

Pressurized Chemical Looping for Direct Reduced Iron Production: Economics of Carbon Neutral Process Configurations

Supplementary Data

Table S1. Cost formulas applied by process unit.

Item	Method	Reference
PCL reactor		
Reformer tubes	Heat exchanger; U-tube	Seider 4th edition
Pressure vessel	Mulet, Corripio, and evans (1981a, b); mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	Seider 4th edition
Reactor internals	Factor of pressure vessel cost (20%)	Industrial expertise
Refractory	Quote for materials and installation labour	RHI, Harbinson-Walker, Kingston Refractory
External fluidized bed heat exchanger		
Reformer tubes	Heat exchanger; U-tube	Seider 4th edition
Pressure vessel	Mulet, Corripio, and evans (1981a, b); mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	Seider 4th edition
Cyclones		
Cyclones	Dust collector; cyclone	Seider 4th edition
Pressure vessel	Pressure vessel sized to contain large number of small cyclones necessary to meet particle cut.	Seider 4th edition
	Mulet, Corripio, and evans (1981a, b); mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	
Refractory	Quote for materials and installation labour	RHI, Harbinson-Walker, Kingston Refractory
Candle filter		
Filter elements	Vendor quote	Mott Filters

Pressure vessel	Pressure vessel sized to contain filter elements with required face velocity.	Seider 4th edition
	Mulet, Corripio, and evans (1981a, b); mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	
Amine absorber/regenerator		
Tower	Tower; packed w/ stainless steel pall rings	Seider 4th edition
	Mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	
Condenser	Compact heat exchanger; plate and frame	Seider 4th edition
Reboiler	Heat exchanger; kettle vaporizer	Seider 4th edition
Simple equipment		
Compressor	Centrifugal	Seider 4th edition
Direct contact cooler	Tower; packed w/ stainless steel pall rings	Seider 4th edition
	Mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	
Dryer	Solid	GPSA Engineering Data Book. (2004).
Duct burner	Incinerator; sized based on duty of injected natural gas	Ulrich 1984
Expansion turbine	Power recovery turbine; gas expander	Seider 4th edition
Fan	Centrifugal, backward curved	Seider 4th edition
Filter (solid-liquid)	Solid-liquid separator; filter; plate and frame	Seider 4th edition
Gas / liquid separators	Vapour liquid separator	GPSA Engineering Data Book. (2004).
Heat exchangers (shell and tube)	Floating head	Seider 4th edition
Heat exchangers (compact)	Plate and frame	Seider 4th edition
Pressure vessels	Mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	Seider 4th edition
Pumps	Centrifugal	Turton 5th Edition
Reformer (Base case)	Fired heater; reformer	Seider 4th edition
Shaft furnace	Gas-solid contactors; gravity shaft; brick lined	Ulrich 1984
Solids transport	Bucket elevator	Seider 4th edition

Storage bins	Bin	Seider 4th edition
Storage silos	Storage tank, cone roof	Seider 4th edition
Vessels	Mulet, Corripio, and evans (1981a, b); mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	Seider 4th edition
