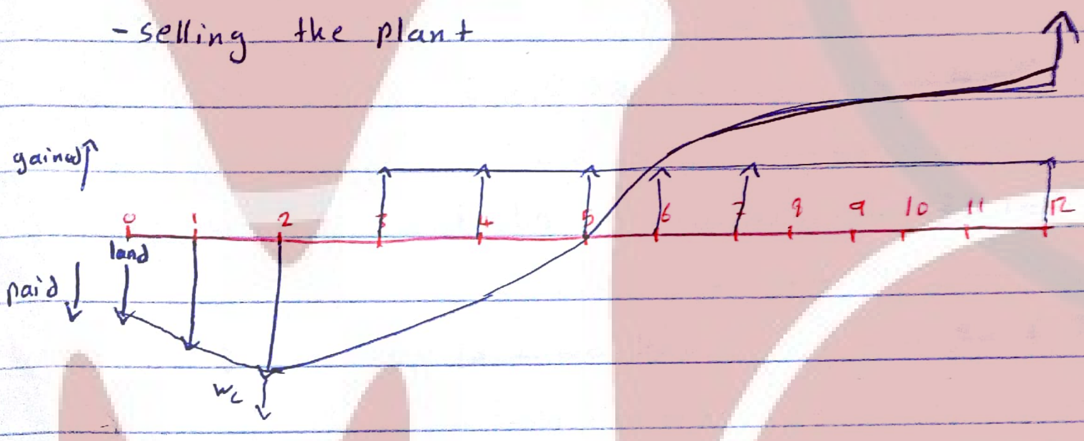
/plant :-

Estemation of capital cost :-

starting a plant you need:-

- purchasing of the Land
- purchasing of the equipments and installation
- Running of the plant
- selling the plant



* classification of capital cost estimation

(1) order of magnitude

compare cost and size of your plant with existing one => [BFD]

(2) study estimate (major equipments should be included) => [PFD]

(3) preliminary design (cost) estimate (scope) add tubing , Layout , electrical, - - - - => [PFD]

(4) Difinitive estimate

(off-site , Layout , instruments , utilitese - - - -)

(5) Detailed estimate

(final PFD, PandID , etc - - -)

These estimates are related to 5 - classes

[Association for Advancement of cost Engeneering] => (AACE)

Class	Level of project Definition	Expected accurcy rang	preparation effort w/ lowest cost index
Class 5	0 - 2 %	4 - 20 % ±	1 unit
class 4	1 - 15 %	3 - 12 %	2 - 4 units
class 3	10 - 40 %	2 - 6 %	3 - 10 units
class 2	30 - 70 %	1 - 3 %	5 - 20 units
class 1	50 - 100 %	1	10 - 100 units

* class 1: has adetailed estimate of $\boxed{(+6\% \text{ to } -4\%)}$ of accurate value $\Rightarrow$ the most accurate estemate

* class 5: has estimate EFoRTs to prepare this class in arange Close to $\boxed{0.015\% \text{ to } 0.3\%}$ of cost of total instulled equipment

$\Rightarrow$ least accurate

example:-

he estimated capital cost of a chemical plant using (class 4) is $2M.
if the plant were to be built, over what range would you expect the actual capital estimate to vary?

sol:

class 4 3–12 % w/ to class 1:

* Lowest expected cost range:
  - high value $= (\$2M)(1+\frac{6}{100}\times 3) = \$2.36M$
  - Low value $= (\$2M)(1+(\frac{-4}{100})3) = \$1.76M$
* highest expected cost range:
  - high value $= (\$2M)(1+(\frac{6}{100})12) = \$3.44M$
  - Low value $= (\$2M)(1+(\frac{-4}{100})12) = \$1.04M$

Example 2:-

compare the cost for performing an order of magnitude estimate and detailed estimate for aplant that costs \$5 M to build?

sol:

Cost of (O.O.M) 0.015 % — 0.3 %

low value: $\left(\frac{0.015}{100}\right)(\$5M) = \$750$

high value: $\left(\frac{0.3}{100}\right)(\$5M) = \$15,000$

Detailed estimate (10 — 100) of (O.O.M)

Lowest
- Lowest expected cost = (\$ 5M) (0.015% x10) = \$ 7500
- highest expected cost = (\$ 5M) (0.3% x 10) = \$150,000

highest
- Lowest expected cost = (\$ 5M) (0.015 % x100) = 75,000
- highest expected cost = (\$ 5M) (0.3% x 100) = \$1.5M

Effect of capacity on purchased equipment cost:-

مراجع لأسعار ال equipments

1- Matches [www. matche. com]

2- peter, Timmer haus; plant design and economics [www. mhhe. com/eng cs/chemical/Peters/data]

$$C_{eq.2} = C_{eq.1}\left(\frac{A_2}{A_1}\right)^{n}$$

size, power, etc.— of new equ. (A_2)

size of old one (A_1)

n → factor

cost of new equ. ($C_{eq.2}$)

cost of exesting equ. ($C_{eq.1}$)

* n: cost index

(if it is not specified, [use n = 0.6]) → six-tenth rule

$$n = \log(C_1/C_2) / \log(A_1/A_2)$$

equipment	Rang	unit	n
- Respecating compressor (with motor drive)	0.7 – 1490	kw	0.84
- Heat exchanger (shell and tube, Cs)	1.9 – 1890	m^2	0.59
- Vertical tanks, Cs	0.4 – 76	m^3	0.3
- centirfugal blower	0.24 – 71	m^3/s	0.6
- Jacketed kettle	0.2 – 3.8	m^3	0.48

Example :-

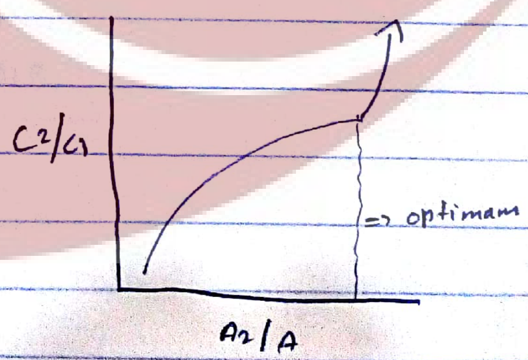
The cost of floating head tank (Base of y = 2014) has a size of 20,000 gallons (75.7 m^3) and made up of Cs, C = \$ 84,400 what will be the cost of 40,000 gallon given that n = 0.5.

sol :-

$$C_{40,000} = C_{20,000}\left[\frac{40,000}{20,000}\right]^{0.5} = \$ 119,359$$

$C_2 = 119,359$
$\Rightarrow$ $C_2/C_1 = 1.4$
$C_1 = 84,400$

A_2/A_1	C_2/C_1
2	1.4
4	2
8	2.8
12	3.46



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* Effect of time on purchased cost equipment :-

$$C_2 = C_1 \left(\frac{I_2}{I_1} \right)$$

cost index at time 2

cost

Cost index

(1) Marshal and swift cost index

(2) chemical engeneering plant cost index (CEPCI)

year	Marshal	CEPCI
1936	817	318
1990	915	358
1995	1028	381
2005	1245	468
2016	—	541.7
2017 (march)	—	562.1
2017 (June)	—	566.6

example :-

The purchased cost of H E ($50\ m^2$) in 2016 is \$ 35,200 (cs, tolerate p = 600 psi) use CEPCE to obtain cost of this equip. of year.

sol:

$$C_{2017} = C_{2016} \left(\frac{I_{2017}}{I_{2016}} \right)$$

$$= 35200 \left(\frac{566.6}{541.7} \right) = \boxed{\$\ 36,818}$$

estimation of capital cost of aplant:

The capital cost of aplant is a summation of many direct and indirect cost.

1- direct project cost

(a) cost of equipment, C_p

(b) material required for instillation, C_m

(piping, insulation, welding, fire protection, welding, instrumentation)

(c) Labor cost, C_L

2- indirect cost

(a) (Taxes, insurance, etc...), C_{FIT}

(b) construction over head, C_o

~~(c) contengenies and fees~~

~~(d) contengency (factors and cover uniform circumer stances~~
~~such as Loss of time value, streams, small change in design)~~

3- contractor engineering expenses

(a) contengenies and fees

(b) contengency (factors and cover uniform circumer stances
such as Loss of time value, streams, small change in design)

4- Auxillary facilities

(a) site development, C_{site}

(purchased Land cost, excaustion smoothing, instillation of hook up electricity, roads, walkway, parking, ... etc)

(b) Auxillary building

(offecies, board room, shape, cafeteria, etc...)

(c) off-site and utility, C_{off}

Long factor :

it is used to estimate of building [major expansion] to an existing plant .

$$C_{TM} = F_{long} \sum_{i=1}^{n=equip} C_{pi}$$

C_{TM} total module cost (capital cost of the plant)

F_{long} Long factor

$\sum C_{pi}$ summation of equipment costs

Values of Long factor based on process :

	Long factor	updated value
fluid - fluid	4.74	5.1
solid - fluid	3.63	4.1
solid - solid	3.10	3.2

example :

A young engineer with phillps petroleum has learned that on expansion of the solid-fluid process plant is expected to have adelivered equipment cost of $1.55 M , estimate the plant total cost .

$C_{TM} = 4.1 \cdot \$1.55 = \$6.35 M.$

Bare module cost :-

This module is used to estimate the total cost of the plant based on direct and indirect cost of the equipments it is calculated based on BASE condition of equipment.

$$C_{BM} = F_{BM}\, C_p^0$$

Direct costs :

		Factor
_(01) Equipment	C_p^0	1
_(02) material	$C_M = \alpha_M C_p^0$	α_M
_(03) Labor	$C_L = \alpha_L (C_p^0 + C_M)$	$\alpha_L (1+\alpha_M)$

_Total direct cost

$$C_{DE} = C_p^0 + C_M + C_L$$

$$= C_p^0 + \alpha_M C_p^0 + \alpha_L (C_p^0 + \alpha_M C_p^0)$$

$$\boxed{= C_p^0 [(1+\alpha_M)(1+\alpha_L)]}$$

indirect cost :

		Factor
-a Freight	$C_{FIT} = \alpha_{FIT} (C_p^0 + C_M)$	$(1+\alpha_M)\alpha_{FIT}$
_b over head	$C_O = \alpha_O C_L$	$(1+\alpha_M)\alpha_L \alpha_O$
_c Engineering	$C_E = \alpha_E C_p^0 C_M$	$(1+\alpha_M)\alpha_M$

_ Total indirect cost

$$C_{IDE} = C_{FIT} + C_O + C_E$$

$$\boxed{C_{IDE} = \alpha_{FIT} (C_p^0 + C_M) + \alpha_O C_L + \alpha_E (C_p^0 + C_M)}$$

$$\boxed{C_{IDE} = (1+\alpha_m)\left[\alpha_{FIT} + \alpha_L \alpha_o + \alpha_E\right] C_p^o}$$

$$C_{BM} = C_{DE} + C_{IDE} = (1+\alpha_m)\left[1+\alpha_L+\alpha_{FIT}+\alpha_L\alpha_o+\alpha_E\right] C_p^o$$

$$F_{BM}^o = (1+\alpha_m)\left[1+\alpha_L+\alpha_{FIT}+\alpha_L\alpha_o+\alpha_E\right]$$

$$\boxed{\therefore\ C_{BM} = F_{BM}^o\, C_p^o}$$

Total module cost:

$$\boxed{C_{TM} = C^o_{BM} + C_{cont} + C_{fee}}$$

* $C_{cont} = \alpha_{cont}\, C^o_{BM}$
* $C_{fee} = \alpha_{fee}\, C^o_{BM}$

$$\therefore\ C_{TM} = (1+\alpha_m)\left[1+\alpha_L+\alpha_{FIT}+\alpha_L\alpha_o+\alpha_E\right](1+\alpha_{cont}+\alpha_{fee}) * C_p^o$$

Example :-

he perchased cost for C_s heat exchanger operating of ~~[illegible]~~ ambient condition, is $10000, the following % are related to direct and indirect cost of H.E:

item	%
Equipment	100
materials	71.4
Labor	63
Freight	8
overhead	63.4
Emgeneering	23.3

calc. the Bare module cost factor F_{BM}^o and C_{BM}^o

sol:

$$\alpha_L = \frac{C_L}{C_p^o + C_M} = \frac{0.63\,C_p^o}{C_p^o + 0.714\,C_p^o} = \frac{0.63}{1+0.714} = 0.368$$

$$\alpha_{FIT} = \frac{C_{FIT}}{C_p^o + C_M} = \frac{0.08\,C_p^o}{C_p^o + 0.714\,C_p^o} = \frac{0.08}{1+0.714} = 0.047$$

$$\alpha_o = \frac{C_o}{C_L} = \frac{0.634\,C_p^o}{\alpha_L (C_p^o + C_M)} = \frac{0.634\,C_p^o}{0.368\,C_p^o + 0.714\,C_p^o}$$

~~0.1136~~ →

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$\alpha_E = \frac{C_E}{C_p^o + C_M} = \frac{0.233 C_p^o}{C_p^o + 0.714 C_p^o} = 0.136$

then ⇒ $F_{BM} = (1 + \alpha_L + \alpha_{FIT} + \alpha_L \alpha_0 + \alpha_E)(1 + \alpha_M)$

$= [1 + 0.368 + 0.047 + (1.005)(0.368) + 0.136](1 + 0.714)$

$= 3.291$

$C^o_{BM} = F^o_{BM} C_p^o = (3.291)(10000)$

$= \$ 32,910$

Bare module cost for non-base condition :-

(material of construction, high pressure)

~~$C_{BM} = F_{BM} C_p^o$~~

$$\boxed{C_{BM} = F_{BM} C_p^o = (B_1 + F_M F_p B_2) C_p^o}$$

F_M = factor related to MOC

F_p = factor relate to pressure.

$$\boxed{\log_{10} F_p = C_1 + C_2 \log_{10} P + C_3 (\log_{10} P)^2}$$

* to obtain B_1, B_2 ⇒ من الأرقام الذي كتبها الدكتور

* to obtain F_M ⇒ table (A-3) = P: 1009

chart (A-18) = P: 1010

Equip.	B_1	B_2
1- Exchanger (double pipe, multipipe --)	1.74	1.53
2- Fixed tube, floating head, U-tube, kettle	1.63	1.66
3- Air color, flate plate	0.96	1.21
4- horezantal vessel	1.49	1.52
5- vertical "	2.25	1.82
6- pumps	1.89	1.35

Example:-

what will be the Bare module cost of afloating head shell and tube H.E ($A = 100 m^2$) at the end of year 2016 operated at 1 bar, Cp^o (2000) = \$25,000

sol:

* $C_{BM} = (B_1 + B_2 F_M F_P) Cp^o$

from table A-3 ? , 1D = ? => use chart => $F_M = 1$, $F_P = 1$

$C_{BM} = (1.63 + 1.66 \times 1 \times 1)$

$= (3.29)(25,000)$

$= \$ 82,300$

$C_{BM_{2010}} = 82,300 \left(\frac{566.6}{394}\right) = \$118,353$

(2) ~~f~~ fired heater, Reboilar, furnace:-

$C_{BM} = Cp^o F^o_{BM} F_P F_T$

$F_T = 1$ for saturated condition

$F_T = 1 + 1.84 \times 10^{-3} \Delta T - 3.35 \times 10^{-6} (\Delta T)^2$

(3) compressors, bloures, Evaporators, vaporizers.

$C_{BM} = Cp^o F^o_{BM} F_P$ as above

(4) sieve tray, value tray, etc ---

$C_{BM} = Cp^o N F^o_{BM} F_q$

N = No. of stages

F_q: quantity factor for trays => $N < 20$ =>

=> use $F_q = 0.4771 + 0.08516 \log_{10} N - 0.3473 (\log_{10} N)^2$

$N > 20$ => $F_q = 1$

estemation of pressure correction for vessels.

$$F_p = \begin{cases} 1 & T < T_{min} \quad p \geq -0.5 \text{ bar} \\ 1.25 & p < -0.5 \text{ bar} \\ \dfrac{(p+1)D}{(2)(944)(0.9)-1.2(p+1)} & T > T_{min} \quad p \geq -0.5 \text{ bar} \end{cases}$$

(t_{min})

thekness

$$t = \frac{pD}{2SE - 1.2p} + CA$$

$\Rightarrow$ p = pressure , D = diameter

S = max allowable pressure

E = weld factor , CA = corrosion allawnes

Total module :-

$$C_{TM} = \sum_{i=1}^{n} C_{TM_i} = 1.18 \sum_{i=1}^{n} C_{BM_i}$$

Grass Root :-

$$C_{GR} = C_{TM} + 0.5 \sum_{i=1}^{n} B M_i$$

New chapter :-

Estimation of Manufacturing cost :

$$C_{OM} = \underbrace{\text{Direct cost}}_{(DMC)} + \underbrace{\text{General expenses}}_{(GE)} + \underbrace{\text{fixed cost}}_{(FMC)}$$

* Direct cost :-

1- raw matirial , C_{RM}

2- utilities , C_{ut}

3- wast treatment , C_{wt}

4- operating labor , C_{OL}

5- direct super vision , $0.18\ C_{OL}$

6- maintenance , repair , $0.06\ [C_{GR} \text{ or } C_{TM}]$

7- supplies , $0.15\ C_{OL}$

8- patents , $0.03\ C_{OM}$

$$DMC = C_{RM} + C_{ut} + C_{wt} + C_{OL} + 0.18\ C_{OL} + 0.06\ C_{\substack{TM \\ GR}} + 0.15\ C_{OL} + 0.03\ C_{OM}$$

$$DMC = C_{RM} + C_{ut} + C_{wt} + 1.33\ C_{OL} + 0.069\ \underset{\substack{C_{TM} \\ C_{GR}}}{FCI} + 0.03\ C_{OM}$$

Fixed capital cost :-

1- Dipreciation → 0.1 FCI or TM

2- Taxes, insurance → 0.032 FCI

3- overhead cost → $0.708\, C_{OL} + 0.036\, FCI$

$$FMC = 0.708\, C_{OL} + 0.168\, FCI$$

General expenses (GE) :-

-1 Administrative cost → $0.177\, C_{OL} + 0.009\, FCI$

-2 Distribution and selling cost → $0.11\, C_{OM}$

-3 Research and Development → $0.05\, C_{OM}$

$$GE = 0.177\, C_{OL} + 0.009\, FCI + 0.16\, C_{OM}$$

$$\boxed{C_{OM} = 1.235\, [C_{RM} + C_{UT} + C_{WT}] + 2.73\, C_{OL} + 0.303\, FCI}$$

* operating Labor cost:-

$N_{OL} = [6.29 + 31.7p^2 + 0.23\, N_{np}]^{0.5}$

Number of Labors

p: no. of Processing Steps for solids [transportation, distrobution, particulate sizing, control ---]

N_{np}: no. of equipments that are related to non solid [Towers, reactors, heat exchangers, heaters, compressor

each Labor Requires $ 50,000 - 60,000

- A labor works 49 weaks/year
- 3 weaks vaccation
- each weak → 5-shifts

∴ Labor works = 5 x 49 = 245 shiftly

A plant operates 365 days / year, this requires 365 (3-shift) = 1095 shift/year

$n_{Labor} = \frac{1095}{245} = 4.5$ ⇒ so I need [4-5] Labors to work in this plant/day

Cost (4-5) (50 000) = ($ 200 000 - $ 250 000)

Labors:-

1- engineer
2- forman
3- board man
4- 1st operator
5- 2nd " (2)
6- 3rd " (3)
7- 4th " (4)

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Example :-

(Refere to hydro dealkylation process (Turton book))

tolune ⟶ benzene

Nomber of major Equipments = 11

What is the number of operating Labor for this process.

sol :

$N_{OL} = [6.29 + 3.17 P^2 + 0.23 N_{np}]^{0.5}$

$N_{OL} = [6.29 + 0.23 (11)]^{0.5} = 2.97 = 3$

Total $(4.5)(3) = 13.4 = 14$

$C_{OL} = (14)(50000) = \$700,000$

http://data.bls.gov ⟹ USA في labors ال يعطي معلومات عن

lities :- (how much fuel that we used ?!)

- utility cost = f (prices of fuel)

The cost of utility is directly proportional with the source :

1- if it is purchased from public or private sector
2- supplied by the company
3- generated by the process.

example :-

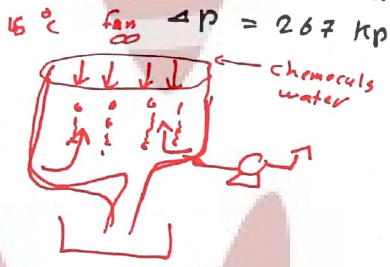
estimate the utility cost for production a circulating water stream using a mechanical drift cooling tower consider a base case and only 1 GJ/h of energy reused from the process

given that : fan power = 1.31 kwh

cost of chemical being used = $0.165 / 1000 kg water

ΔP = 267 kpa

from heuristic => $\varepsilon = 0.75$



$q = c_p \, m \, \Delta T$

$1 \times 10^9 \, J/h = m \, (4180 \, J/kg) \, (45 - 15°)$

$\boxed{m = 7974 \text{ kg/hr}}$ => water cirulating

water exaporeted ??

$\lambda_{water} = 2417 \text{ kJ/kg}$

$m_{evaporate} = \dfrac{1 \times 10^9}{2417 \times 10^3} = 41307 \text{ kg/h}$

$w_{pump} = \dot{V} \Delta P$

this assuming 100% efficient pump

$w_{pump} = \dfrac{\dot{V} \Delta P}{\varepsilon} = \dfrac{\frac{\dot{m}}{\rho} \Delta P}{\varepsilon} = \dfrac{\frac{7974}{1000} \times 267}{0.75} \cdot \dfrac{1}{3600} = 0.79 \text{ kw}$

kw is per 1 GJ

→

cost of electricity = \$0.06 /kw from table

total cost of electricity

$= [0.79\ kw + 1.31\ kw]\ 0.06$

$\boxed{= \$\,0.125 / 1\,G\delta}$

cost total of chemicals $= \frac{\$0.165}{10000\ kg\ water} \times 413.7$

$= \frac{\$0.068}{1\,G\delta}$

cost of makeup water : $\frac{\$0.354}{1\,G\delta} \cdot 1\,G\delta = \$\,0.354$

total cost = cost makeup water + cost of chemicals + cost of electricity

$= 0.354 + 0.068 + 0.125$

$= \$\,0.54 / G\delta$

Cost of raw material:

[chemical market Reporter]

~~[illegible]~~ stream factor $= \frac{No.\ of\ days}{365} < 1$

$S.F \approx 0.95 - 0.98$

xample :-

or Toluene-benzene process

low rate of toluene = 10,000 kg/hr

Benzene = 8210 kg/hr

stream factor = 0.95

hat are the yearly cost/rate of both reactant and products

given that cost of toluene = \$0.322/kg

Benzene = \$0.349/kg

sol:

yearly consumption of toluene =

flow rate $= \frac{10,000\ kg}{hr} \Big| \frac{24\ hr}{1\ day} \Big| \frac{365\ day}{1\ year} \cdot 0.95 = 83,200,000\ kg/year$

toluene $= 0.322 \times 83\,200\,000 = \$\,26,773,600 / year$

H.w + الأذكار الأحد: مي بلانت

7/11/2017

H.w: problems 3, 4, 5,

...ction rate of Benzene

$$= 8210\ \frac{kg}{hr} \left| \frac{24\,hr}{1\,day} \right| \frac{365\ day}{1\ year} \cdot 0.95$$

$= 68,323,620\ kg/year$

price of benzene $= 68,323,820 * 0.349$

$= \$\ 23,844,443\ /year$

<u>your porocess is not feasable</u>

example :-

estimation the cost of manifacturing for plant with the following given information

equipment	utility used	efficiency η	(MG) usage	Annoul cost
E-201				
E-202	Lps		3800	10,800
E-203		—	5550	270,000
E-204	cw	—	4200	11,900
E-204	Lps	—	3090	150,000
E-205	electricity	0.8	1.6 kw	786
	electricity	0.8	1.5 kw	726

you should be able to calculate

Raw materials is not give , $C_{TM} = \$\ 898,000$

$C_{OM} = 0.303\,FCI + 2.73\,C_{OL} + 1.235\,(C_{RM} + C_{ut} + C_{wt})$

$N_{OL} = [6.29 + 31.7\,\cancel{p}^2_0 + 0.23\,\cancel{N_{np}}_6]^{0.5} = 2.77$

operator $= 2.77 \times 4.5 = 13$

$C_{OL} = \$\ 50,000 \times 13 = \$\ 650,000$

C_{RM}

$C_{ut} = 10,800 + 270,000 + 11,900 + 150,000 + 786 + 726$

$= \$\ 443312$

$C_{wt} = 0$

see waste treatment cost

$C_{OM} = 0.303 \times 898,000 + 2.72(650,000) + 1.235\,[C_{RM} + 444,212 + 0]$

$= \$\ 2483,000 + 1.235\ C_{RM}$

you pay even plant is non operating.

...nt :

① 2-11-2017 الخميس

Engineering Economic and Analysis:

* Invest ⟶ Bank ⟶ profit
  ↓
Value of many ⟶ (Company Project) ⟶ profit

* money (if invested) ⟶ generate money

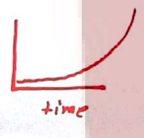
present value $\xrightarrow{\text{intrest}}$ new value

present value of money
Future value //
Life time (# of year)
intrest

* The yearly intrest rate = $\frac{F-P}{n}$

* Future value:

$F = (1+ni)\,P$



types of interest:

1- simple $\quad F = P(1+ni)$ — F: future value, P: present value, n: year, i: intrest rate

2- compound interest $\Rightarrow F = P(1+i)^n$ ⟸ this is the standard

3- interest is changing w/ time $\Rightarrow F = P \prod_{i=1}^{n} (1+i)$ ← ضرب

example :-

How much you need to invest in saving account based on 6% interest rate to have \$5000 in 5 years ??

sol:

$F = \$5000$

$F = P(1+i)^n = P(1+0.06)^5 \Rightarrow P = 3{,}736$

base for compound intrest:

- yearly
- monthly
- daily
- contineous

$\Bigg\}$ $r = \frac{i_n}{m}$ ← number of periods $\Rightarrow$

example:

i - per year

needed per month $\Rightarrow r = \frac{i}{12}$

example:

for the case $i = 12\%$, what will be the interest per month?

sol:

$r = \frac{12}{12} = 1\%$

Effective interest rate:

$$i_{eff} = (1 + \frac{i_n}{m})^m - 1$$

$$F = P(1 + \frac{i_n}{m})^m$$

example:-

what is the effective annual intreset for anominal rate of 8% per annum when compounded monthly?

sol:

$i_n = 8\%$; $m = 12$

$$i_{eff} = (1 + \frac{8\%}{12}) - 1 = 8.3\%$$

for a given $P = 1000$

$$F = P(1 + i_{eff})$$

$$= 1000(1 + \frac{0.08}{12})^{12}$$

$$= 1083$$

Conteneous compound interest :

$$i_{eff} = e^{in} - 1$$

Example :

How much you would have to invest at 6 % for 6 years to obtain \$ 1791 Assume Basic interest .

sol:

$$P = F\left(\frac{1}{(1+i)^n}\right) = 1791\left(\frac{1}{1+0.06}\right)^6 = 1263$$

chapter 7 + 8

Cash flow diagram:-

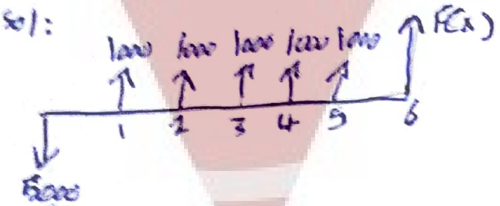
X-axis → time
Y-axis → cash flow
Upward ⇒ earn money
down word ⇒ lost mony

Example:-

You invest today, withdraw \$1000 at the end of each year, how much you have at the end of 6 years.

$i = 6\%$

sol:



$P_1 = \frac{F_1}{(1+0.06)^1} = \frac{1000}{1+0.06} = 943.4$

$P_2 = \frac{F_2}{(1+0.06)^2} = \frac{1000}{(1+0.06)^2} = 890$

$P_3 = 839.6$

$P_4 = 792.1$

$P_5 = 747.3$

$P_x = \frac{x}{(1+0.06)^6} \Rightarrow 5000 = 943.4 + 890 + 839.6 + 792.1 + \frac{x}{(1+0.06)^6} \Big\} \Rightarrow x = \$1117.2$

sol 2: bring all mony till the end

$F_P = 5000(1+0.06)^6 = 7092.6$

$F_1 = 1000(1+0.06)^5 = 1338.2$

$F_2 = 1000(1+0.06)^4 = 1265.5$

$F_3 = 1000(1+0.06)^3 = 1191$

$F_4 = 1123.6$

$F_5 = 1060$

$F_P - \sum_{i=1}^{5} F_i = x = 1117.2$

Scanned by CamScanner

A uniform series of cash transaction

(2)

$F_n = A\left[(1+i)^1 + (1+i)^2 + \cdots\right]$

$\ast$ $F_n = A\left[\frac{(1+i)^n - 1}{i}\right]$

$F_n = P(1+i)^n$

$F_n = A\left[\frac{(1+i)^n - 1}{i}\right]$

$A = \frac{F i}{(1+i)^n - 1}$

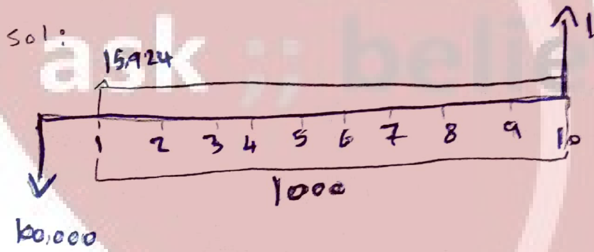
$A = \frac{P(1+i)^n \ast i}{(1+i)^n - 1}$

$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$

Example:-

A piece of equipment costs \$100,000. if a UoT Engineer is borrowed this amount from a bank with 9% interest and should these amount be paid within 10 years with a fixed payment yearly. The equipment needs \$1000/~~month~~ year for operation and yield a profit of \$15,924 ~~monthly~~ yearly. She was expecting to sell this equip. at the end with \$10,000. Do you think this engineer learn something from economy??

Sol:



$A = 15,924 - 1000 = 14924$

$P = 100000$

$F = 10,000$

$A = \frac{P(1+i)^n \ast i}{(1+i)^n - 1} = \frac{100,000(1+0.09)^{10} \ast 0.09}{(1+0.09)^{10} - 1}$

$\boxed{= 15,582}$

$A = \frac{F i}{(1+i)^n - 1} = \frac{10,000(0.09)}{(1+0.09)^{10} - 1} = \boxed{658.2}$

$\sum A_i = 14,924 + 658.2 - 15,582 = \boxed{\$ 0.2}$

→

solve based on $i = 0.08$

$$\sum A_i = 14,924 + 690.3 - 14902$$

$$\boxed{= \$\ 712}$$

No.

Plant :-

7-11-2017

Depreciation :-

1- straight Line :-, $d_k^{SL} = \frac{FCI - SV}{n}$

2- Declining balance method :- $V_{\text{at present}} = V_{\text{origenal}} (1-f)^{a}$ → no. of years, at year 2 → a=2, at year 3 → a=3

$$f = 1 - \left(\frac{S}{V}\right)^{1/n}_{\text{present}}$$

Example :-

origenal price of equipment \$22,000, used for 10 years, sold for \$2000. what is the price of this equipment after 5 years?

sol :

- straight Line $d = \frac{FCI - SV}{n} = \frac{22,000 - 2000}{10} = 2000$

$$V_5 = FCI - a d = 22000 - 5 \times 2000 = 12000$$

- Declining balance :

$$f = 1 - (S/V)^{1/n} = 1 - \left(\frac{2000}{22000}\right)^{1/10} = 0.2131$$

$$V_5 = V(1-f)^5 = 22000(1-0.2131)^5 = \$6650$$

3- Sum of year Digits method :-

$$d_K^{SYD} = \frac{[\overset{\text{total no of years}}{n} + 1 - \overset{\text{the year I want}}{K}](FCI - S)}{n/2\,(n+1)}$$

why SYD :

	$n/2\,(n+1)$
year 1 : 1	1
year 2 : 2	3
year 3 : 3	6
year 4	

4- Double declining balance method :-

$$d_k^{DDB} = \frac{2}{n}\left[FCI - \sum_{i=0}^{k-1} d_i\right]$$

example:-

$FCI = 150\,000\,000$

$S = 10\,000\,000$

$n = 7$ years

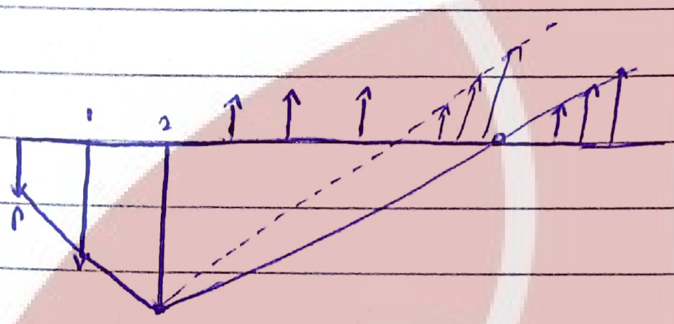
depreciation comparsion ??

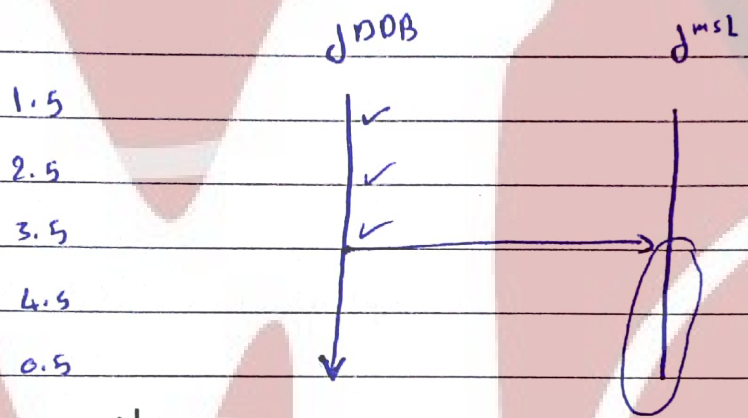
year	d_k^{SL}	d_k^{SYD}	d_k^{DDB}	$BV = FCI - \Sigma d_i$ $= FCI - \Sigma d_i$ $\times 10^{-6}$
0	-	—	—	150
1	$\frac{150-10}{7} = 20$	$\frac{(7+1-1)(150-10)}{28} = 35$	$\frac{2}{7}(150-0) = 42.9$	$150 - 42.9 = 107.1$
2	20	$= 30$	$\frac{2}{7}(150-42.9) = 30.6$	$107.1 - 30.6 = 76.5$
3	20	$= 25$	$\frac{2}{7}(76.5) = 21.9$	$76.5 - 21.9 = 54.6$
4	20	$= 20$	15.6	39
5	20	$= 15$	11.1	27.9
6	20	$= 10$	8	19.9
7	20	$= 5$	9.9 $FCI - \Sigma d_i - S$	10
	140	140	140	10

Current dipreciation method :-

Modified accelerated cost recovery system [MACRS]

=> starting with DDB ending with msL. => work for 5 years.





as d↑ => tax↓

example :-

consider an equipment that has a FCI = 100000 $

calculat the modefide accelerated cost recovery dep. system.

$$d_k^{DDB} = 2/5\left[FCI - \sum_{i=0}^{k-1} d_i\right] \quad , \quad d_k^{sL} = \frac{FCI - \sum d_{k-1}}{(n-k)}$$

ضربت ب ½ لأن الـ relation معمولة على أساس (1) سنة

year	d_k^{DDB}	d_k^{sL}
1/2	= 2/5 [100k − 0] × 1/2 = 20K	—
1.5	= 2/5 [100 − 20] = 32	= (100 − 20) / 4.5 = 7.78
2.5	= 2/5 [100 − 52] = 19.2	= (100 − 52)/3.5 = 13.71
3.5	= 2/5 [100 − 71.2] = $\boxed{11.52}$	= (100 − 71.2) / 2.5 = $\boxed{11.52}$ تساوت القيم
4.5	= 2/5 [100 − 82.7] = 6.91	= (100 − 82.7) / 1.5 = 11.52 → ومن ذلك فأنتقل عليها
0.5	—	dep for last 0.5 year . . . .

$$= 0.5\left(\frac{100 - 82.7}{1.5}\right) = 5.76$$

No.

Depreciation

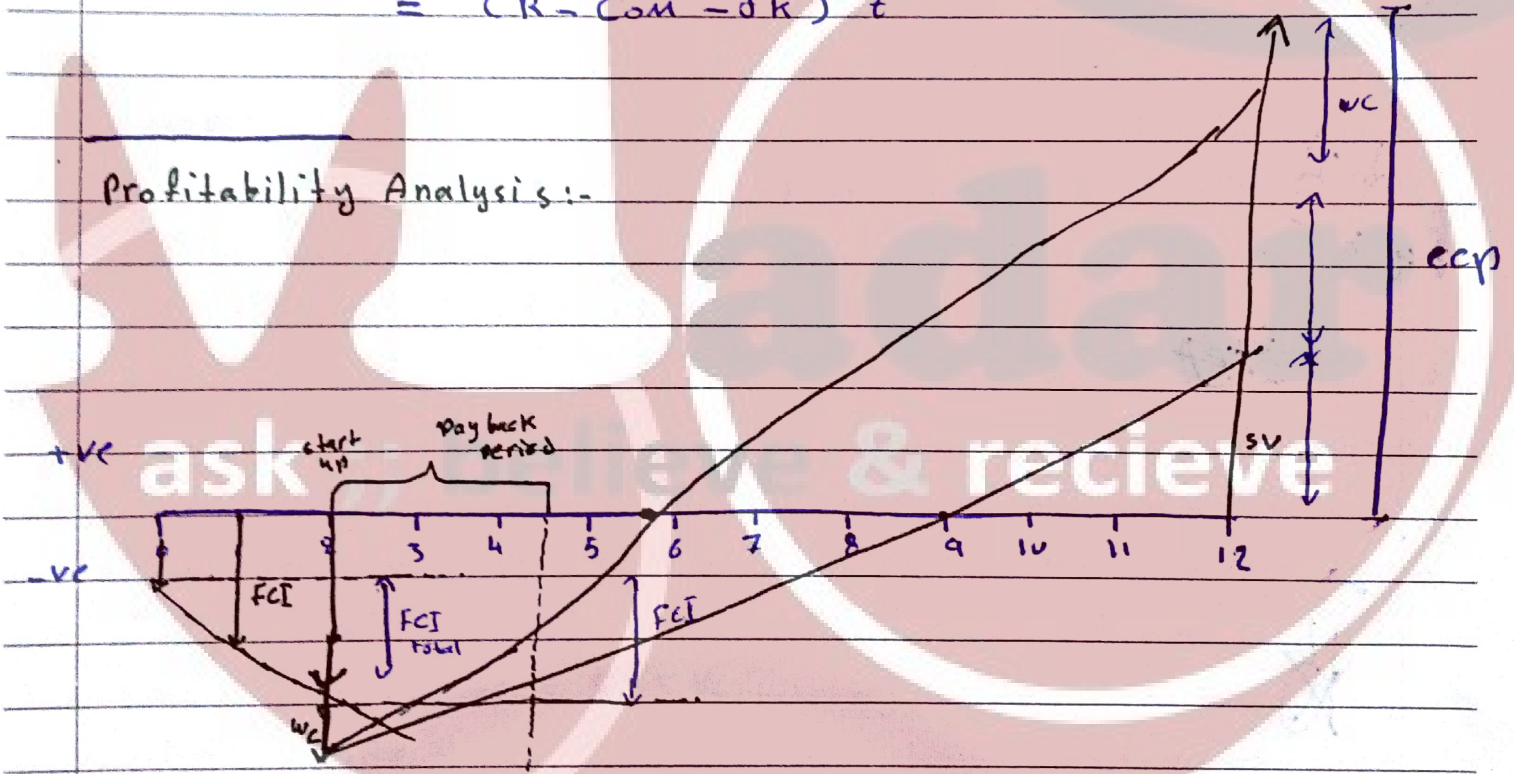
year	dk
0.5	20
1.5	32
2.5	19.5
3.5	11.52
4.5	11.52
0.5	5.76

Taxation, cashflow, profits.

income tax = (Revenue − expenses). tax rate

$= (R - C_{OM} - d_k)\ t$

Profitability Analysis:-



* Criteria : [1] time → Payback period
[2] net positive value [3] rate of return

1- time criteria:-

pay back period: time from start up, to recover the FCI

2- cash criteria:-

cummulative cash position (CCP)

cummulative cash Recovery (CCR), $\frac{\Sigma \text{ of all positive values}}{\Sigma \text{ of all negative cash}}$

$$CCR = 1 + \frac{CCP}{\text{land} + WC + FCI}$$

3- Intrest Rate criteria:-

Rate of return an investment (RoRoI)

$$RoRoI = \frac{\text{Avg annual net profit}}{FCI} \Rightarrow \frac{\text{slope}}{FCI} \cdot \frac{1}{n}$$

n service life [10 years] from start up

Example:-

Anew chemical plant is going to be built with the required capital investment:

1)- cost of land = \$10 M

2)- FCI = \$150 M

FCI_1 = \$90 M

FCI_2 = \$60 M

* plant starts up after 2 years from installation.

WC = 20% of FCI = 0.2 * 150 = \$30 M

yearly sales revenue = \$75 M

CoM = \$30 M

Taxation = 45%

salvage value = \$10 M

Depreciation based on 5 years MACRs

project life = 10 years.

* calculate, PBP, RoR, Net positive cash flow.

No.

End of year	investment	dk	FcI - Σdi	R	COM	net profit
0	-10	—	0	—	—	—
1	-90	—	90	—	—	—
2	-30-60	—	150	—	—	—
3		30	120	75	30	38.25
4		48	72	75	30	46.35
5		28.8	43.2	75	30	37.71
6		17.28	25.92	75	30	32.53
7		17.28	8.64	75	30	32.53
8		8.64	0	75	30	28.64
9				75	30	24.74
10				75	30	
11				75	30	
12				75	30	24.75

Cash flow	net cash flow
-10	-10
-90	-100
-90	-190
38.25	-151.75
46.35	-105.4
	-67.69
	-35.16
	-2.64
	+26
	+50.75
	+75.50
	+100.25
	+170.3