PDE

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Sep 08,14

Economics

Total Capital Investment:-

It is a total investment required to start a project. Consist of two types

→ Fixed Capital Investment → Manufacturing F.C.I / → Non-Manufacturing F.C.I

Actually capital invested for start of plant

→ Working Capital Investment

to fulfill plant worse condition

* Fixed C.I :-

It is the capital needed to supply the neccessary manufacturing and plant facilities and It is the actual money that is invested in the project.

» Manufacturing fixed Capital :-

Money that is directly related to the process (plant) operation (production).

ex → equipments, piping, electricity, raw material cost etc

installation, manufacturing,

» Non-Manufacturing fixed Capital :-

Money that is indirectly related to the process operation

ex → shops utilities, facilities for employees, construction overhead etc

administrative offices

all office indirectly related

accounting offices

* Working C.I :- money, that we keep aside for emergency purpose

Capital neccessary for the handling of emergency purposes.

ex → in case of strike.

** Depriciation :-

0	V_0	3L
1	V_1	2.4L
2	V_2	2.0L

3L → 2.4L : 0.6L Depriciation.

These values are known as Book Value or (V_2) Asset Value n service life — 10

: 50 K → salvage value $V_s \neq 0$ → scrap = 0 = V_s

Book Value

It is the net present value of the equipment at the end of the year. It is represented by V_a. Which means | yearly cont with h
net present value of the equipment at the end of the year 'a'

$$\boxed{d_a = V_{a-1} - V_a}$$

Depriciation amt

Service Life:-

The period during which the use of the property is economically feasible is known as the service life. It is denote by 'n'

Salvage/Scrap Value:-

Salvage is the net amt of money obtainable from the sale of used property over and above any charges involved in the removal and sale. (over & above charge is de installation)

Scrap is the value obtainable from the equipment is neglible then it is dismentaled and sold as junk. The profit then obtained is known as the scrap value.

It is represented as V_s.

Salvage value $V_s \neq 0$
Scrap " $V_s = 0$

Depriciation :-

Equipments, buildings, and other material objects composing (FCI) a ~~ple~~ manufacturing plant require an initial investment, which must be written of as an manufacturing expense. In order to write ~~write~~ ~~right~~

of this cost, ~~dus~~ a decrease in value is assumed to occur through out the usual life of the material. This decrease in value is designated as depriciation.

Reasons of depriciation.
factors

Physical Depriciation

Technological Advances bcz improvement in technolgy value of previous technoloty depriciates

Economic changes value of dollar changes / change in currency

Methods of Calculating Depriciation :—

- Do not consider the Time Value of Money :—
- Consider the time Value of Money.

Don't consider Time Value	Consider Time Value
1.) Straight line Method	1.) Sinking - Fund.
2.) Declining Balance Method	2.) Present - Worth
3.) Double Declining Balance Method	
4.) Sum of the year Digits Method.	

Straight line Method :-

Assumptions

1.) Depriciation amt is same for the subsiquent years.

$$d_1 = d_2 = d_3 = \cdots = d_n$$

2.) After the service life, the value may be salvege or scrap.

$$V_s \neq 0, \quad \& \quad V_s = 0.$$

n = service lyf
d = depriciation amt.

$$\boxed{d = \frac{V_o - V_s}{n}}$$

V_o = Value of equiment at the start of operation.
V_s = Value of equiment after service lyf

$V_1 = V_0 - d$

$V_2 = V_1 - d = V_0 - d - d = V_0 - 2d$

$V_3 = V_0 - 3d$ —

$$\boxed{V_a = V_0 - ad}$$

V_a = book value of equipment after a year.
a = any year.
d = depreciation.

Q.) The original value of an equipment is Rs 10,000. The salvage value is Rs 500, at the end of ~~the~~ its useful lyf period of 5yr. What is the asset value in Rs, after 2 year by st. line method.

V_0 = original value = 10000

V_s = Salvag value = 500

n = service lyf = 5

$$d = \frac{10000 - 500}{5} = 1900$$

$$V_2 = 10000 - 2 \times 1900 = 6200$$

Declining Balance Method :- (Depreciation)

Assumptions :-

1) The depreciation amt for the subsequent yrs is nt same.

$$d_1 \neq d_2 \neq d_3 \neq d_4 \cdots \neq d_n$$

2) The %age fixed factor is same

f = 10%.

V_0	10L	$d_1 = 1L$	10%
V_1	9L	$d_2 = 90000$	10%
V_2	8.1L		

depreciation is nt same — fixed factor is same

3) It is applicable only for salvage value.

$V_s \neq 0$.

$$d_1 = V_0 \times f$$

$$d_2 = V_1 \times f$$

$$\boxed{d_a = V_{a-1} \times f}$$

$$V_1 = V_0 - d_1$$

$$= V_0 - V_0 f = V_0 (1-f)$$

$$V_2 = V_1 - d_2 = V_0(1-f) - V_1 \times f$$

$$= V_0 (1-f)^2$$

$$\boxed{V_a = V_0 (1-f)^a}$$

$$V_s = V_0 (1-f)^n$$

$V_a = V_s$ Comparision
$a = n$

$$\left(\frac{V_s}{V_0}\right)^{1/n} = (1-f)$$

$$\boxed{f = 1 - \left(V_s/V_0\right)^{1/n}}$$

$V_s = 0$
then $f \neq 100\%$.
$\therefore$ this method is not valid for scrap value.
$\because$ equipment can't depreciate by 100%.

Q.) above question by declining balance method. also calculate depreciation amt for second yr.

$$f = 1 - \left(\frac{500}{10000}\right)^{1/5}$$

$$= 0.450719$$

$$V_2 = 10000 (1-f)^2$$

$$= 10000 \times 0.3017088$$

$$= 3017.088$$

$$d_2 = V_1 \times f$$

$$= V_0 (1-f) \times f$$

$$= 2475.713$$

Double Declining Balance Method:-

Same as the declining balance Method but applicable for the case of scrap value.

$$d_a = V_{a-1} \times f$$

$$V_a = V_0(1-f)^a$$

$$\boxed{f = 2/n}$$ service life

Q) same question, $V_s = 0$, Calculate V_2, d_2

** if it is salvage go for declining, if it is scrap go for double decliny

$$f = 2/5 = 0.4$$

$$V_2 = V_0(1-f)^2$$
$$= 10000 \times 0.36$$
$$= 3600$$

$$d_2 = V_0(1-f) \times f$$
$$= 2400.$$

** If $V_s = 0$, then $f \neq 100\%$, we go for double declining.

Sum of the year digit Methods:-

Assumptions:-

⇒ The depriciation amount is not same of the subsiquent years.

$$d_1 \neq d_2 \neq d_3 \neq \dots \neq d_n$$

⇒ % fixed factor is not same.

⇒ Applicable for salvage as well as scrap.

$$\boxed{d_a = \frac{n-a+1}{\Sigma n}\{V_0 - V_s\}}$$

n = service lyf

$\Sigma n = \frac{n(n+1)}{2}$ sum of natural nos.

$V_1 = V_0 - d_1$

$V_2 = V_0 - d_1 - d_2$

$V_3 = V_0 - d_1 - d_2 - d_3$

there is no shortcut we have to find all $d_1, d_2, d_3 \ldots$

Q) Same quest = $V_2 = ?$ & $d_2 = ?$

$$d_2 = \frac{5-2+1}{15}\{10000-500\} \qquad \frac{5(6)}{2}$$

$= \frac{4}{15}\{9500\}$

$= 2533.333$

$$d_1 = \frac{5-1+1}{15}\{9500\}$$

$= 0.333 \times 9500$

$= 3166.66$

$V_2 = V_0 - d_1 - d_2$

$= 4300.00$

Q:) A piece of equipment originally costing Rs 40,000 was put into use 12yrs ago. At the tym the equipment was put into use, the service lyf was 20yrs and the salvage value was assumed to be zero. On this basis a straight line depriciation fund was set up. The equipment can now be sold for Rs 10,000 and a more advanced model can be installed for Rs ~~550~~ 55,000. Assuming the depriciation fund is available for use. How much new capital must be supplied to make the purchase.

$$d = \frac{40000}{20}$$
$$= 2000$$

depriciation amt in saving = 12×2000
$= 24000$

after starting total saving = $24000 + 10000$
$= 34000$.

new capital required = $55000 - 34000$
$= 21000$.

PBT

PBT = Profit before Tax = Income − Expense after the start

TP = Taxable Profit = PBT − Depreciation — before start of plant some part of FC also used to save some tax.

PAT = Profit After Tax = $(1-i)TP$ — i: Tax rate

money which an owner can use for its own personal use.

Expense + Depriciation = TFC

Sep 09, 14

Q.) The investment for an asset cost Rs 10000, an the asset was assumed to have a service lyf of 12yrs with 2000 salvage value. After the asset has been in use for 5yrs the remaining service lyf and final salvage value are reestimated at 10 yrs and 1000 resp. Under this condition what is the depriciation cost during the 6th yr of the total lyf if st. line depriciation is used.

$V_o = 10000$

$n = 12$

$V_s = 2000$

$a = 5$

$n_r = 10$

$V_{s_r} = 1000$

depriciation after 5yrs: $d = \frac{10000 - 2000}{12}$

$= 666.66$

depriciated value of equipment: $V_a = V_0 - a\,d$ | $a=5$

$= 6666.66$

New estimate of depriciated value: $d = \frac{6666.66 - 1000}{10}$

$= 566.66$

Q.) A property has an initial value of Rs 50,000, service lyf of 20yrs. and final salvage value Rs 4000. It has been proposed to depriciated the property by text book declining balance method. Would this method will be acceptable for income tax purposes in comparision to St. line method. If both are compared for initial 3yrs of plant lyf.

$V_0 = 50{,}000$, $n = 20$, $V_s = 4000$

$f = 1 - \left(\frac{V_s}{V_0}\right)^{1/n}$

$= 0.1186$

$V_3 = V_0(1-f)^3$

$= 34{,}232.09.$

$d_3 = V_2 \times f$

$= 4{,}606.8$

St. line

St $= d = 2300$

$(d_1 + d_2 + d_3) = 6900$ ₹

$$(d_1+d_2+d_3)_{DBM} = 15768 \text{ ₹}$$

DBM method is acceptable bcz we for more value we have to pay less tax

Q.) The initial cost of the completly installed reactor is Rs 60000, $V_s = 10,000$. The total annual expenses for the plant is Rs 1,00,000. How many years of useful lyf should be estimated for the reactor if 12% of the total annual expenses for the plant are due to the cost for the reactor depriciation. st. line Method is used for depriciation purposes.

$V_0 = 60000$, $V_s = 10,000$

$E_A = 1,00,000$

$n = ?$

$f\% = 12\%$

$d = 12000$

$$12000 = \frac{60000 - 10000}{n}$$

$$n = 4.16 \text{ yr}$$

Q.) A person has a total income of 1 million/yr. and all expenses except depriciation amt are 6 lakh/yr. At the start of the first yr of operation. A composite account of all the depriciable items shows a value of 8,50,000. and the over all service lyf is estimated to be 20 yrs. The total V_s at the end of service lyf is estimated to be 50,000. 30% of all the profit before taxes must be paid out as income taxes. What would be the reduction in the income tax charges for the first yrs of the Operation. If sum of year digit method were used for depriciation accounting instead of St. line method. Ans = 10,857.08

$TI = 1$ million. $= 100,00,000$

Expense $= 6,00,000$

V_0 / Composite Depriciation $= 8,50,000$

$n = 20$

$V_S = 50,000$

$PBT = I - E$

$= 4,00,000$

Taxes is never applied over PBT, it's applied over TP

$$\boxed{\text{IT paid} = \frac{30}{100} \times \cancel{4,00,000} = \cancel{1,20,000}.}$$

$$\cancel{d_1 = \frac{20-1+1}{1}} \{\cancel{1,00,00,000} - 50,000\}$$

$=$

$$d_{SLM} = \frac{8,50,000 - 50,000}{20}$$

$= 40,000$.

$$d_{SDM} = \frac{\overset{20}{\cancel{20}} - 1 + 1}{\frac{20 \cdot 21}{2}} \{8,50,000 - 50,000\}$$

$= \cancel{1,60,000}$ 76190.476

$\cancel{30}\ (TP)_{SDM} = 4L - (d)_{SDM}$

$= 3,23,809.52$

$30\% (TP)_{SDM} = 97,142.857$

$(TP)_{SLM} = 4L - (d)_{SLM} = 3,60,000$

$30\%\ (TP)_{SLM} = 108,000$.

Q.) A plant has a service lyf of 7, $V_s = 30\%$ of initial value. for what min^m fixed %age factor will be the depriciation amt for the 2^nd yr. calculated by DMBM, be equal to that calculated by the st. line method.

0.113

$$V_0 =$$

$$V_s = 30\% \text{ of } V_0$$

$$n = 7$$

$$d_2 = \frac{V_0 - 0.30V_0}{7}$$

$$V_2 = V_0 - 2\left(\frac{V_0 - 0.30V_0}{7}\right)$$

$$f = 1 - \left(\frac{0.30\,V_0}{V_0}\right)^{1/n}$$

$$= 1 - 0.8419 = 0.1580.$$

$$V_2 =$$

$$(d_2)_{DBM} = (d_2)_{SLM}$$

$$V_1 \times f = \frac{V_0 - V_s}{n}$$

$$V_0(1-f)f = \frac{V_0 - 0.3V_0}{7}$$

$$f - f^2 = \left(\frac{\cancel{0.7V_0}^{0.1}}{\cancel{7}}\right)\frac{1}{\cancel{V_0}}$$

$$f - f^2 = 0.1$$

$$f^2 - f + 0.1 = 0$$

$$f = \frac{-(-1) \pm \sqrt{(-1)^2 - 4\times 0.1\times 1}}{2\cdot 1}$$

$$= \frac{1 \pm \sqrt{1-0.4}}{2\cdot 1}$$

$$= \frac{1 \pm 0.7745}{2}$$

$$= 0.112,\ 0.88725$$

minm value $f = 0.112$

Interest :-

Interest :-

It is the money returned to the owner of the capital for the use of their capital. It is of two types.

1> **Simple Intrest :-**

It requires compensation payment at a constant intrest rate based on the original principle.

$$Z = Pin$$

$$\boxed{S = P + Z = P + Pin = P(1+in)}$$

2> Compound

If payment is not made at the specified tym interval then Intrest on intrest will be there.

0	P	Pi
1	P(1+i)	P(1+i)i
⋮		
n−1		

$$S = P + Pi = P(1+i)$$

$$S = P(1+i) + P(1+i)i$$

$$= P(1+i)^2$$

$$\boxed{S = P(1+i)^n}$$

When the compounding is annual, then

$$\boxed{S = P(1+i)^n}$$. $i =$ effective interest rate compounded annually

if compounding is not annual,

$$\boxed{S = P\left(1+\frac{r}{m}\right)^{mn}}$$

$r =$ nomial interest rate based on annual basis.
$m =$ no. of intervals/year.

iss word se pehle r aur baad me m. ki value hoti

Q.) 6% compounded semi-annually.
$r \leftarrow$ $\rightarrow m$.

1.5% per quarter

$r = 1.5 \times 4 = 6\%$

Q.) 3% per quarter compounded quartery

$r = 3 \times 4 = 12\%$ $m = 4$

Effective interest rate :-

It is defined as the actual annual return on the principal, u get after the 1 yr is more than the nomial interest rate bcz of the compounding effect at the end of a quarter, month, semi-annual period. This increased ~~on~~ rate is known as effective interest rate.

$$\boxed{i_{eff} = \left(1+\frac{r}{m}\right)^{m} - 1}$$

Q.) It is desired to borrow 1000 to met a financial obligation. The money can be borrowed from a loan agency at a monthly intrest rate of 2%. Determine a total amount after 2 yrs when compounded monthly. Also calculate the effective intrest rate.

$P = 1000$ ₹

$m = 12$

$n = 2$

$r = \cancel{0.02}\ 0.02 \times 12 = 0.24\%.$

$$S = 1000\left(1 + \frac{0.24}{12}\right)^{12\times 2}$$

$= \cancel{40,431.78}\ 1608.437$

$$i_{eff} = \left(1 + \frac{r}{m}\right)^{m} - 1$$

$= \cancel{8.358}\ 0.2682$

Continous Compounding :-

When tym period of compounding becomes extremely small or no. of intervals/year becomes extremly large. Then the intrest is calculated by the help of continous compounding.

$$\boxed{S = Pe^{rn}}$$ → exponential

$m \to \infty$
$t \to 0$

$$\boxed{i_{eff} = e^{r} - 1}$$

per (min/hr) compounding

Q.) Same questn.

$$S = P.e^{rn} = 1000(.12)^{0.2\times 2}$$

$=$

Annuity

P ⇒ Present Value

S ⇒ Future Value

Annuity :-

An annuity is a series of equal payment occuring at equal tym intervals,

Equal Payment Equal Intervals

Har 6 mth k baad 10,000, & 10,000. Ye mtlb hota h isse

as home loan

The payment of this type can be used to pay off a debt, accumulate a desired amt of capital, Recieve a lumpsump of capital as in insurance plane and in the insurance plan.

Let capital R represent uniform periodic payment made during n discrete period. such that the first payment being made at the end of the first year.

Future Value of annuity

future value of annuity

$$S = R(1+i)^{n-1} + R(1+i)^{n-2} + \dots + R(1+i) + R \quad \text{—(1)}$$

$$S(1+i) = R(1+i)^{n} + R(1+i)^{n-1} + \dots + R(1+i) \quad \text{—(2)}$$

$$S(1+i) - S = R(1+i)^{n} - R \quad (2)-(1)$$

$$\boxed{S = \frac{R}{i}\left[(1+i)^{n} - 1\right]}$$

to accumulate some money

desire to have some money.

$$S = P(1+i)^{n}$$

Present value of Annuity

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

desire to borrow some money → P

need to pay some money → R

Q.) It is desired to have 9000 ₹ available 12 yrs from now. If 5000 is available for investment. Then calculate the annual rate of compound intrest.

$S = 9000$
$n = 12$ $\qquad i = ?$
$R = 5000$

5000/= R/

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

$$9000 = 5000\,(1+i)^{12}$$

$$1.8 = (1+i)^{12}$$

$$i.\ 0.05020$$
$$= 5.02\%$$

Q> What will be the amt aft 10yrs, if 2000 ₹ is deposited wid a nominal intrest rate of 6%. compounded semi-annually.

$n = 10$
$S = ?$
$P = 2000$
$r = 6\%$ $\qquad m = 2$

$$S = P\left(1+\frac{r}{m}\right)^{mn}$$

$$= 3612.22\ ₹$$

Q.> A loan of Rs 2000 was made at 6% S.I per year for 4yrs. at the end of this tym, no intrest had been paid and the loan was extended for 6 more year at a new effective compound intrest rate of 8% /yea. What is the total amt at the end of 10yrs.

$S = Piz$, $\quad \cancel{S} = 2000 \times 0.06 \times 4$
$= 480$ $\qquad S\cancel{=}\ 2480. = P_{New}$

$$S = P_{New}(1+i)^n$$

Here we consider 4+6 = 10, $\quad = 2480(1+0.08)^{\cancel{6}\,10} = \cancel{3935.44}.\ 5354.138$

Q.) A person borrows Rs 50,000 at an effective intrest rate of 10%. He wish to pay of the debt 5yrs by taking equal ~~Interval~~ payment in each year. How much the each payment have to be?

$P = 50{,}000$

$R = ?$

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

$$50{,}000 = \frac{R}{0.1}\left(\frac{(1+0.1)^n - 1}{(1+0.1)^n}\right)$$

$R = 13189.87$ ₹

Q.) An annuity due is being used to accumulate money with a effective compound intrest rate of 8%, and Rs 1000 is deposited at the begning of each year. What will be the total amt of annuity due after 5 yrs.

$R = 1000$

$i = 0.08$

$n = 5$

This formula is used for Annuity due is used or payment is done at starting.

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

Annuity = deposited end of yr.

Annuity dew = deposited begning of yr.

$$= \cancel{5,866.60}$$

$$S = 6335.929 ₹$$

Present worth method :-

$$V_0 \leftarrow P = \frac{R}{i}\frac{(1+i)^n - 1}{(1+i)^n}$$

Dep. amt.

Present value is considered

Depreciation and Same

Sinking fund Method

hypothetical method not at all used any where.

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

$$\downarrow$$

$$V_0 - V_s$$

Future value
in sence money req. to purchase

accumulate the money.

$$V_0 - V_a = \frac{R}{i}\left[(1+i)^a - 1\right]$$

$$V_0 - V_a = \frac{(V_0 - V_s)i}{i}\frac{\left[(1+i)^a - 1\right]}{\left[(1+i)^n - 1\right]}$$

$$\boxed{V_a = V_0 - (V_0 - V_s)\left[\frac{(1+i)^a - 1}{(1+i)^n - 1}\right]}$$

book value of equipment

Q.) A piece of equipment has an initial installed value of Rs 12000. It is estimated that its useful lyf period will be 10yrs and Vs at the end of the useful lyf will be 2000. Depreciation will be charged by making equal charges each yr. Fst payment being made at the end of the fst yr. The depriciation fund will be accumulated at an annual interest rate of 6%. At the end of the useful lyf, enough money must have been accumulated to account for the decrease in the equipment value. Determine the yearly cost due to depriciation?

$V_0 = 12000$, $n = 10$, $V_s = 2000$, $i = 0.06$

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

$$12000 - 2000 = \frac{R}{0.06}\left[(1+0.06)^{10} - 1\right]$$

$$= 759.$$

for 10 yrs = 759 × 10 = 7590.

★ Those methods are better which don't consider time value of money.

Profitability

Methods of Profitability

Rate of return of Investment Method.

Net present Value Method

Discounted cash flow / Internal rate of return Method

Capitalized cost pay method.

Payout period method.

Rate of return of investment

It is defined as the ratio of profit to investment.

Use to check pt

$$\frac{PBT}{FCI}, \quad \frac{PAT}{FCI}, \quad \frac{PBT}{TCI}, \quad \frac{PAT}{TCI}$$

Q.) A plant requires an initial fixed capital of 9 L and 1 L of working capital. It is estimated that the annual income will be 8L, and the annual expenses including depreciation will be 5.L 20T, before IT. IT amts to 34% of all pre tax profits. Calculate the annual % return on total initial investment Before income tax.

$$\frac{PBT}{TCI} = \frac{8L - 5.20L}{9L+1L}$$

$$=$$

Calculate the annual % return of F.C.I after income tax.

20.53% Ans.

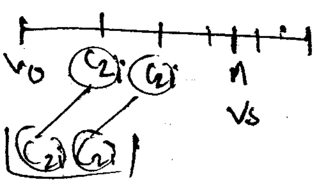
$$PAT = (1-\underset{34\%}{i}) \times 2.8L$$

$$=$$

$$\frac{PAT}{F.C.I} = \frac{\quad}{9L}$$

ROR are pt values, and they are the pt values. ROR don't consider the ∴ they are not that accurate.

Capitalized cost Method "low the best



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

$$V_0 - V_s = \frac{C_2\, i}{i}\left((1+i)^n - 1\right]$$

$$C_2 = \frac{V_0 - V_s}{(1+i)^n - 1}$$

$$\boxed{C.C = V_0 + C_2}$$

Prepetuity

Capitalised cost related to the investment represents the amt of money that must be avialable initially to purchase the equipment and simultaneous provide sufficient fund or intrest accumulation to permit por-patual replacment of the equipment.

Prepetuity - pay

Q:> There are 3 tender m_1, m_2, m_3. for m_1 service lyf is 10yr, Initial value is 15 Lakh, for 6 yrs - and ~~M~~ inital value 15 Yr, 6Yr, M_3 → 18 Yr, 18 L.
Which is the best acc. to CC method if rate of intrest is 10%.

	initial Value	Yr.
M_1	10	4
M_2	15	6
M_3	18	8

Q:> Two pumps are under consideration for insulation.
1st one initial value 40000, $V_s = 3900$, 2nd initial valu 50000, $V_s = 20,000$. Using the CC method find the common lyf of the pumps. If both the pumps are equally economical.
I=10%

$$C_2 = \frac{V_0 - V_S}{(1+i)^n - 1}$$

$=$

$$\frac{41000 - 3900}{(1+0.10)^n - 1} = \frac{50000 - 20000}{(1+0.10)^n - 1}$$

$$40000 + \frac{36100}{1.1^n - 1} = \frac{30,000}{1.1^n - 1} + 50000$$

$$\frac{36100}{\cancel{1.1^n - 1}} = \frac{30000 + 10000(1.1^n - 1)}{\cancel{1.1^n - 1}}$$

$$36100 - 30000 = (11000)^n - 10000$$

5>

Q>A H.E with a negligible Scrap value cost Rs 4050, and will have a useful lyf of 6yr. Another proposed H.E of equivalent design capacity cost Rs 6800. But will have a useful lyf of 10yrs and a salvage value of 800. Assuming a left of 8% year. Determine which H.E is cheeper.

1st one.

$$= \frac{4000}{(1+0.08)^6}$$

Q.7 A new storage tank can be purchased and ~~sold~~ installed for Rs 10,000. This tank would last for 10yrs. Another storage tank of capacity equivalent to the new tank is available and it has been proposed to repair the old tank instead of buying new 1. If the tank were repaired it would have useful lyf of 3yrs before the same type of repairs would be needed again. neither tank have any scrap value. Money is worth 9%. compounded annually - On the basis of equal capitalized cost for the two tank. how much can be spend for repairing the existing tank.

New

$V_0 = 10,000$

$n = 10yr$

$V_s = 0$

Old

$n = 3yrs.$

$V_s = 0$

34614

$i = 0.09$

$$10000 + \frac{10000}{(1+0.09)^{10}-1} = V_0 + \frac{V_0}{(1+0.09)^{3}-1}$$

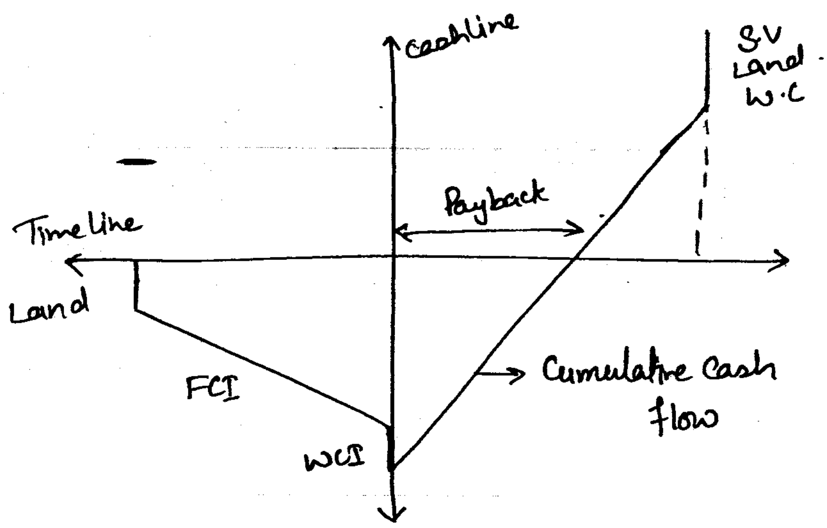
$17313.3433 =$

Payout Period / Payback tym

The total money available after the end of any year is called cash flow

PAT + Depriciation.

T



FC recover FC

The minimum length of tym theoretically neccessary to recover the original depriciable capital investment in the form of cash flow to the project, is known as the pay back tym.

$$t = \frac{FCI}{CF} \text{ — Profit}$$

Net Present Value Method :-

Best method, accurate, tell abt whole plant.

The initial F.C = 1L , W.C = 10,000, N = 5 yr , Vs = 10,000

given Year	Predicted Cash flow	Discounting Factor $i = 0.15$ — given
0	1,10,000	
0 – 1	30,000	26100
1 – 2	31,000	23,420
2 – 3	36,000	23 700
3 – 4	40,000	22900
4 – 5	43000 + SV + WC (10000, 1000)	21400 (9000 + 5000)
5		

Present value

↳ money get = 127500

Invest = 110000 = FC + WC

NPV = 17500 > 0

Internal rate of return.

The rate at which NPV is ~~zero~~, is known as the internal rate of return.

i = 20.7%.
maxm interest rate which shud be borrowed to start a plant.

Q) F.C.I for a chemical plant is Rs 40 Million wid an estimated useful lyf of 6 yrs and a salvage value of 4 million. The rate of interest is 15%. Tax rate is 25%. in the first yr of operation the income from sales is Rs 20 million. and the manufacturing expences are 5 million. The plants depriciate on a st. line basis.
i) calculate the ROR on investment.

$$ROR = \frac{PBT}{FCI} = \frac{I - E}{FC} = \frac{20-5}{40}$$

if it is not mentioned in the question we take PBT

$$= \frac{15}{40} = 0.375$$

Q) for the same data the net present value in million at the start and at the end of the first yr of operation R.

NPV = Total Discounted Cash flow (we earned) — total initial investment (we invent)

$$NPV_{start} = 0 - 40 = -40 \text{ Million}$$

$$NPV_{1^{st} yr} =$$

At the end of the first yr,

$$PBT = 20-5 \qquad (I-E)$$
$$= 15 \text{ Million}$$

$$TP = 15-6 = 9M. \qquad (PBT - \text{depriciat})$$

$$PAT = 0.75 \times 9M = 6.75M. \quad ((1-i)TP)$$

$$\text{Cash flow} = 6.75+6 = 12.75M \qquad (PAT + \text{Depri})$$

$$\boxed{NPV_{1st\,yr} = 12.75 - 40 = -27.25M}$$

$$\left(P = \frac{S}{(1+i)^1}\right)$$

$$\text{Present value of Cash flow} = \frac{12.75}{(1+0.15)^1} = 11.08M$$

$$NPV_1 = 11.08 - 40 = -28.92$$

Q) if cash flow remains same at each year calculate the payback tym.

$$t = \frac{FCI}{CF}$$
$$= \frac{40}{12.75} = 3.137$$

Q) for same data, if we consider tym value of money, $t = ?$

if we consider tym

t >.

$$\frac{12.75}{(1+i)} + \frac{12.75}{(1+i)^2} + \frac{12.75}{(1+i)^3} + \cdots = 40$$

$$P = \frac{R}{i}\left[\frac{(1+i)^n - 1}{(1+i)^n}\right] = 40$$

$$= \frac{12.75}{0.15}\left(\frac{1.15^n - 1}{1.15^n}\right) = 40$$

$$= 85\left(1 - \frac{1}{1.15^n}\right) = 40$$

$$1 - \frac{1}{1.15^n} = 0.4705$$ 4.55

$$1.15^n = 1.888$$

$$n = 4.55$$

Q.) A process has a fixed capital of Rs 150 Lakh, WC of Rs 30L and salvage value 0. Annual revenue from the sales are Rs 250L manufacturing cost are Rs 145 L and the other expences are 10% of revenue. Assume the project lyf spain of 11yr, ~~text~~ tax life of 5yrs. and Intrest rate to be 10%. Tax rate is 40% & St. Line depriciation i.e 20%/year is applicable. Calculate the discounted value of the profit before tax, for the total plant lyf period.

$F.C. = 150L$, $WC = 30L$, $V_s = 0$

$n = 11yrs$

$MC = (145 + 25)$
170

$DV = 250$, 10%
$= 80$

$$PBT = I - E$$
$$= 250 - 145 - 25$$
$$= 80 \text{ Lakh.}$$

$$P = \frac{80}{0.1}\,\frac{(1+0.1)^{11} - 1}{(1+0.1)^{11}} = 519.60 \simeq 520L.$$

ii.) The discounted value of depriciation benefit over the tax lyf is.
Present value
saving tax, if u apply depriciation method.

	PBT = 80L	when depreciation applied, TP = 50L
40%	PAL = 48L	PAT = 30L
	Tax Paid = 32L	Tax paid = 20L

$\boxed{\text{Tax Saved} = 12L}$

Present value. $P = \frac{12}{0.1}\left[\frac{(1+0.1)^5 - 1}{(1+0.1)^5}\right]$ 45.48

n=5 $= 45.48$

F.C.I or initial investment.

Q.) A company has a depreciable investment of ₹ 36,400 which is depreciated in equal installment in 2 yr. Assume that the tax rate is 50%. and the interest rate is 10%. The net present value of the tax that the company would have saved if it had depreciated 2/3rd of investment in the first yr and rest in the second yr is ?

$d_1 = \frac{2}{3} \times 36400$

$=$

36400

18200	24270	= Profit 6070 →	tax paid 50%. 3035 → Money saved.
18200	12130	= loss 3035	

amt of tax saved $P = \frac{3035}{1+i} - \left\{\frac{3035}{(1+i)^2}\right\}$

$= 250.826$

Str before Plant, after str

Payback

Break even pt.

(Rakshi)

Break even-point :—

Break even point is defined as the point where the total pdt cost equals total annual sale, Here total pdt cost means total annualised cost

$PBT = I - E$

$TP = PBT - Dep$

$= I - E - Dep$

$0 = TP = I - (TAC)$

$\boxed{I = TAC}$ (Break even pt)

Total sale ← $x \cdot n$ = $y \cdot n$ + Fixed Cost → Total cost.

x → selling Price; y → cost price; Fixed Cost → Depreciation

Q) The annual direct pdtion cost for a plant operating at 70% capacity are 2.80L. while the sum of annual fix charges and other expenses is 2L. What is the breakeven pt in units of pdt^n per yr. If total annual sales are 5.60L and pdt sales at Rs 40/unit.

$$n = \frac{360000}{40} \quad \frac{\text{Total sale}}{\text{Sell price}}$$

$$= 14000$$

$$C.P. = \frac{280000}{14000} = 20₹$$

$$\boxed{40n = 20n + 2L}$$

$$20n = 2L$$

$$n = 10,000$$

Q) for same data, what were the annual Gross earning and the net profit of this plant at 100% capacity when the tax is required 15% of 1st 50000, 25% on 50000-70000 and 34% on above 75k. and 5% ~~on~~ on the gross earning from 1L to 3.35L. Calculate?

When Capacity	units.
70%	14000
100%	$\frac{14000}{0.7}$

Gross Annual earning = $GAE = 40\left(\frac{14000}{0.7}\right) - \left[20\left(\frac{14000}{0.7}\right) + 2L\right]$

$= \cancel{592000}$ 2L

15% on 50000 = 7500

25% on 25000 = 6250

34% on 125000 = 42500

5% of 1L = 50,000

GAE = 2L.
but this tax is paid
over more than 1L
so 1L.

Tax paid = 15% of (50000) + 25% of (25000) + 34% of (1.25L)
+ 5% of (1L)

= 61250.

Net Profit = 2L − 61250.

<u>Alternative Investment</u>:-

Design	1	2	3	4
Total initial installed cost	10,000	16,000	20,000	26,000
Operating cost per year	100	100	100	100
Fixed charges (% of initial cost per year)	20	20	20	20
Value of heat saved	4100	6000	6900	8850

Owner demand minm of 10% turnover.

$$ROR_1 = \frac{4100 - (100 + 2000)}{10000}$$

$$= 0.2 = 20\%$$

(20% of 16000)

$$ROR_2 = \frac{6000 - (100 + \overset{3200}{\cancel{2000}})}{16000} = 0.2437 = \cancel{24.37\%}\ 16.81\%$$

$$ROR_3 = \frac{6900 - (100 + \cancel{1000}\ 4000)}{20000} = 0.14$$

$$= 14\%.$$

$$ROR_4 = \frac{8850 - (100 + 5200)}{26000} = 0.1365$$

$$= 13.65\%.$$

__1 & 2__

$$\frac{2700 - 2000}{16000 - 10000} = \frac{700}{6000} = 11.66\ \%$$

2 is good.

__2 & 3__

$$\frac{2800 - 2700}{20000 - 16000} = \frac{100}{400} = 2.5\%.$$

2 is good,

__2 & 4__

$$\frac{3550 - 2700}{26000 - 16000} = \frac{850}{1000} = 8.5\%.$$

2 is good.

Sep 15, 14

Optimisation

1.> Find the optimisation Variable? (x)

2.> Identify the optimisation function? (f) cost / profit

$$f = g(x)$$

3.> $\dfrac{df}{dx} = 0$

Q.> Obtain the optimal diameter of a cylindrical storage vessel of volume V. The curved shell cost Rs C_s ₹/m² and the flat top-end bottom plate Rs C_p ₹/m²

Sol^n

optimisation variable = d

optimisation function $f = \cancel{2\pi r^2 h} = $

$$A = 2\pi r^2 + 2\pi r h$$

$$\text{Total cost} = 2\pi r^2 C_p + 2\pi r h\, C_s$$

$$V = \pi r^2 h$$

$$h = \frac{V}{\pi r^2}$$

$$TC = 2\pi r^2 C_p + \cancel{2\pi r}\frac{V}{\cancel{\pi r^2}} C_s$$

$$= 2\pi \frac{d^2}{4} C_p + \frac{2V}{r} C_s$$

$$\frac{dTC}{dd} = \frac{2\pi C_p \cdot 2d}{4} + \cancel{4}(-1)\frac{V C_s}{d^2}$$

$$\frac{dTC}{d'd'} = \frac{\pi}{\cancel{2}}\cancel{C_p}\ \pi C_p d + -\frac{4VC_s}{d}$$

$$\pi C_p d = \frac{4VC_s}{d}$$

$$d = \left(\frac{4VC_s}{\pi C_p}\right)^{1/3}$$

2.) A plant manufacture compressor at the rate of n units per day The daily fixed charges are 20,000 ₹/daily and the variable cost per Compressor is $500 + 0.2N^{1.3}$ ₹/compress. Sailing Price per compressor is Rs 1000, ₹/Compressor. The no. of compressor to be manufactured in order to maximise the daily profit is. ?

$$F.C = 20000 \text{ ₹/daily}$$

$$V.C = 500 + 0.2N^{1.3} \text{ ₹/compressor}$$

$$S.P = 1000 \text{ ₹/compressor}$$

No of units manufactured per day = N units/day.

$$\text{Profit} = Pe - E$$

$$= \left\{ 1000 \frac{₹}{\text{compressor}} \times N \frac{\text{compressor}}{\text{day}} \right\} - 20{,}000 - (500 + 0.2N^{1.3}) N$$

$$P = N \times 1000 - 20000 - 500N - 0.2N^{2.3}$$

$$= 500N - 20{,}000 - 0.2N^{2.3}$$

$$\frac{dP}{dN} = 500 - 0.2 \times 2.3 N^{1.3}$$

$$= 500 - 0.46 N^{1.3}$$

$$500 = 0.46 N^{1.3}$$

$$N^{1.3} = 1086.956$$

2.) A plant produces phenol The V.C is Rs/tonn of phenol is related to the plant capacity. P (tonn/day) as 45000 + 5P. The fixed charges are 1L/day. The SP of phenol is Rs 50,000/tonn. Find the optimal plant capacity for minimum cost per tonn/phenol.

$$VC = (45000 + 5P) \text{ ₹/ton}$$

$$P = \text{ ton/day}$$

$$SP = 50000 \text{ ₹/tonn}$$

$$FC = 10^5 \text{ ₹/day}$$

$$\text{Cost function} = V.C + FC =$$

$$= (45000 + 5P) + 10^5 \text{ ₹/day} \times \frac{1}{P} \frac{\text{day}}{\text{ton}}$$

$$= 45000 + 5P + \frac{10^5}{P}$$

$$\frac{d(C.F.)}{dP} = 5 + \frac{10^5(-1)}{P^2}$$

$$= 5 - \frac{10^5}{P^2}$$

$$-\frac{2 \cdot 10^5}{P^3}$$

$$5 = \frac{10^5}{P^2}$$

$$P^2 = 20{,}000$$

$$P = \pm 141.42 \text{ tonn/day.}$$

Find max^m daily profit.
500

$$\text{Profit} = 50000 \text{ ₹/tonn} \cdot P \text{ (ton/day)} - 10^5 - (45000 + 5P)P$$

$$= 50000P - 45000P - 5P^2 - 10^5$$

Q) Find the break even capacity.

$$50000 P = \left(45000 + 5P + \frac{10^5}{P}\right)P + \cancel{10^5}$$

~~46414.215~~

$$\boxed{P = 20}$$

Q) Due to a 20% drop in the pdt of selling price, the pay back period of a new plant increased to 1.5 times that ~~initiated~~ estimated initially. If production cost & Production rate remains unchanged, if production CP the new SP is C_s. Then find the ratio of C_p by C_s

when depre.

$$t = \frac{FCT}{CF} \;\Big/\; \frac{I}{Profit}$$

20%

$CF = I - E$

$$t_1 = \frac{I}{SP - CP}$$

$$t_1 = \frac{I}{x - CP} \quad \text{---(1)}$$

$$t_2 = \frac{I}{C_s - C_p} \quad \text{---(2)}$$

$$t_2 = 1.5 t_1$$

1/2

$$\frac{t_1}{1.5 t_1} = \frac{I / x - CP}{I / C_s - C_p}$$

$$x - 0.2x = C_s$$

$$0.8x = C_s$$

$$x = C_s / 0.8$$

$$0.666 = \frac{C_s - C_p}{\frac{C_s}{0.8} - C_p} = \frac{(C_s - C_p)\,0.8}{C_s - 0.8 C_p}$$

$$0.8333 (C_s - 0.8 C_p) = C_s - C_p$$

$$2 C_p = \cancel{0.1666}\, C_s$$

$$C_p / C_s = 0.5$$

Q) A batch reactor produces 10^5 kg of a pdt per year. The total batch tym in hrs of the reactors is $k\sqrt{P_B}$ where P_B is pdt/batch (kg) & k is 1.0 hr/$\sqrt{kg}$. The operating cost of the reactor is Rs 200/hr. The total annual fix charges are Rs 340 P_B and annual raw material cost is Rs 2 million. The optimum size in kg of each batch is.

$t = k\sqrt{P_B}$ $\quad \frac{Pdt}{batch\ (kg)}$.

Op. Cs = 200 ₹/hr

$= P_B$.

T.P = 10^5 kg/yr

$t = 0.1 \frac{hr}{\sqrt{kg}} \cdot P$

Solⁿ

Total prodⁿ = 10^5 kg/yr

$t_B = k\sqrt{P_B}$ hr

$P_B = \frac{kg\ of\ Pdt}{Batch}$

Op Cost = 200 ₹/hr

Fixed charges = 340 P_B ₹/yr

Raw Material Cost = 2×10^6 ₹/yr.

$$T.C = 340\,P_B \tfrac{₹}{yr} + 2\times10^6 \tfrac{₹}{yr} + 200\ ₹/hr \times 1.0\sqrt{P_B} \times \frac{10^5\ kg/yr}{P_B\ kg/batch}$$

$$= 340\,P_B + 2\times10^6 + 2\times10^7 \frac{1}{\sqrt{P_B}}$$

$$= 340 + 2\times10^7 \left(-\tfrac{1}{2}\right)\frac{1}{(P_B)^{3/2}}$$

$$340 = \frac{10^7}{(P_B)^{3/2}}$$

$$(P_B)^{3/2} =$$

$$P_B = 952.82\ \frac{kg\ of\ Pdt}{Batch}$$

$$\frac{d(C.F)}{dP_B} = 340\,P_B + 2\times10^6 + 200\ ₹/hr\ 0.1\sqrt{P_B}$$

$$= 340 + 20\left(-\frac{1}{2\sqrt{P_B}}\right) \times 10^5$$

$$340 = \frac{100}{\sqrt{P_B}}$$

$$\sqrt{P_B} = \frac{100}{340}$$

$$P_B = 8.65\times10^{-4}$$

184390.88

Cost Index :— cost Area-cost

It is an index value which relates the cost of equipment at a certain tym, w.r.t the cost of equipment at certain basic tym

Marshall & Swift

$$\frac{(\text{Cost of the Equipment})_{Y_1}}{(\text{Cost of the Equipment})_{Y_2}} = \frac{\text{Cost Index of Year } Y_1}{\text{'' '' '' '' } Y_2}$$

Q) The cost of a distillation tower in the year 2000 is Rs x find the Cost of the distillation column in year 2004 if the cost index for the yea 2000 & 2004 are 480 & 520 resp.

$$\frac{x}{y} = \frac{480}{520}$$

$$x = 0.92\,y$$

$$y = 1.08\,x$$

Cost Capacity Rule / Six-tenth Rule :—

year = const. capacity

$$\frac{(\text{Cost of the Equipment})_{Y_1}}{(\text{'' '' '' ''})_{Y_2}} = \left(\frac{\text{Capacity } C_1}{\text{Capacity } C_2}\right)^{6/10}$$

Q) The cost of a drum drier is 2 millio ₹, what is the Cost of the drum drier with double the surface area.

$$\frac{2}{x} = \left(\frac{1}{2}\right)^{6/10}$$

$$x = 3 \text{ million ₹}$$

Q.) Purchase of H.E of 20 m^2 area was 5,00,000 ₹ in 2006. What will be the estimated cost of a similar H.E of 50 m^2 area in yr 2013. The cost index 2006 & 2013 are 430.2 & 512.6

$$\frac{5,00,000}{x} = \frac{430.2}{512.6} = \frac{20}{50}$$

$x = 2L$

5L — 2006 — 20 m^2

Cost — 2013 — 20 m^2

5,95,769.40 — 2013 — 20 m^2

Cost — 2013 — 50 m^2

10,45,00000

Lang Multiplication Factor :-

Type of Plant	Factor for fixed ~~solid~~ Capital Investment	Factor for T.C.I
Solid Processing Plant	3.9	4.6
Solid-Fluid Processing Plant	4.1	4.9
Fluid-Processing Plant	4.8	5.7

Q.> For a solid processing plant, the delivered equipment cost is 10L ₹. using Lang multiplication factor approximate the fixed capatial & total Capital

FCI
or = Factor × Delivered Equipment Cost.
TCI

$$F.C.I = 3.9 \times 10L$$

$$= 39L$$

$$T.C.I = 4.6 \times 10L$$

$$= 46L.$$

Q.> The heat integration is planed is a process plant at an investment of Rs 2 million. This would result in net energy saving of 20 GJ/year. If the nominal rate of intrest is 15% and the plant lyf is 3yr. Then the break event cost of energy in Rs/GJ is?

$$R = \frac{P i (1+i)^n}{(1+i)^n - 1} = x \frac{₹}{GJ} \times \frac{20\,GJ}{yr}.$$

Design of cylindrical & Spherical Vessels:—

Cylindrical & spherical vessels may be the thin wall or thick wall vessels, ~~depending~~ upon the opr. temp & press. range.

The thin wall vessels are those vessels in ~~which~~ which thickness to diameter ratio is less than 0.1

Let a cylindrical vessel of length L, diameter d & thickness t is subjected to an internal pressure P. This will ~~cal~~ cause ~~Two type~~ Longitudinal stress (σ_L) and tangential stress (σ_θ)

$$\sigma_L = \frac{PD}{4t} \quad , \quad \sigma_\theta = \frac{PD}{2t}$$

$$\boxed{\sigma_\theta = 2\sigma_L}$$

For spherical vessel,

$$\sigma_L = \frac{PD}{4t} \quad , \quad \sigma_\theta = \frac{PD}{4t}$$

$$\boxed{\sigma_L = \sigma_\theta}$$

for conical vessel,

$$\sigma_L = \frac{Pr}{2t\cos\alpha} \qquad \sigma_\theta = \frac{Pr}{t\cos\alpha}$$

$$\boxed{\sigma_\theta = 2\sigma_L}$$

Bcz of the shape of the sphere, it undergoes minimum stress and therefore the minm absolute stress value.

$$\sigma_{min} = \frac{PD}{4t}$$

The calculation of thickness for cylindrical vessel.

$$t = \frac{PD_o}{2fJ+P}$$

P = Design Pressure, which is 5% more than the maxm operating pressure of the vessel.

D_o = Outer dia or nominal dia.

f = Maxm allowable stress value, that a material can handle.

J = Joint efficiency factor.
general value of J = 0.85.

t = Calculated wall thickness.

$= t + C.A$

The actual wall thickness equals to calculated wall thickness plus corrosion allowance. CA is generally 2mm

Standard Wall thickness

The next integer to the actual wall thickness

Q.) A process vessel is to be designed for the maxm operating pressure of 500 kN/m2. The vessel has the nominal dia has 1.2m. The maxm allowable stress value 118 MN/m2. What ~~wh~~ will std. plate thickness to fabricate the cylindrical vessel.

(5, 7, 9, 11)

5% more press = 525

$$= \frac{5\cancel{25} \times 1.2}{2 \times 118 \times 10^3 \times 0.85 + 5\cancel{25}}$$

6

$$P = \frac{2fJt}{D_o - t}$$

For spherical Vessel :—

$$t = \frac{PD_o}{4fJ + P}$$

$$P = \frac{4fJt}{D_o - t}$$

Q.) if a spherical vessel having the same dia & thickness is fabricated with the same quality steel. What max int. press. the sphere will withstand safely.

t = 5

$$= \frac{4 \times 118 \times 0.85 \times \cancel{5}}{1.2 - 5}$$

$$P = 1.6$$

Heads & Closures

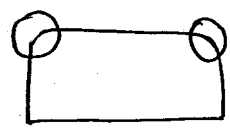
Heads of cylindrical vessels are to be closed before putting them into operation. This is done by means of heads & closure.

Flat heads :-

Generally used for man holes in low pressure vessels. They can also be used as closures for small diameter vessels under low pressure.

Flanged only heads :-

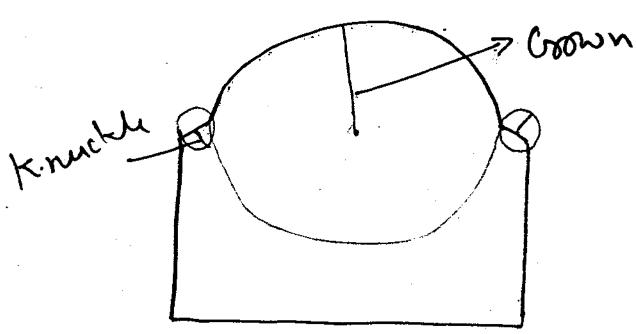
It is a type of flat head in which gradual change in shape at the corner is there.



This head is used to close the ends of horizontal storage vessel at atm. pressure.

Flanged Shallow Dished & Flanged Standard Dished :-

These two are also known as torrispherical head.



If the crown radius is greater than the shell outside dia meter the head is known as Flanged Shallow dished.

The crown radius is equal to or less than the shell outside diameter the head is known as Flanged standard Dished.

For designing pt of view,

$$\frac{r_k}{r_c} \geq 0.6$$

These types of heads are used for vertical process vessel for low pressure.

Ellipsodial head :-

For this case

Cheapest.

$$r_k = r_c$$

They are used for the vertical process vessel operating at high pressures and they are most economical heads available for vessel under high pressure.

Hemi-spherical head :-

For a given thickness, this type of head is the strongest among all.

This is the most expensive head and widely use for high pressure vessel.

Conical head or Reducers

They are used as bottoms for evaporators, crystallizers etc. Advantage lies in the fa they allow accumulation & removal of solids from such equipment.

They provide a smooth transition b/w two ~~d~~ parts of different ~~dia~~ dia in cylindrical process vessel.

Supports for Process Vessel

A process vessel is usually supported in a vertical or in horizontal position depending upon the process requirement.

Distillation column is supported in ~~V~~ vertical position.

Heat Exchanger " " " horizontal "

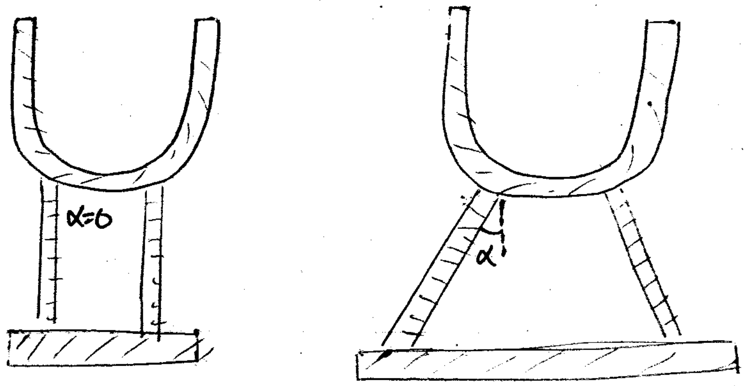
For vertical vessel the common support are.

1) skirt Support → cylindrical, → conical
2) Lug support / Bracket
3) Leg Support.
4) Ring support

For horizontal vessel the common support are

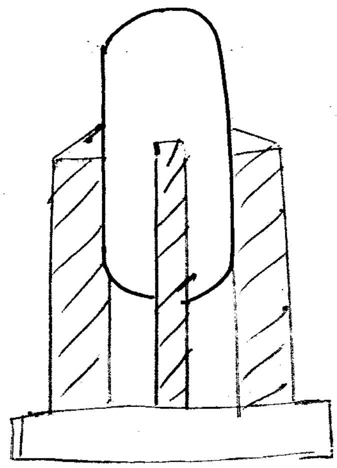
1.) Saddle Support
2.) Ring "
3) Leg "

Skirt Support



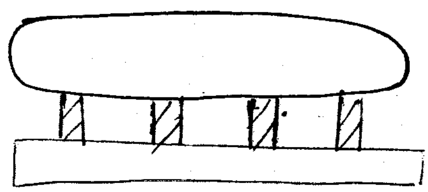
These support are found to be most suitable for taller vessel and they are also useful for the vessels subjected to major loading

Lug Support or Bracket Support.



They are used to support vertical vessels having smaller height or the vessels which are subjected to minor loading

Saddle Support



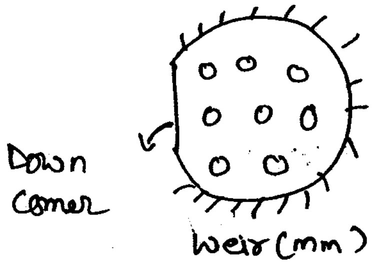
They are used for generally thick wall vessel, the no. saddle should be 3 or more, for thin walled vessels the saddles are provided at the points near the ends of vessels.

Contactors:-

They are basically plate or tray contactors.

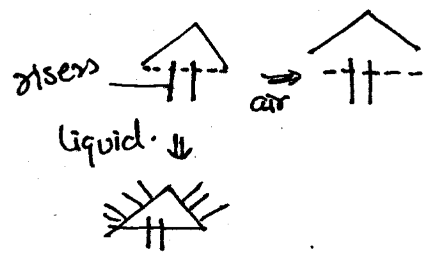
Cross flow plates are the most common type of plate contactor used in the distillation column. They are of 3 types:-

i.) Sieve tray:-



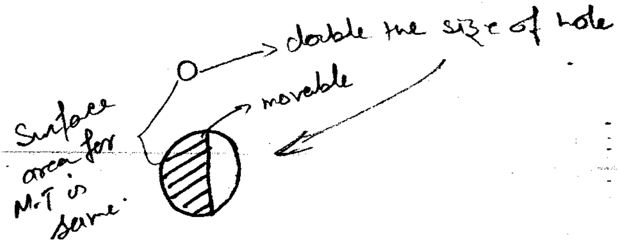
The simplest type of cross flow plates are the sieve plates. The vapour passes up through the perforations and the liquid is retained on the plate by the vapour flow.

ii.) Bubble Cap:-



These are the plates in which the vapour passes up through ~~perforatio~~ short pipes called as risers covered by a movable cap. The use of cap ensure that a level of liquid is maintained on the tray at all vapour flow rates.

Valve tray :—



Valve plates are essentianly the sieve plates with large dia. holes covered by moveable flabs which lifts as the vapour flow increases. As the area for the vapour flow variess wid the flow rate the ~~whole~~ valve plates can operate at wider range of flow rate as comparced to sieve plates.

Summary:—

The sieve plates are the cheapest and least prone to ~~falling~~ fouling and are satisfactory for most applications. The moving valve plates should be considered when vapour flow rate varry. Their cost is more than the sieve but they have increased performance. The bubble cap should only be used where very low vapour rates have to be handeled as they are the most expensive and most prone to fouling.

Packing Vs Tray

The plate columns can be designed to handle a wider range of liquid-gas flow rates then packed column as the packed column are not suitable or very low liquid rate.

The efficieney of a plate can be predicted wid more accuracy in comparision to packing.

In the tray column it is easir to make provision for the withdrawl of side stream.

Peterolieum refinery, different section of distillation column

It is easier to make a provision for cooling and cleaning at different section.

For the corrosive liquid packed column are used, bcz packing is cheaper than the tray.

For the liquids containg some solid particles, it is easier to make provision for cleaning in plate column.

The pressure drop is lower for the packing than the plates.

Packed column are most suitable for handling foaming system, bcz there is a continous contact system in the packing in comparision to plate columns, in which there is discrete contact system.

The packed columns are favourable for small diameter vessels in which it is difficult to make provision for the tray.

Pumps & Compressor: —

Centrifugal pump & Reciprocating pump.

Selection of pump based on the criteria of total head & total flow rate.

Specific speed of the centrifugal pump & based on the sp. speed selection of pump.

Pressure drop in a pipe line.

Net positive section head / Cavitation.

Storage & transport.
→ gases
→ liquids.