

# 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
<b>PCL reactor</b>		
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
<b>External fluidized bed heat exchanger</b>		
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
<b>Cyclones</b>		
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
<b>Candle filter</b>		
Filter elements	Vendor quote	Mott Filters

Pressure vessel	Pressure vessel sized to contain filter elements with required face velocity.	Seider 4th edition
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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
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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
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Reboiler	Heat exchanger; kettle vaporizer	Seider 4th edition
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**Simple equipment**

Compressor	Centrifugal	Seider 4th edition
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Direct contact cooler	Tower; packed w/ stainless steel pall rings	Seider 4th edition
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Mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.

Dryer	Solid	GPSA Engineering Data Book. (2004).
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Duct burner	Incinerator; sized based on duty of injected natural gas	Ulrich 1984
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Expansion turbine	Power recovery turbine; gas expander	Seider 4th edition
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Fan	Centrifugal, backward curved	Seider 4th edition
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Filter (solid-liquid)	Solid-liquid separator; filter; plate and frame	Seider 4th edition
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Gas / liquid separators	Vapour liquid separator	GPSA Engineering Data Book. (2004).
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Heat exchangers (shell and tube)	Floating head	Seider 4th edition
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Heat exchangers (compact)	Plate and frame	Seider 4th edition
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Pressure vessels	Mass of vessel calculated with an allowance for platforms, ladders, a nominal number of nozzles and manholes.	Seider 4th edition
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Pumps	Centrifugal	Turton 5th Edition
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Reformer (Base case)	Fired heater; reformer	Seider 4th edition
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Shaft furnace	Gas-solid contactors; gravity shaft; brick lined	Ulrich 1984
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Solids transport	Bucket elevator	Seider 4th edition
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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

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