A key advantage to this method of separation is that it's done with dry particles, eliminating the need for any downstream drying.

The crude input requirements are determined by parameters to define the rare earth oxide (REO) equivalent content of the ore, the recovery rate of the process, and the final concentration of rare earth oxide equivalent mineral in the product. The default REO content of the ore is based on Mountain Pass ore containing bastnaesite, and the default recovery rate and product concentration is based on the recovery rate of carbon in a commercial triboelectrostatic separation process that separates fly ash from unburned carbon (Pradip & Fuerstenau, 2013; Bittner et al, 2009). However to provide a realistic assessment of an actual process, these parameters will need to be changed to match the specific materials being separated.

The expected and low values for electricity usage are based on the stated electricity usage for the belt-type, commercial separator – 1 kW per ton of fly ash (Separation Technologies LLC, 2008). The high value is based on the highest energy consumption per kg of throughput for a commercial drum separator (Fote Machinery Manufacturing Company, 2013).

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	Value	Units (Per Reference Flow)
Inputs		
rare earth ore, to beneficiation [Intermediate products]	5.43E+00	kg
Electricity [Electric power]	9.76E-03	kWh
Outputs		
rare earth concentrate, from electrostatic [Intermediate products]	1.00E+00	
solid waste [Waste for disposal]	4.43E+00	kg

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

Embedded Unit Processes

None.

References

Bittner, J.D., Gasiorowski, S.A., Hrach, F.J. (2009). Fly Ash Carbon Separation and Ammonia Removal at Tampa Electric Big Bend. In World of Coal Ash Conference; May 4-7, 2009. Retrieved July 14, 2014 from http://www.flyash.info/2009/116-gasiorowski2009.pdf

Fote Machinery Manufacturing Company (2013). Electrostatic Separator. Retrieved July 14, 2014 from http://www.sinoftm.com/copper_wire_crusher_machine/electrostatic-separator.html

Pradip and Fuerstenau D.W. (2013). Design and development of novel flotation reagents for the beneficiation of Mountain Pass rare-earth ore. Minerals and Metallurgical Processing. Vol. 30, No. 1, pp. 1-9.

Separation Technologies LLC (2008). Our Proprietary Separation Solution. Retrieved July 14, 2014 from http://www.proash.com/wordpress/?page_id=86

Wei, J. and Realff, M.J. (2005). Design and Optimization of Drum-type Electrostatic Separators for Plastics Recycling. *Industrial & Engineering Chemistry Research 2005 44 (10)*.

Section III: Document Control Information

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Original/no revisions

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