3rd ~~Load (Extendable)~~

$$\text{Demand factor} = \frac{\text{Maximum demand}}{\text{Connect load}}$$

$$\text{Average load} = \frac{\text{No of units (kwh) generate in a day / M / Y}}{\text{24 hour / Hours in a month / 8760 hours}}$$

OR " Demand

$$\text{Load Factor} = \frac{\text{Average load or Demand}}{\text{Max demand}} = \frac{\text{Unit gener.} \cdot T \text{ hour}}{\text{Max dem.} \times T \text{ hour}}$$

$$\text{Diversity Factor} = \frac{\text{Sum of individual max. demands}}{\text{Max demand on Power Station}}$$

$$\text{Plant capacity factor} = \frac{\text{Average demand/load}}{\text{Plant capacity}} = \frac{\text{Actual eng. Produced}}{\text{Max. energ. have been Prod}}$$

$$\text{Plant use factor} = \frac{\text{Station o/p in kwh}}{\text{Plant capacity} \times \text{Hours of use}}$$

Energy generated/Annum = Max demand $\times$ Load fact $\times$ Hours in year

Average load = max demand $\times$ Load Factor

Unit generated / Day = $\text{kw} \times \text{Time} + \text{kw} \times \text{Time}$

Reserve capacity plant = Plant capacity − maximum demand

$$\text{Maximum energy that could be Produced} = \frac{\text{Actual energy produced in day}}{\text{Plant use factor}}$$

3.2 Given,

Connected load = 43 MW

maximum dem = 20 MW

Unit generat/ann = 61.5×10^6

Demand factor = $\frac{\text{Max. demand}}{\text{Connected load}}$

= 0.465

Average load = $\frac{\text{Unit gene./annu}}{8760}$

= 7020 KW

Load factor = $\frac{\text{Average demand}}{\text{Max demand}}$

= 0.351

3.3 Given,

max ~~demand~~ Power = 100 MW

100 MW for 2 hours

50 MW for 6 hours

Operating day = 365 - 45

= 320

energy per day = $(100 \times 2) + (50 \times 6)$

= 500 MWh

energy per year = 500×320

= 160000 MWh

Max dem/year = $100 \times 24 \times 320$

= 768000 MWh

Annual Load factor = $\frac{160000}{768000}$

= 20.8 %

3.4 Given,

(i)

max demand = 25 MW

load factor = 60%

Plant capacity factor = 50%

Plant use factor = 72%

Plant capacity = $\frac{\text{Average demand}}{\text{Plant capacity fact}}$

Load factor = $\frac{\text{Average demand}}{\text{Maximum demand}}$

$\Rightarrow$ Average demand = 0.6×25

= 15 MW

$\therefore$ Plant capacity = $\frac{15}{0.5}$

= 30 MW

$\therefore$ Reserve capacity = 30 - 25 MW

= 5 MW

(ii)

Average demand = $\frac{\text{Unit gen. per day}}{24}$

$\Rightarrow$ unit gene.. day = 24×15

= 360 MWh

(iii) Max energy that could be produced

= $\frac{\text{Actual energy produced in day}}{\text{Plant use factor}}$

= 500 MWh / day

3.5 Given,

max demand = 15000 KW

Annu. load factor = 50%

Plant capacity Factor = 40%

~~unit generated/Annum = 15000×0.5~~

$$\text{Average load} = \frac{\text{Units gene. per year}}{8760}$$

$$= \frac{15000 \times 0.5 \times 8760}{8760}$$

$$= 7500 \text{ kwh}$$

$$\text{Plant capacity} = \frac{7500}{0.4}$$

$$= 18750 \text{ kw}$$

Reserve capacity = 18750 − 15000

= 3750 KW

3.7

The Sum of max demand of three types of load = 1500 + 2000 + 10000

= 13500

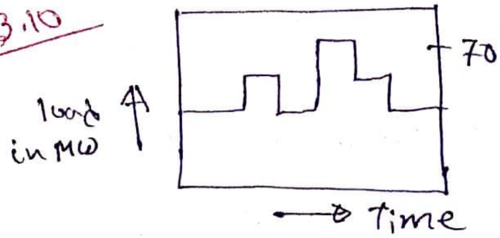
diversity factor = 1.35

∴ Max demand on Power Station

$$= \frac{13500}{1.35} = 10000 \text{ KW}$$

$$\therefore \text{Connected load (individual)} = \frac{\text{Max dem. on Power Stat} \times \text{diversity Fa.}}{\text{Demand factor}}$$

3.10



max. demand = 70 MW

unit gene./day = (40×6 + 4×50 + 2×60 + 4×50 + 4×70 + 4×40)

$= 12 \times 10^5$ kwh

$$\text{Average load} = \frac{12 \times 10^5 \text{ kwh}}{24}$$

= 50000 kw

$$\text{Load Fac.} = \frac{50000 \text{ kw}}{70 \times 10^3}$$

= 0.714

3.14

$$\text{Daily load factor} = \frac{\text{Average load}}{\text{max dem.}}$$

$$\text{Average dem.} = \frac{\text{No of unit gen./day}}{24}$$

$$= \frac{6 \times 260 + 200 \times 8 + 160 \times 4 + 100 \times 6}{24}$$

$$= \frac{4400 \times 10^3}{24} \text{ kw}$$

$$\therefore \text{Daily load factor} = \frac{4400 \times 10^3}{24 \times 260 \times 10^3}$$

4×75×10³

= 0.750

$$\text{Plant capacity factor} = \frac{\text{Average load}}{\text{Plant capacity}}$$

$$= \frac{4400 \times 10^3}{4 \times 75 \times 10^3 \times 24} \times 100\%$$

= 61.1 %

$$\text{Fuel req/day} = \frac{2860 \times 4400 \times 10^3}{10000}$$

= 1258.4 tons.

Steam Power Plant

$$\text{Thermal efficiency} = \frac{\text{Heat equivalent of mechanical energy}}{\text{Heat of coal combustion}}$$

$$\text{Overall efficiency} = \frac{\text{Heat equivalent of electrical output}}{\text{Heat of coal combustion}}$$

$$= \text{Thermal efficiency} \times \text{electrical efficiency}$$

$$\text{Electrical efficiency} = \frac{\text{Heat equivalent of electrical output}}{\text{Heat of mechanical energy}}$$

* $1\ \text{kwh} = 1000 \times 3600 = 36 \times 10^5\ \text{J} = 860\ \text{K cal}$

* Heat of coal combustion $=$ calorific $\left[\frac{\text{kcal}}{\text{kg}}\right] \times$ coal [kg]

* $\text{kwh} \times 860 = \text{Kcal}$

2.1 Given,

overall efficiency = 20%

Coal = 0.6 kg

Calorific value = ?

Heat of coal comb. = Calorific × coal

$$\text{overall effi} = \frac{\text{Electrical o/p}}{\text{Heat of coal comb.}}$$

$$\Rightarrow \text{Heat of coal com.} = \frac{860}{0.2} \text{ K cal}$$

$$= 4300 \text{ Kcal}$$

$$\therefore \text{calorific} = \frac{4300}{0.6} \times \frac{\text{Kcal}}{\text{kg}}$$

$$= 7166.67 \frac{\text{Kcal}}{\text{kg}}$$

2.2. Given,

Max. demand = 20000 KW

Load factor = 40%

Boiler efficiency = 85%

Turbine " = 90%

i) Thermal efficiency = Boiler eff × ~~thermal~~ Turb.

= 0.85 × 0.9

= 0.765

(ii)

unit generate/annu = Max dem × L.F × Hours in Y

= 20000 × 0.4 × 8760 kwh

Coal consumption/Annu = 0.9 × 20000 × 0.4 × 8760

$$= \frac{0.9 \times 7008 \times 10^4}{1000}$$

= 63072 tons

Annual coal bill =

= 300 × 63072

= 189,21,600

2.3 Given,

30 lakhs taka per Annum

Calorific value = 5000 kcal/kg

300 taka/ton

thermal efficiency = 33%

electrical efficiency = 90%

Average load = ?

$$\text{Average load} = \frac{\text{Electrical o/p or Units g.}}{8760}$$

overall efficiency = 0.33 × .9

= 0.297

$$\text{Coal used/Annu} = \frac{30 \times 10^5}{300}$$

= 10^4 ton

= 10^7 kg

Coal combustion = $10^7 \times 5000$

= 5×10^{10} Kcal

P.T.O

$$\text{overall effi.} = \frac{\text{Heat of electrical o/p}}{\text{Heat of coal combust-}}$$

$\Rightarrow$ Heat .. Electr.. o/p $= 0.297 \times 5 \times 10^{10}$

$= 1485 \times 10^{7}$ kcal

$$\text{Units gener.. /Annu.} = \frac{1485 \times 10^{7}}{860} \text{ kwh}$$

$$\text{Average load} = \frac{1485 \times 10^{7}}{860 \times 8760} \text{ kw}$$

$= 1971$ kw

2.5. Given,

Calorific value $= 6400$ kcal/kg

unit generated $= 100$ MW

Thermal efficiency $= 30\%$

Electrical efficiency $= 92\%$

Coal consumption/H = ?

$$\text{overall effi.} = \frac{\text{Heat of Electrical o/p}}{\text{Heat of Coal consump..}}$$

overall effic. $= 0.3 \times 0.92$

$= 0.276$

$$\text{Heat of coal consump} = \frac{100 \text{ MWh}}{0.276}$$

$= 362.318 \times 10^{3}$ kwh

$= 362.318 \times 10^{3} \times 860$

$= 311.6 \times 10^{6}$ kcal

Coal consump. = calorific $\times$ coal combustion

$$\Rightarrow \text{Coal combustion} = \frac{311.6 \times 10^{6} \text{ kcal}}{6400 \text{ kcal/kg}}$$

$= 48687$ kg

Hydro electric power

$$\text{Overall eff} = \frac{\text{Electrical o/p in heat units}}{\text{Potential Energy of water}}$$

$$\text{Load factor} = \frac{\text{o/p power}}{\text{Installed capacity of the plant}}$$

$$\text{Plant eff.} = \frac{\text{Firm capacity}}{\text{Gross Plant capacity}}$$

$$\text{Firm capac.} = \frac{\text{Yearly Gross o/p}}{\text{Hours in a year}}$$

overall eff. = (penstock $\times$ turbine $\times$ generator) efficiency

$1 \text{ m}^3 = 1000$ L

density $= 1000 \ \frac{\text{kg}}{\text{m}^3}$

2.6 Given,

$m = 5\times10^6\ m^3 \times 1000\ \frac{kg}{m^3}$

$= 5\times10^9\ kg$

$H = 200\ m$

Overall eff = 75 %

Electrical enerergy = ?

overall eff. $= \frac{\text{Electrical energy}}{\text{Potential energy}}$

Potential energy = mgH

$= 5\times10^9\times9.81\times200$

$= 9.81\times10^{12}\ j$

∴ Electrical energy $= 0.75\times9.81\times10^{12}$

$= 7.35\ 75\times10^{12}$

$= \frac{7.3575\times10^{12}}{3660\times1000}$

$= 2.04\times10^6\ kwh$

2.7. Given,

$H = 39\ m$

$m = 94\times1000$

effici-- = 80%.

* Potential energy OR Gross Plant capa.

mgH

$= 94\times1000\times9.81\times39$

$= 35963.46\times10^3\ \omega$

Plant eff $= \frac{\text{Firm capacity}}{\text{Gross plant capacity}}$

⇒ Firm capacity $= 0.8\times35963.46\times10^3$

$= 28770\ kW$

Firm capacity $= \frac{\text{Yearly Gross o/p}}{\text{Hours in a year}}$

∴ Yearly Gross o/p $= 28770\times8760$

$= 252\times10^6\ kwh$

2.8 Given,

$H = 100$ metres

$m = 1 m^3/s$

Hydroelectric eff. $= 0.86$

Electrical eff. $= 0.92$

Electrical energy/Hour = ?

$$\text{Overall eff} = \frac{\text{Electrical o/p energy}}{\text{Potential energy}}$$

Potential energy $= mgH$

$= 1000 \times 9.81 \times 100$

$= 981000 \, j$

Overall effi. $= 0.86 \times 0.92$

$= 0.7912$

Electrical o/p energy $= 0.7912 \times 981000$

$= 776.16$ kw

Electrical o/p energy/Hour $= 776.16$ kwh

2.10 Given,

Reservoir Area $= 2.4 \times 10^6$ m

$m = 5 \times 10^6 \times 1000$

$H = 100$ m

Penstock eff. $= 95\%$

turbine " $= 90\%$

generation " $= 85\%$

Electrical energy o/p = ?

$$\text{Overall eff.} = \frac{\text{Electrical o/p energy}}{\text{Potential energy}}$$

overall eff $= 0.95 \times 0.9 \times 0.85$

$= 0.726$

Potential energy $= mgH$

$= 5 \times 10^6 \times 1000 \times 9.81 \times 100$

$= 4.905 \times 10^{12} \, j$

$\therefore$ Electrical o/p $= 0.726 \times 4.905 \times 10^{12}$

$$= \frac{3.56103 \times 10^{12}}{1000 \times 3600}$$

$= 989175$ kwh

* Let,

x metre fall in 3 hours

weight of water in 3 hours = -

$m = 2.4 \times 10^6 \times x \times 1000$

Potential energy in 3 Hours = -

$mgH = 2.4 \times 10^6 \times x \times 1000 \times 9.81 \times 100 \, j$

$$\text{Average power produced} = \frac{2.4 \times 10^6 \times x \times 1000 \times 9.81 \times 100}{3 \times 60 \times 60}$$

$= 21.8 \times 10^4 x$ kwh

electrical o/p $= 21.8 \times 10^4 x \times 0.726$

$\Rightarrow 15000 \text{ kw} = 15.84 x \times 10^4$ kw

$\Rightarrow x = 0.0947 \text{ m} = 9.47$ cm

2.12

installed capacity = 10 MW

H = 20 m

Overall eff. = 80%

Load factor = 40%

River discharge in m3/sec ⇒ Q = ?

Consider the duration of the one week

unit generated/week = Max dem × L.F × 24×7

$= 10 \times 10^3 \times 0.4 \times 24 \times 7$ kwh

$= 67.2 \times 10^4$ kwh

Potential energy ⇒ mgH

⇒ Q × 1000 × 9.81 × 20

⇒ 196200 Q

Electrical o/p = potential × overall eff

= 196200 Q × 0.8

Electrical o/p/week = 196200Q × 0.8 × 24×7
= 26369.28 Q kwh

Now

$67.2 \times 10^4 = 26369.28\,Q$

⇒ Q = 25.48 m3/sec

2.13 Given,

H = 15 m

Overall eff. = 85%

Load factor = 40%

Average daily discharge = ?

Pondage required = ?

Installed capacity = ?

Average daily discharge

$= \dfrac{500+520+850+800+875+900+546}{7}$

= 713 m3/s

the discharge of (sat, sun, mon) are less than average discharge volume of water available

$= 713 \times 3 \times 24 \times 3600$ m3

$= 2139 \times 24 \times 3600$ m3

water required in three days

$= (500+520+546) \times 24 \times 3600$

$= 1566 \times 24 \times 3600$ m3

Pondage required

$= (2139-1566) \times 24 \times 3600$

$= 495 \times 10^5$ m3

2.11:

Load factor $= \dfrac{\text{output power}}{\text{installed capacity of plant}}$

Electrical energy = overall eff X Potential energy

$= 0.85 \times 713 \times 1000 \times 9.81 \times 15$

$= 89180$ KW

$\therefore$ Installed capacity $= \dfrac{89180 \times 10^3}{0.4}$

$= 223$ MW

Given,

Energy delivered by Reactor per hour

$= 300 \text{ MW} \times 3600$ sec

$= 1.08 \times 10^{12}$ j

Energy realsed per fission = 200 Mev

$= 200 \times 10^6 \times 1.66 \times 10^{-19}$

$= 3.2 \times 10^{-11}$ j

No of atoms Required per hour

$= \dfrac{1.08 \times 10^{12}}{3.2 \times 10^{-11}}$

$= 33.75 \times 10^{21}$

Nuclear Power Plant

$^{m\,235}_{p\,92}U$; $n = 235 - 92$

1 amu $= 1.66 \times 10^{-27}$ kg

1 mole = molecular weights in gram

$\boxed{1 \text{ mole } H_2 = 2 \text{ gm}}$

Avog No. $= 6.023 \times 10^{23}$

1 mole Avog No atoms

235 — 6.023×10^{23}

* 1 ev $= 1.66 \times 10^{-19}$ j

* capacity 10 MW, 50 MW - - - basically per sec J বোঝায়

6.023×10^{23} atoms mass $= 235$ g

33.75×10^{21} " " $=$ ~~235×33.75~~

$= \dfrac{235 \times 33.75 \times 10^{21}}{6.023 \times 10^{23}}$

$= 13.17$ g

2.18.

Given,

Fuel $= 2 kg$

Avog. No $= 6.023 \times 10^{26}$ /kilo mole

No of atoms in 2 kg fuel $= \frac{2}{235} \times 6.023 \times 10^{26}$

$= 5.12 \times 10^{24}$

The fussion rate $= \frac{5.12 \times 10^{24}}{30 \times 24 \times 60 \times 60} = 1.975 \times 10^{18}$

Energy Released per fission $= 200 \times 10^{6} \times 1.6 \times 10^{-19}$

$= 3.2 \times 10^{-11}$ J

Energy Released per Second $= 3.2 \times 10^{-11} \times 1.975 \times 10^{18}$

$= 6.32$ MW