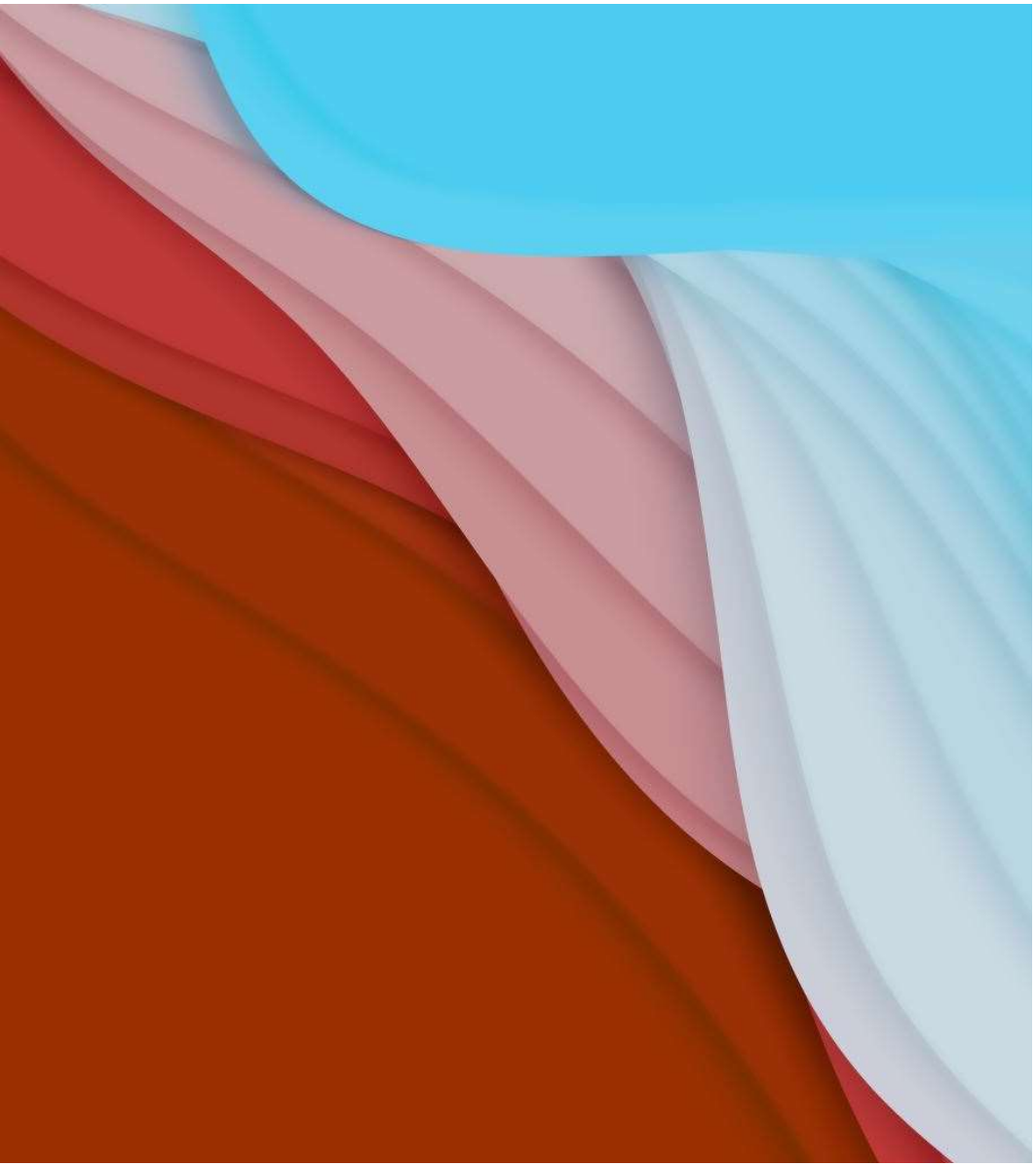

CEN4415
PROCESS DESIGN I

3. PERCENTAGE OF DELIVERED EQUIPMENT COST METHOD

This method for estimating the fixed or total-capital investment requires determination of the delivered-equipment cost.

The other items included in the total direct plant cost are then estimated as percentages of the delivered-equipment cost.

$$C_n = [\Sigma E + \Sigma(f_1 E + f_2 E + f_3 E + \ldots)](f_t) \qquad (3)$$

where $f_1, f_2 \ldots$ = multiplying factors for piping, electrical, instrumentation, etc.
f_t = indirect cost factor always greater than 1.

TABLE 17

Ratio factors for estimating capital-investment items based on delivered-equipment cost

Values presented are applicable for major process plant additions to an existing site where the necessary land is available through purchase or present ownership.? The values are based on fixed-capital investments ranging from under $1 million to over $20 million.

Item	Percent of deliveredequipment cost for Solid-processing plant‡	Solid-fluid-processing plant ‡	Fluid-processing plant ‡
Direct costs			
Purchased equipment-delivered (including fabricated equipment and process machinery) §	100	100	100
Purchased-equipment installation	45	39	47
Instrumentation and controls (installed)	9	13	18
Piping (installed)	16	31	66
Electrical (installed)	10	10	11
Buildings (including services)	25	29	18
Yard improvements	13	10	10
Service facilities (installed)	40	55	70
Land (if purchase is required)	6	6	6
Total direct plant cost	264	293	346
Indirect costs			
Engineering and supervision	33	32	33
Construction expenses	39	34	41
Total direct and indirect plant costs	336	359	420
Contractor's fee (about 5% of direct and indirect plant costs)	17	18	21
Contingency (about 10% of direct and indirect plant costs)	34	36	42
Fixed-capital investment	387	413	483
Working capital (about 15% of total capital investment)	68	74	86
Total capital investment	455	487	569

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4. LANG FCTORS METHOD

This method is used to predict at the ORDER or RATIO level.

TABLE 18
Lang multiplication factors for estimation of fixed-capital investment or total capital investment

Factor x delivered-equipment cost = fixed-capital investment or total capital investment for major additions to an existing plant.

Type of plant	Factor for: Fixed-capital investment	Factor for: Total capital investment
Solid-processing plant	3.9	4.6
Solid-fluid-processing plant	4.1	4.9
Fluid-processing plant	4.8	5.7

5. POWER FACTORS METHOD - Plant Capacity Ratio

This method for study or order-of-magnitude estimates relates the fixed-capital investment of a new process plant to the fixed-capital investment of similar previously constructed plants by an exponential power ratio.

For certain similar process plant configurations, the fixed-capital investment of the new facility is equal to the fixed-capital investment of the constructed facility C multiplied by the ratio *R,* defined as the capacity of the new facility divided by the capacity of the old, raised to a power X.

$$C_n = C\,(R)^x$$

- This power has been found to average between 0.6 and 0.7 for many process facilities. Table 19 gives the capacity power factor (x) for various kinds of processing plants.

$$C_n = C\,(R)^x$$

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2. Turton R., Bailie R.C., Whitin W.C., Shaeiwitz J.A. 1998, Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, New Jersey.