Table 15.1 Reference equipment purchase costs and related capacities with corresponding values for parameter n and f (eqn (15.1)).[25]

Equipment	Year	Ref. Capacity, S_A	Units	Ref. Cost, P_A (GBP)	n	f (%)
Batch Crystalliser	2007	7.5	Volume (m^3)	192 000	0.68	10.33
Forced Circulation Crystalliser	2007	1	kg crystal s^{-1}	520 000	0.53	10.33
Draft Tube MSMPR	2007	1	kg crystal s^{-1}	538 000	0.63	10.33
Pumps	2015	—	—	958	—	—
Pipes[a]	2007	1	Length (m)	62	1.33	—

[a]Additional cost factors for alloying considerations may be required.[25]

excluding ancillaries, equipment delivery, electrical, engineering and piping expenses.[24] Parameter n scales costs for differences in capacity, while f describes differences in design and operation; values for n and f can be found in the literature.[25] Examples of reference crystallisation equipment costs and their capacities with their corresponding values of n and f are provided in Table 15.1; further values for specific equipment can be found in the references therein.[25]

Various methods exist to calculate the cost of delivered installed equipment costs. Wroth factors can be used to calculate the cost of delivered installed equipment;[26] additional costs are associated with the calculation of construction, process piping and instrumentation to give the battery limits installed costs (BLIC), a major component of CapEx. The Chilton method can be implemented for the estimation of BLIC for manufacturing processes.[23] Working capital (WC, *i.e.*, short term investments required to maintain operation) is calculated as a function of the costs of annual material requirements. There are additional factors for construction (typically 30% of BLIC[27]) and contingency to account for error in cost estimation (20% of BLIC[27]). Extra considerations for offsite capital are associated with grass-roots construction.[24] Total CapEx is taken as the sum of BLIC, WC, construction, contingency and offsite capital components.

15.2.2 Operating Expenditure (OpEx)

Total operating expenditure (OpEx) is the sum of materials, waste handling, utilities, labour and quality control.[27] Material costs are calculated from process mass balances required to meet a desired product capacity; material prices are estimated from available vendors and databases. Variation of material prices can be considered as a form of sensitivity analysis for comparative evaluation.[23] Waste handling and utilities costs vary with location, waste stream composition and extent of waste treatment required, but can