Water and Waste water treatment

CT 274

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Water Filtration

Purpose:

1- Removal of remaining suspended solids
2- Removal of about 90 - 99% of bacteria
3- Removal of algae
4- Removal of iron & manganese
5- Removal of colour , taste & odour

Theory (mechanism) of filtration:

1- Straining action الحجز:
يعمل الرمل كأنه مصفاة (يتم حجز الحبيبات التي يكون حجمها أكبر من حجم الفراغات)

2- Sedimentation: الترسيب
تعمل الفراغات بين الرمل كأنها أحواض ترسيب صغيرة جدا

3- Adhesion الالتصاق:
تتكون طبقة جيلاتينية علي سطح حبيبات الرمل تلتصق عليها المواد الصلبة

4- Electric action التجاذب الكهربائي:
تتجذب الحبيبات الصلبة ذات الشحنة السالبة إلى حبيبات الرمل ذات الشحنة الموجبة

5- Biological action التفاعلات الحيوية:
تلتصق البكتيريا على حبيبات الرمل وتتغذى على أملاح الحديد والمنجنيز

Factors affecting filtration:

1. Rate of Filtration
2. Sand properties and depth
3. Water depth above sand layer
4. Under drainage system
5. Cleaning of filters
6. Preceding treatment process عمليات التنقية التي تسبق الترشيح
7. The remaining suspended solids
8. Algae and bacteria نسبة الطحالب و البكتريا بالمياه

(51)

Types of filtration:

I) Gravity Filters:
1. Slow Sand Filter
2. Rapid Sand Filter

II) Pressure Filters:
- pressure of water = (2.8 - 4.2) kg/cm^2
- Used for treated water of small amount of turbidity
- يعطي كفاءة منخفضة

III) Mechanical filters:
- Rotating Drum يمكن استخدامها في المساحات الصغيرة

Direct filtration:

إذا كانت SS في المياه قليلة جدا يمكن إلغاء مرحلة sedimentation وعمل filtration مباشرة

Use direct filtration if:

- Turbidity < 5
- Manganese < 0.05 ml
- Iron < 0.3
- Color < 40 unit

Rate of filtration = (60-120) $m^3 / m^2 / day$

(52)

Design criteria

R. S. F.	S. S. F.
-Rate of filtration "R.O.F." = 100 -200 m^3/m^2d - $n_t = n_w + 1$ for wash $n \leq 5$ $= n_w + 2$ for wash $5<n\leq30$ $= n_w + 4$ for wash $n > 30$ - L = (1 – 1.25)B , (L,B)= 5 - 8 m - a for one filter = 40 – 64 m^2 - Rate of washing (R.O.W)= (5-6)R.O.F - Time of wash water = 8 --- 10 min - operation 12 --- 36 hrs - washing- 25 ----- 35 min	-Rate of filtration "R.O.F." = 3-8 m^3/m^2d - No. $n \geq 2$ - L ≤50 m , B ≤ 50 m - L = (1 – 1.25)B - a for one filter = 1000 – 2500 m^2 -operation 2 ---- 6 months - cleaning 2 ----- 15 days -preparing 1 ----2 weeks -used with small Pop. ≤30.000C

Mechanism of action (Theory)

R. S. F.	S. S. F.
1) Straining action 2) sedimentation action 3) adsorption on gelatinous films 4) electrical action 5) biological action (bacteria + organics) The actions through all of the sand layer.	Mechanical straining and biological action on sand top layer (the action on the sand surface or dirty skin)

(53)

Cleaning:

R. S. F.	S.S.F.
• compressed air (2-5)min • pressurized water (8-10)min • preparation period (15-20)min	• Removal of dirty skin + (1-3)inch of sand top layer • Replacing it with new sand + preparation period (7-15 d)

Cleaning process steps for RSF:

a) **during filtration:**
v_1 on influent pipe & v_2 on effluent pipe are open

b) **cleaning process:**
1- Close V1 & V2

2- drainage of water
Open V3 &V6 until water level become 10 cm above sand layer.

3- Washing by air
open V4 (2-5) min.

4- Washing by pressured water
open (V5 + V3) for (8-10) minutes
If no air , the time will be (15-20) min

5- Preparing of filter
open V1 & V6 (15-20) min

Notes
Operation cycle → no. of wash times / d
12 hr → no. of wash = 2/d
24 hr → no. of wash = 1/d
36hr → no. of wash = 2/3 /d

(54)

Example

A W. T. P. of daily input 80,000 m^3. It is required to design the RSF units & find the amount of wash water required per day and % of wash water.

Given

Q_{des} = 80 , 000 m^3/d

Req.

- n, L, B of RSF
- amount of wash water per day

sol^n

Q_{des} = 80,000 m^3/d

R. S. F.

ass . ROF = 150 $m^3/m^2/d$
so A = Q / ROF = 80000 / 150 = 533 .33 m^2

for n

n = 533.33 /(40- 64) = 13.33 ----- 8.33 → take n_w = 10

So L = 8 m so B = 6.67 m → 6.65 m

L, B (5 - 8) m → ok

n_{total} = 10 + 2 for wash = 12

n_t = 10 + 2 = 12
L = 8 m , B = 6.65 m

Amount wash water (m^3/d)

ROW = (5-6) ROF = 5 x 150 = 750 $m^3/m^2/d$

Wash water for each filter = ROW x area of one filter x time of wash water
= 750 $m^3/m^2/d$ x (8 x 6.65) x 10 *min* / (60 x 24)
= 277 m^3

ass no. of washing times per day = 1 time /day

Total amount of wash water = W W for one filter x n_T x no of wash times/day
= 277 x 12 x 1 = 3324 m^3

% of wash water per day = $Q_{wash\ water}$ / Q_{plant} = (3324/ 80,000) x100= 4.15%

(55)

Example

A W. T. P. of daily input 50,000 m3 & working period 15 hr/ day.
Design the filter units:
1) As SSF
2) As RSF & find the amount of wash water required for washing two filters

Given
Qdes = 50 , 000 m3/d
w.p = 15 h/d

Req.
1) n,L, B of SSF
2) n,L, B of SRF + amount of wash water per day

Sol
Qdes = 50,000 / 15 = 3333.33 m3/ hr

1) SSF
ass . ROF = 5 m3/m2/d

so A = Q / ROF = 3333.33 m3/ hr * 24 / 5 m3/m2/d = 16000 m2

take a = 2000 m^2 = 50 m * 40 m

so n = 16000/2000 = 8 filters

n = 8
L = 50 m
B = 40 m

2) R. S. F.
ass ROF = 150 m3/m2/d
so A = Q / ROF = 3333.33 x24 / 150 = 533 .33 m2

for n
n = 533.33 /(40 → 64) = 13.33 ---- 8.33

so take n_w = 10
so L = 8 m so B = 6.67 m ~ 6.65 m

n total = 10 + 2 for wash = 12

n = 10 + 2 = 12
L = 8 m , B = 6.65 m

(56)

Amount of wash water (m3/d)

ROW = 5 x150 = 750 m3/m2/d
Wash water for 2 filter =
=ROW * area of one filter x time of wash water x n filters x no wash times
= 750 m3/m2/d x (8 x 6.65) x 10 min / (60 x 24) x 2 x 1
= 555 m 3

Example

Given:
Existing W.T.P with 8 R.S.F, a = 8 x 6 , max ROF= 6 m/ hr

Req: Q_{max} , amount of w.w./d

sol. $n_t = 8 = 6 + 2$ for wash.

$Q_{max} = (6 \times 8 \times 6) \times 6\ m^3/m^2/hr = 1728\ m^3/hr.$

amount of w.w./d $= (5 \times 144\ m^3/m^2/d) \times (8 \times 8 \times 6) \times 10\ min/(24 \times 60)$
$= 1920\ m^3$

Example
An existing W.T.P with 10 R.S.F working & 2 R.S.F. for wash each of area = 8 x 6 m^2 with max rate of rate of filtration = 150 $m^3/m^2/d$.
Check if this plant can serve a future pop of 400 000 c with max w.c. = 250 LCD & if unsafe find the additional units with the same dimensions.

Sol.

$Q_{max\ exist} = 150 \times 10 \times 8 \times 6 = 72000\ m^3/d.$

$Q_{max\ req.} = 400\,000 \times 250 / 1000 = 100\,000\ m^3/d. > Q_{max\ exist}$

we need additional units

$Q_{add} = \Delta Q = 100\,000 - 72\,000 = 28\,000\ m^3/d$

$SA_{add} = 28000 / 150 = 186.7\ m^2$, take a = 8 x 6

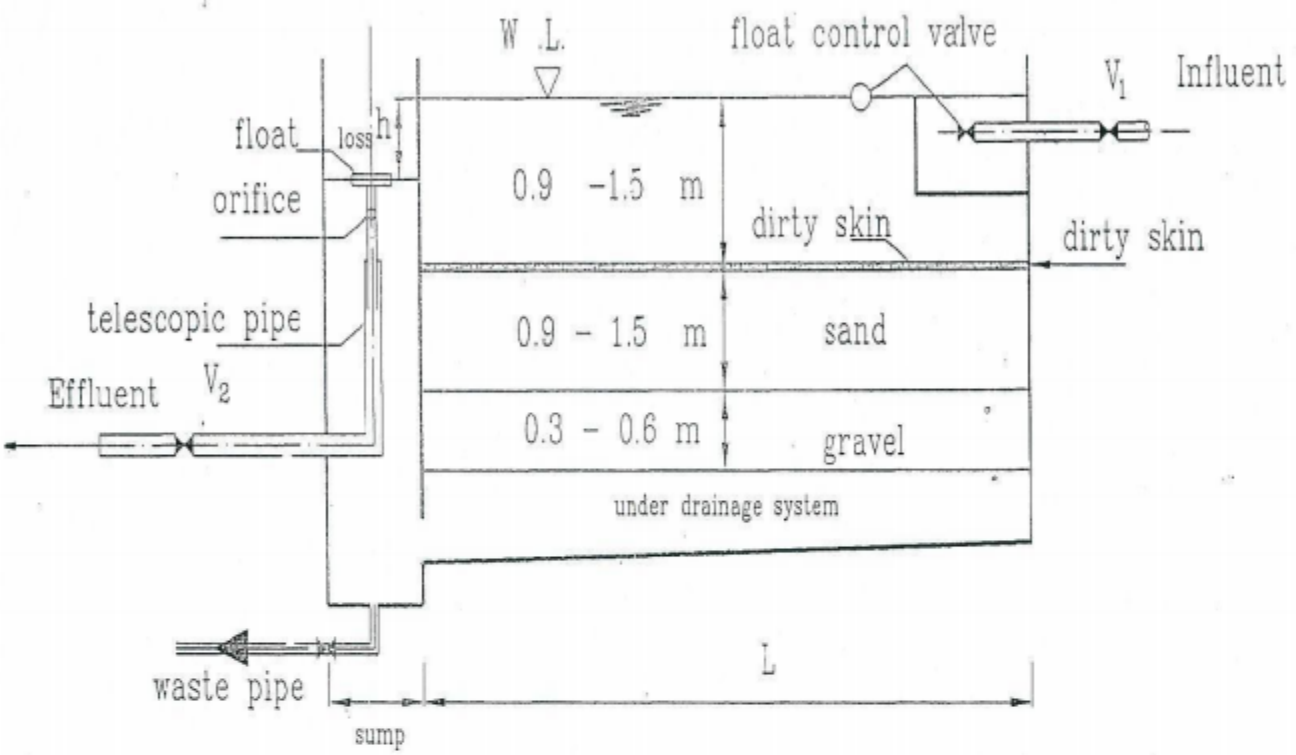
$n = 186.7/48 = 3.9 \quad n_{w\ add} = 4$

$n_{working\ total} = 10 + 4 = 14$ take n s.b total = 2

$n_{total} = 14 + 2 = 16$ (even)

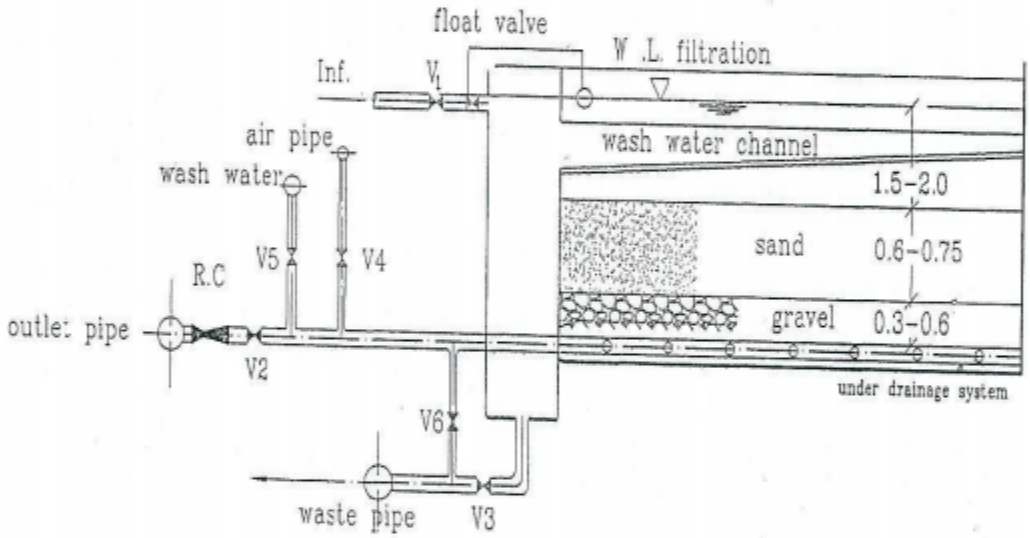
$n_{add} = 16 - 12 = 4$ filters.

(57)



Slow Sand Filter

(58)



Rapid Sand Filter

(59)