

UNIT - 8

- 1) It should have the capability of supplying the H₂O at suitable press.
- 2) The fire demand should be meeting out sufficiently.
- 3) purity of H₂O should be maintained.
- 4) It should have the resistance to leakage & should be completely H₂O tight.

Requirements of a Good Distribution System:-

Layout of Distribution networks

1. Dead end system (Tree Sys) one main pipe → a no of submain pipes → each submain divided in to several branch pipes called laterals
2. C.R.P.d. Con → Interlaced sys & Retundation sys.
3. Ring Sys Circular, a Closed ring either circular or rectangular.
4. Radial "

Methods of distribution :-

- 1) By gravitational Sys
- 2) " pumping "
- 3) By combined gravity & pumping Sys.

Distribution reservoirs:

Used to store the treated H₂O for supplying H₂O during emergencies (such as during fires, break downs, repair etc). & also to help in absorbing the hourly fluctuations in the normal H₂O demand.

Types

may be made of Steel, R.C.C & masonry, depending upon their elevation w.r.t the ground.

1. Surface reservoir
2. Elevated "
3. Stand pipes.

Storage capacity of D.R

The total storage capacity of a D.R is the summation of

1. Balancing storage mass curve method
2. Breakdown " Analytical
3. Fire " "

Detection of leakages in the underground Dis. pipes

- 1) by direct observations
- 2) " using sounding rods
- 3) " plotting hydraulic gradient line
- 4) " using waste detecting meters.

Analysis of complex pipe networks.

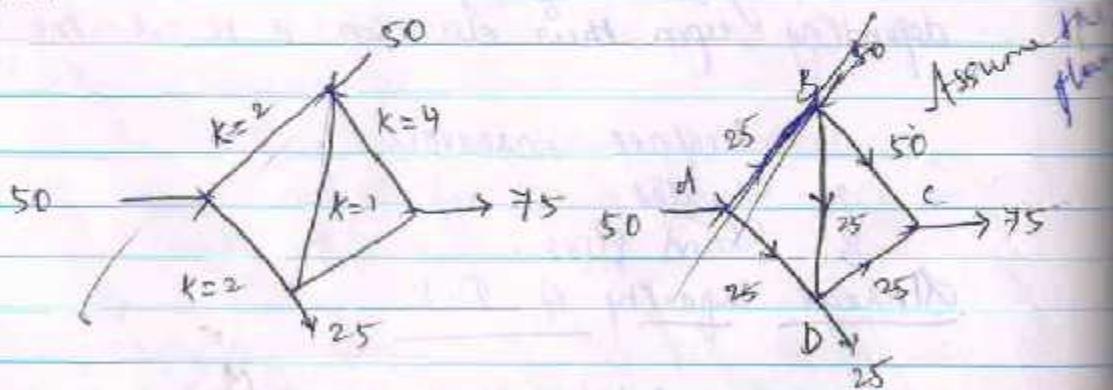
- 1) Hardy Cross method
- 2) Equivalent pipe "

Appurtenances in the D.s.g.-

Various valves such as, glue valves, check valves, air valves, drain & scan valves etc certain other appurtenances such as fire hydrants, metres, H₂O taps, stop cocks, pipe bends etc.

Q

Determine the distribution of flow in the pipe network shown in fig 10.25. The Head loss, h_L may be assumed as $k Q^2$. The flow is turbulent & pipes are rough. The value of k for each pipe is indicated in the fig. Use Hardy-Cross method.



Hardy cross procedure for 2nd correction.

Pipe	Assumed flows Q_{a1} (l/s)	$k(\text{gn})$	$HL = k \cdot Q_{a1}^2$	HL/Q_{a1}	Corrected Q_{a2} after 2 nd correction $Q_{a2} = Q_{a1} + \Delta_1$ l/s.
for loop ABDA (Loop I)					

AB 25 2 1250 50 +22.5

BD (common pipe) 25 1 625 25 +35.0 *

DA -25 2 -1250 50 -27.5

$$\Delta_1 = \frac{(-) 2.5}{2 \cdot 2 \left(\frac{HL}{Q_{a1}} \right)} = \frac{-625}{2 \times 125} = (-) 2.5$$

for loop BCDB (Loop II)

BC 50 4 10000 200 37.5

CD -25 3 -1875 75 -37.5

DB (common pipe) -25 1 -625 25 -35.0

$$\Delta_1 \text{ in 2nd loop} = \frac{(-) 7500}{2 \times 300} = (-) 12.5$$

* Corrected flow in common pipe BD

$$= 25 + \Delta_1 - \Delta_2$$

$$= 25 - 2.5 + 12.5 = 35 \text{ l/s.}$$

Hardy Cross procedure for Second correction.

pipe	Assumed flows k (Q_a)	$H_L = k_s Q_a^2$	H_L/Q_a	corrected flow after 2 nd correct.
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Job Loop AB DA

A_B 22.5 2 1012.5 50 19.8

B.D (C.P)	35.0	1	1225.0	25	32.6*
DA	-27.5	2	-512.5	50	-30.2
			<u>725</u>	<u>135</u>	

$$\Delta_2 = \frac{-725}{2 \times 135} = -2.7$$

for loop & CDR (loop B)

BC 37.5 4 5623 150 37.2

CD -37.5 3 -4218.75 192.5 -37.8

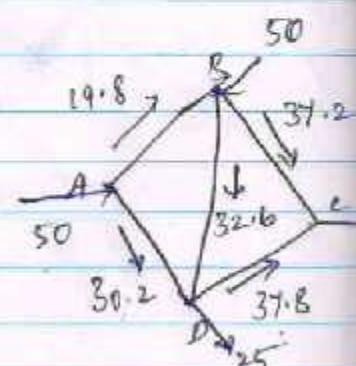
$$\begin{array}{r}
 DB \quad -37.5 \quad | \quad \frac{+406.25}{\underline{181.25}} \quad \frac{35}{\underline{297.5}} \quad -32.6^* \\
 \end{array}$$

$$\Delta_2 \text{ in } 2^{\text{nd}} \text{ loop} = (-) \frac{181 \cdot 25}{2 \times 297.5} = (-) 0.3$$

Corrected flow in common pipe BD

$$= 35 + \Delta_2 -$$

$$= 32.61/\lambda$$



The corrected flows obtained in 2nd Table after 2nd correction are now plotted on the pipe network in fig to check balancing of flow at each pt, to verify the answer.

Analysis of Network Design.

The term analysis of net work designs means that the analysis of pressure inside the main pipes, & sub mains etc.

Equivalent pipe method.

Hardy cross "

method of section.

Circle method

Graphical "

Electric network analyzer method

Pitotometer distribution studies.

Equivalent pipe method:-

Equivalent pipe

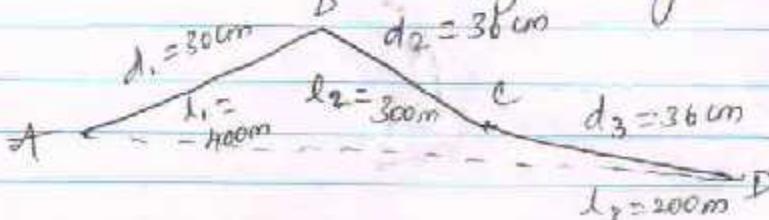
This method is sometimes used as an aid in solving large networks of pipes, in which it becomes convenient to, first of all, replacing the small loops by single equiv. pipes having the same discharging capacities & causing the same head loss.

The length of the equivalent of pipe will be given by doruji formula.

$$L_E = D_E^5 \left[\frac{L_1}{D_1^5} + \frac{L_2}{D_2^5} + \dots \right]$$

Ex

Find the Equivalent length of A m dia pipe for the networks as shown in fig using doruji formula.



$$L_E = D_E^5 \left[\frac{L_1}{D_1^5} + \frac{L_2}{D_2^5} + \frac{L_3}{D_3^5} \right]$$

$$= (0.4)^5 \left[\frac{400}{(0.3)^5} + \frac{300}{(0.36)^5} + \frac{200}{(0.36)^5} \right]$$

$$= 2,209.38 \text{ m.}$$

Length of the equivalent pipe by Darcy's formula.

$$= 2,209.38 \text{ m.}$$

In this method, pipe circuit can be reduced into a single equivalent pipe by using the following two principles of hydraulics.

- Theory:*
- 1) The loss of head caused by a given flow of H_2O through the pipes connected in series is additive.
 - 2) The qty of discharge flowing through the diff pipes connected in H^1 will be such as to cause equal head loss through each pipe.

Darcy-Weisbach method :-

It is a trial & Errors method of analysing the press in a D.P.S. networks. In this method S.V. laws are applicable.

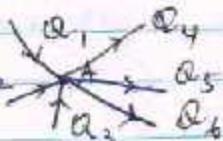
i) In a closed circuit, the sum of the head loss in individual elements will be zero.

$$(i) \sum h = 0$$

ii) At junction pts the algebraic sum of quantities of H_2O entering & exiting that junction will be zero.

$$Q_1 + Q_2 + Q_3 - Q_4 - Q_5 + Q_6 = 0.$$

$$Q_1 + Q_2 + Q_3 + Q_6 = Q_4 + Q_5$$



iii) In a H_2O junction, the sum of the quantities of H_2O entering to the junction is equal to the sum of the quantities of H_2O leaving the junction.

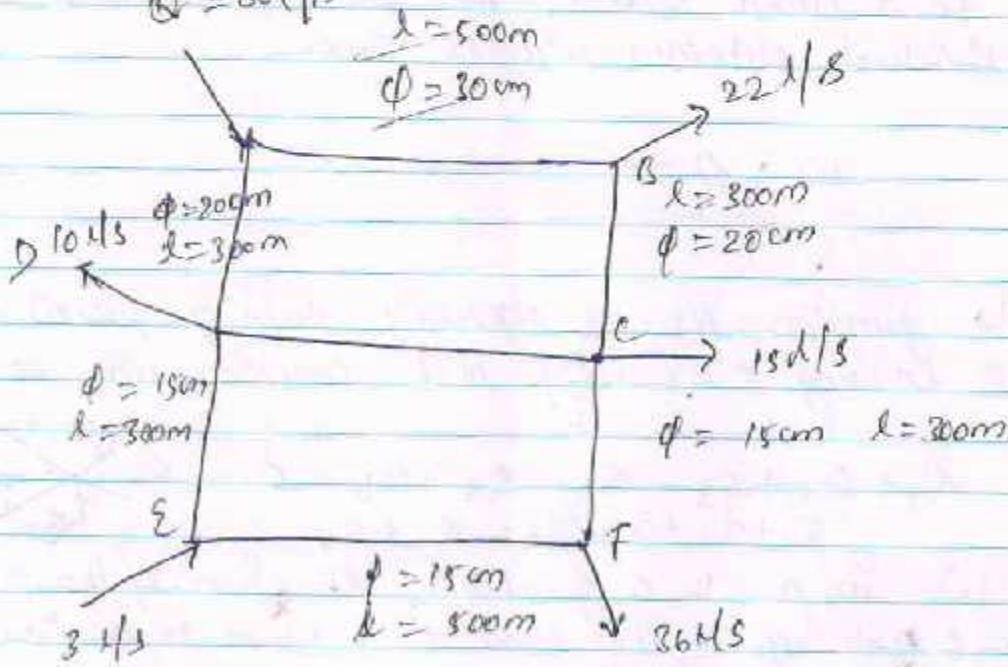
iv) In network sys each pipe is related to other pipe w.r.t. head loss (h) & qty of H_2O (Q).

$$\Delta = \frac{-\zeta H_L}{n \cdot f (H_L/Q_a)} \quad (f. \quad H_L \rightarrow \text{head loss} \\ \zeta \rightarrow \text{assumed flow})$$

ii. Const (see 1.85 for Hazen-Williams flow & for 2 for Darcy-Weisbach/ Manning's formula)

Calculate the head losses & the corrected flows on the various pipes of a D/P network shown in fig. The diameters & no length of the pipes used are given against each pipe. Make use of Hazen's method & William Hazen's formula. Compute the corrected flows after 2 corrections.

$$Q = 80 \text{ l/s}$$



2

$$H_L = \frac{1}{0.094} \left(\frac{Q}{C_H} \right)^{1.85} \frac{l}{d^{4.87}}$$

$$C_H = 100 \text{ assumed}$$

$$H_L = \frac{1}{0.094} \left(\frac{Q}{100} \right)^{1.85} \frac{l}{d^{4.87}}$$

$$= \frac{l}{470} \cdot \frac{Q^2}{d^{4.87}}^{1.85}$$

$$K = \frac{l}{470 d^{4.87}} \quad k.$$

$$H_L = K \cdot Q^2$$

Iron & Manganese removal from H₂O:-

→ Iron & manganese salts are generally found dissolved together in well H₂O or anaerobic reservoir H₂O. in invisible dissolved state.

→ When their contents exceed abt 0.3 mg/l & 0.05 mg/l respectively. They become objectionable due to the following reasons.

- 1) They cause discolouration of clothes washed in such H₂O, due to deposition of red/brown coloured oxides of iron / manganese.
- 2) They make the H₂O unpleasant in taste.

in
① Combination \bar{C} OM
② Coat \bar{C} OM

When present \bar{C} out Combination \bar{C} OM, they can be easily removed by aeration, followed by sedimentation & filtration.

When present \bar{C} combination \bar{C} OM, it becomes difficult to break the bond b/w them & to cause their removal. However, when once the bond is broken, they can be removed as above.

This bond may be removed either by adding lime & thereby increasing the pH value of H₂O to abt 8.5 to 9.

Manganese Zeolite, a natural green sand coated \bar{C} manganese dioxide, can also be used for removing soluble iron & manganese from water.

Calculate the amt of lime & soda reqd to treat 2 million litre of hard H₂O containing carbonate hardness equal to 15° French, & mg hardness equal to 9° French & a total hardness of 24° French.

Ans :-

1° French = 10mg/l of hardness as CaCO₃

mg Hardness = 90 mg/l.

Carbonate H. = 150 mg/l.

Total H. = 240 mg/l.

Ans :-

Total Hard = Total Hard - mg Hard

Total Hard = carbon hard + non carbon Hardness

240 mg = 150 mg/l + non carbonate Hard.

non carbonate Hardness = 90 mg/l.

Lime is reqd to remove Hardness.

= carbonate Hardness + magnesium Hardness

= 150 + 90 = 240 mg/l.

① Q'ty of lime reqd to remove 240 mg/l (as CaCO₃) of Hardness.

From molecular masses, we find that 100 parts of CaCO₃ reqd 56 parts of pure lime (CaO) for treatment.

100 mg/l of CaCO₃ will require = $\frac{56}{100} \times 240 \text{ mg/l CaO}$

= 135 mg/l of quick lime

Hence, quick lime needed = 135 mg/l.

Since 2 million litres of H_2O to be treated,
Total quick lime reqd.

$$= 135 \text{ mg/l} \times 2 \times 10^6 \text{ litres.}$$

$$= 270 \text{ kg.}$$

(ii) Qty of Soda is reqd to react w/ the entire
non carbonate hardness of 90 mg/l (as CaCO_3)

From molecular masses

100 parts of CaCO_3 requires = 106 parts of Na_2CO_3

\therefore 90 mg/l of CaCO_3 will require = $\frac{106}{100} \times 90$

$$= 95.4 \text{ mg/l of soda.}$$

Total Soda reqd in millions of H_2O

$$= 95.4 \times 2 \times 10^6 \text{ l.}$$

$$= 190.8 \text{ kg.}$$

1 kg = 10^6 mg

mg \rightarrow kg.

Disinfection :- | Sterilisation:

→ The filtered H₂O which is obtained either from the SSF or RWF may normally contain some harmful disease producing bacteria in it.

→ These bact must be killed in order to make the H₂O safe for drinking.

→ The chemicals used for killing these bacteria are known as disinfectants, & the process is known as Disinfection or Sterilisation.

* To :-

→ The process of purification is the most ~~dangerous~~ becoz the bacterially contaminated H₂O may lead to the spread of various diseases & their

→ The presence of turboparticles, colour of minerals etc may lead to the ^{not be} spread of various dangerous, but the presence of even a single harmful organism will definitely prove dangerous.

The disinfectant chemical should be harmless, unobjectionable to tongue, economical & measurable by simple tests.

Chlorine has been found to be the best & the most ideal disinfectant & is now invariably used throughout out the world.

Minor methods of Disinfection :-

- 1) Boiling of H₂O
- 2) Treatment with excess lime
- 3) " " OZONE
- 4) " " Iodine & bromine
- 5) " " ultra violet rays
- 6) " " potassium permanganate
- 7) " " Silver, called Electro-katadyn process

Major - chlorination.

Chlorine in its various forms is invariably & almost universally used for disinfecting public H₂O supplies.

→ It is cheap, reliable, easy to handle, easily measurable, & above all, it is capable of providing residual disinfecting effects for long periods.

disadv-

when used in greater amounts, it imparts bitter & bad taste to the H₂O, which may not be liked by certain sensitive tongued consumers.

Various forms in which chlorine can be applied:-

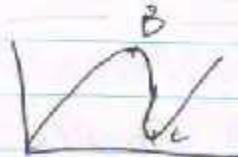
- i) In the form of liquid chlorine or as chlorine gas
- 2) " " " chlorine tablets
- 3) " " " hypo chlorine or bleaching powder
- 4) " " " chloramines (i) a mixture of ammonia & chlorine.

5) In the form of chlorine dioxide.

Types of chlorination & certain important Definitions:-

- i) plain chlorination 0.5 mg/l
- ii) pre $\rightarrow 0.05 \text{ mg/l}$
- iii) post " $0.1 \text{ to } 0.5 \text{ mg/l}$
- iv) Double " $0.1 \text{ to } 0.2 \text{ mg/l}$ Flash mixers \rightarrow Flocculators \rightarrow Sedimentation Tank \rightarrow SSF \rightarrow RCF \rightarrow Disinfection unit \rightarrow SLE
- v) Break point "
- vi) Super "
- vii) De chlorination.

Resi
chlor



Appd chlorine mg/l

Residuals Management:-

These residuals may be organic & inorganic mixtures in liquid, solid & gaseous forms depending on the treatment method adapted to the waste H_2O .

The common types of treatment process include Screening, coagulation / flocculation, precipitate softening plant, membrane separation etc.