Cost Correlations for Equipment

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All prices refer to North American prices for mid 1970 corresponding to a Marshall–Stevens index of 300. Most prices are for carbon steel (c/s) equipment although some are quoted for stainless steel (s/s) construction.

More details are given by Woods (1974).

$$C_2 = C_1 \cdot \frac{I_2}{I_1}$$

$$C_2 = C_{base} \cdot \left(\frac{\text{Required Size}}{\text{Base Size}}\right)^n$$

Cyclones:						
Single high efficiency c/s: FOB	10	capacity, 10^3 scfm	3	1 – 80	0.56	30
Multi: FOB	10	capacity, 10^3 scfm	2	1 – 150	0.66	30
Deaerators:						
Vacuum type: FOB	200	capacity, US gpm	8.8	50 – 1000	0.43	

	Size	Unit	Cost 10^3 $	Range	n	Error %
Forced draft type: FOB	100	capacity, US gpm	5.4	50 – 800	0.45	
Dialysis: Installed	3	membrane area, 10^3 ft^2	32	0.5 – 60	0.79	
Digester: anaerobic: Installed	{10 / 300}	volume, 10^3 ft^3	{37 / 480}	1 – 35 / 35 – 600	0.41 / 0.97	
Distillation tower; complete tower-trays: Installed	4000	$\left(\frac{\text{actual}}{\text{trays}}\right)\left(\frac{\text{feed, lb/yr}}{10^6}\right)^{0.65}$	1000	300 – 30,000	1.0	26
Drives:						
Gear unit: FOB excl motor	{40 / 500}	$\left(\frac{\text{drive, hp at 1800 rpm}}{}\right)\left(\text{nominal reduction ratio}\right)^{0.5}$	{0.58 / 3.6}	4 – 150 / 150 – 2000	0.45 / 0.75	
V belt and pulley: FOB	10	drive, hp	0.14	2 – 30	0.88	
Sprockets and roller chain: FOB	10	drive, hp	0.055	2 – 10	0.21	
Dryers:						
Cone, jacketed vacuum s/s: FOB incl auxil	10	working capacity, ft^3	9.2	1 – 300	0.50	
Drum, atmos c/s: FOB excl. motor	100	surface area, ft^2	22	10 – 400	0.52	40
Fluidized bed, direct fired c/s: FOB incl auxil	10	$\left(\frac{\text{diam, ft}}{}\right)\left(\text{fluidizing velocity, ft/sec}\right)^{0.35}$	45	3 – 26	0.73	
Dryers:						
Rotary, indirect fired c/s: FOB incl motors	4	peripheral area, 10^2 ft^2	28	1 – 20	1.00	40
Rotary, direct fired c/s: FOB incl auxil	4	peripheral area, 10^2 ft^2	18	1 – 40	0.88	30
Installed	100	solid waste, ton/d	150	40 – 600	0.84	40
Rotary, steam tube c/s: FOB incl motor	10	heating area, 10^2 ft^2	18	4 – 70	0.75	30
Rotary, vacuum c/s: FOB incl auxil	1	peripheral area, 10^2 ft^2	23	0.2 – 10	0.49	30
Roto-louvre, atmos c/s: FOB incl auxil	2	peripheral area, 10^2 ft^2	35	0.5 – 10	0.62	10
Sand bed, for sludge: Installed	{20 / 200}	surface area, 10^3 ft^2	{29 / 220}	5 – 43 / 43 – 1000	0.63 / 0.96	50
Shelf, vacuum c/s: FOB excl trays, vac. equip	1	tray area, 10^2 ft^2	5.1	0.15 – 10	0.56	
Spray ~150°C c/s: FOB	5	water evap/hr, 10^3 lb	150	0.25 – 20	0.71	

	Size	Unit	Cost 10^3 $	Range	n	Error %
Tray-Truck c/s: FOB excl trays	1	tray area, 10^2 ft^2	4	0.20 – 15	0.37	
Tunnel c/s: FOB incl auxil excl motor	4	heated surface, 10^2 ft^2	64	1.5 – 15	0.93	20
Transported bed c/s: FOB incl auxil	1	water evap/hr, 10^3 lb	40	0.60 – 20	0.42	30
Turbo c/s: Del incl motors	1	drying area, 10^3 ft^2	48	0.20 – 20	0.66	
Ejectors:						
Single stage; 100 psig steam: FOB ejector	3	(lb/hr air)/(mm Hg abs.)	0.80	0.2 – 30	0.50	70
Two stage: FOB incl condenser, piping	1	(lb/hr air)/(mm Hg abs.)	1.9	0.2 – 10	0.43	30
Multistage: FOB incl condenser, piping	10	(lb/hr air)/(mm Hg abs.)	5.0	0.2 – 100	0.26	40
Electrodialysis:						
Membranes, spacers, electrodes: FOB	40	area, 10^3 ft^2	400	20 – 80	0.70	
Unit for 4000 ppm feed: Installed	1	capacity, 10^6 US gal/d	1,600	0.02 – 100	0.82	
Electrostatic precipitators, G-S, FOB	{1 20}	gas flow, 10^4 cfm at 40°C	{23 115	0.1 – 8 8 – 100	0.39 0.81	40 40
Electrostatic separators: Del incl motor	10	capacity, 10^3 lb/hr	12	2 – 70	0.60	
Elevators, bucket: Del excl motor	10^3	(ton/h)(length, ft)$^{1.6}$	3	$10^3 - 5 \times 10^5$	0.46	35
Engines, gasoline: FOB	400	drive, hp	50	30 – 7000	0.82	70
Evaporators: Natural circulation c/s: FOB	50	heating area, ft^2	10	20 – 200	0.50	
Forced external circulation c/s: FOB	1	heating area, 10^3 ft^2	65	0.2 – 5	0.74	40
Internal circulation, horizontal tube c/s: FOB	5	heating area, 10^2 ft^2	20	1 – 90	0.47	30
vertical basket c/s: FOB	5	heating area, 10^2 ft^2	21	1 – 60	0.55	60
Vertical long tube; rising/falling film c/s: FOB	10	heating area, 10^2 ft^2	23	0.1 – 1000	0.68	70
Vertical agitated film 316 s/s: FOB	{0.05 1}	heating area, 10^2 ft^2	{10 45	0.01 – 0.18 0.18 – 2.5	0.36 0.62	30 30
Jacketed glass lined vessel: FOB	1	volume, 10^2 US gal	16	0.5 – 10	0.48	
Extractors: Podbielniak centrifugal: Del	{10 25}	capacity, US gpm	{15 27	4 – 15 15 – 40	0.37 0.78	
Rotating disc, c/s: Del	10^2	(height, ft)(diam., ft)$^{1.5}$	3.5	3 – 2000	0.84	60
Vertical agitated, s/s: Del incl motor	10^2	(height, ft)(diam., ft)	43	1 – 5000	0.81	

	Size	Unit	Cost 10^3 $	Range	n	Error %
Horizontal mixer-settler unit, rubber lined: I	10^2	horiz. area, ft^2	30	15 – 600	0.67	30
Extruders, c/s: FOB incl variable speed drive	10	drivepower, hp	11	2 – 200	0.59	60
Fans: Centrifugal radial: Del excl motor	30	capacity, 10^3 scfm	2.3	3 – 200	0.84	40
incl motor	30		4.5	3 – 100	0.92	40
Vane axial: FOB excl motor	10	capacity, 10^3 scfm	5.2	4 – 40	0.65	60
incl motor	3		6.0	1 – 10	0.35	60
Propeller: FOB package incl motor	20	capacity, 10^3 scfm	0.50	1 – 100	0.40	50
Feeders:						
S, rotary star: Del excl motor	10	diam., inches	1.3	3 – 10	0.66	
Apron: Del excl hopper, motor	400	(ton/hr)(length, ft)$^{0.55}$	12	50 – 5000	0.70	
Filters:						
Plate and frame c/s: Del	1	effective area, 10^2 ft^2	1.7	0.1 – 10	0.55	
Pressure leaf, vertical c/s: Del	1	effective area, 10^2 ft^2	5.1	0.3 – 15	0.57	30
horizontal c/s: Del	1	effective area, 10^2 ft^2	7.1	0.3 – 15	0.51	40
Vacuum rotary drum c/s: FOB incl motor	1	effective area, 10^2 ft^2	19	0.1 – 15	0.48	50
Vacuum rotary disk c/s: FOB incl motor	1	effective area, 10^2 ft^2	16	0.4 – 10	0.68	
Horizontal plate, c/s: Del filter	5	effective area, ft^2	3.2	1 – 10	0.62	
Horizontal tilting pan c/s: FOB	1	effective area, 10^2 ft^2	32	0.1 – 45	0.33	
Belt filter: s/s: FOB	200	effective area, ft^2	80	100 – 350	0.58	
Microstrainer c/s: Installed	10	capacity, 10^6 US gal/d	300	0.3 – 100	0.84	
Deep bed: Installed	100	horiz. area, ft^2	72	1 – 20,000	0.63	
Flotation:						
Dissolved air for LS: Installed	1	capacity, 10^6 US gal/d	35	0.1 – 10	0.47	
Induced draft for SS: Del	{0.4 / 2}	capacity, 100 ft^3	{1.6 / 3.6}	0.21 – 1 / 1 – 3	0.37 / 0.74	
Foam separators for waste water: Installed	1	capacity, 10^6 US gal/d	56	0.25 – 5	0.80	
Furnaces:						
Box type direct fired c/s: Del	40	heat absorbed, 10^6 Btu/h	54	10 – 400	0.75	40
Vertical cylinder direct fired c/s: FOB	10	heat absorbed, 10^6 Btu/h	40	0.5 – 100	0.74	50
Multiple hearth c/s: Installed	1	capacity, 10^3 lb/h	430	0.15 – 4	0.59	

	Size	Unit	Cost 10^3 $	Range	n	Error %
Fluid bed incinerated: Installed	{0.5 3}	capacity, 10^3 lb/h	{270 900	0.4 – 1 1 – 9	0.53 0.78	
Generators: turbine drive: FOB incl drive	10^4	power output, kW	600	3000 – 50,000	0.73	20
Grit chamber for waste water: Installed	300	surface area, ft²	18	50 – 1500	0.37	40
Heat Exchangers:						
Shell-tube, floating head c/s: Del Fixed tube × 0.85; U-tube × 0.87; kettle × 1.35	1	surface area, 10^3 ft²	6.5	0.02 – 20	0.59	40
Shell-tube—finned tube floating head c/s: Del	{2 6}	total area, 10^3 ft²	{ 6.7 15	0.7 – 3 3 – 10	0.57 0.78	20 20
Air cooled, finned c/s: FOB	3	bare tube area, 10^3 ft²	26	0.2 – 20	0.8	30
Plate coil c/s serpentine type: Del	{10 30}	surface area, ft²	{0.033 0.063	5 – 15 15 – 40	0.36 0.78	
Cascade, cast iron: Del	1	surface area, 10^2 ft²	0.40	0.4 – 2.5	1.0	20
Double pipe, c/s internal finned: Del	20	total area, ft²	0.40	3 – 250	0.14	20
Plate 316 s/s: Del	{150 350 700}	surface area, ft²	{ 5.5 13.0 22.0	100 – 200 200 – 500 500 – 1000	0.65 0.65 0.90	
Plate-fin (lamella) c/s: Del	3	surface area, ft²	3.0		1.00	100
Spiral plate (Rosenblad) c/s: Del	{1 3 7}	surface area, 10^2 ft²	{1.4 2.2 3.7	0.4 – 2 2 – 4 4 – 7	0.27 0.48 0.72	
Spiral tube c/s: Del	{ 5 30}	coil area, ft²	{0.12 0.47	2.5 – 7.5 7.5 – 60	0.43 0.83	
Tank suction header c/s: FOB	2	surface area, 10^2 ft²	1.3	0.3 – 20	0.58	
Bayonet heater c/s: Del	3	surface area, ft²	0.14	1 – 6	0.35	80
Mandrel wound Al: FOB	15	surface area, 10^3 ft²	180	10 – 20	0.76	
Cubic; graphite: FOB	70	surface area, ft²	1.7	10 – 200	0.46	
Coils in a tank c/s: FOB excl tank	30	surface area, ft²	0.29	1 – 300	0.33	
Thermal screw c/s: FOB excl motor	1	surface area, 10^2 ft²	10	0.1 – 4	0.78	40
Electric immersion c/s: FOB	50	energy, kW	0.70	10 – 200	0.87	