Filter Media
Filtre Yatak Malzemeleri

Dr. A. Saatci

Filtre Malzemeleri

Filtre Tabanı (ABD Tipi)

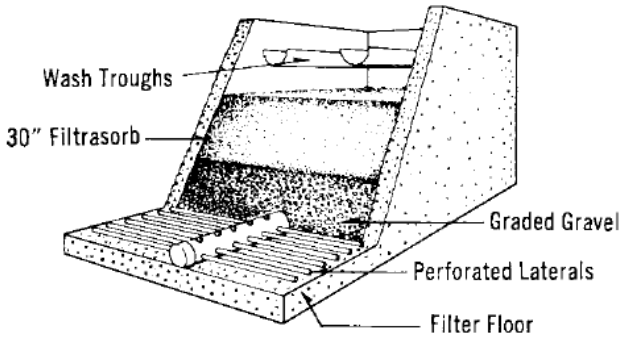


FIGURE 8.8 Rapid gravity filter with manifold and lateral underdrain system. (*Source:* After C. P. Hoover, Water Supply & Treatment, National Lime Assoc.)

Nozül Sistemi

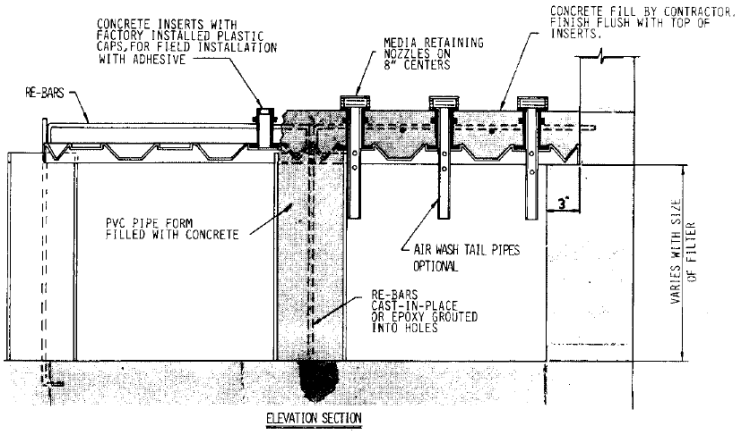
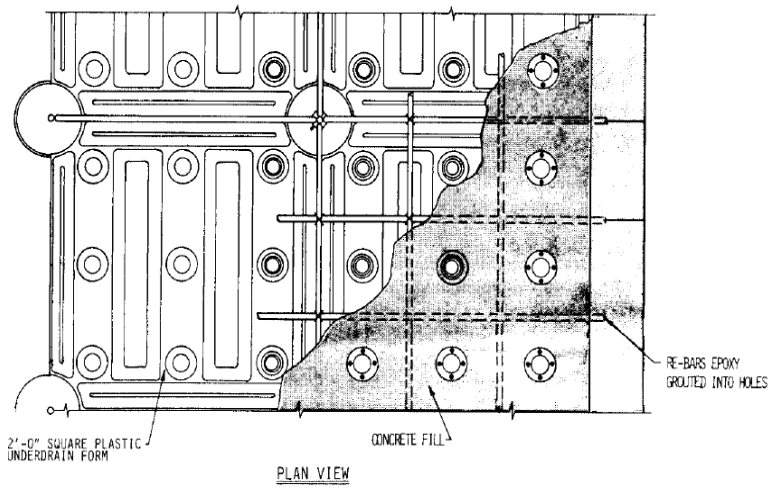
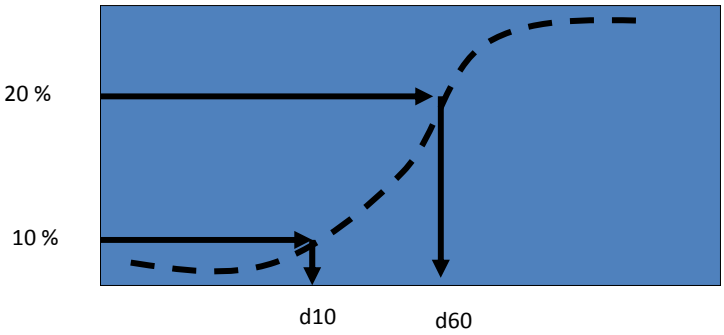


FIGURE 8.9 Nozzle underdrain system consisting of a monolithic, cast-in-place, concrete slab on a permanent plastic underdrain form with nozzles capable of air and water distribution. (*Source:* Multicrete II™, Courtesy of General Filter Co., Ames, Iowa.)

Filtre Tabanı



UC = d60/d10 < 1.42



ABD Filtre Malzemesi

Yeknesaklık Katsayısı(ABD Filtreleri Yatak Derinliği: 60 cm – 90 cm)

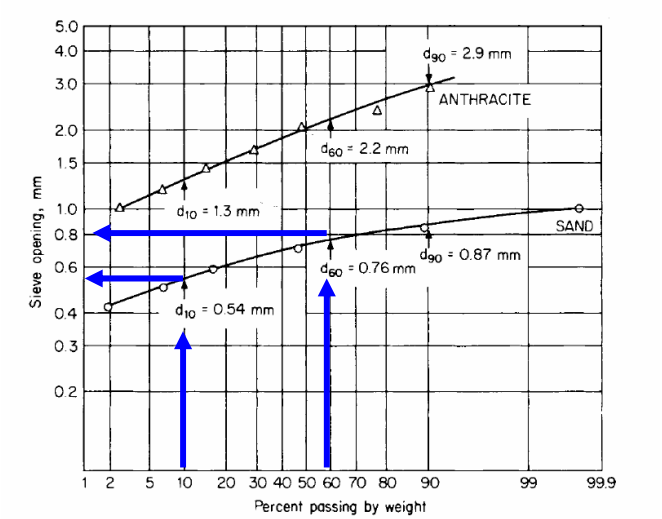


FIGURE 8.3 Typical sieve analysis of two filter media.

Filtre Malzemeleri

	Silica sand	Anthracite coal	Granular activated carbon	Garnet	Ilmenite
Grain density, ρ_s, Kg/m^3	2650	1450–1730	1300–1500*	3600–4200	4200–4600
Loose-bed porosity ϵ_o	0.42–0.47	0.56–0.60	0.50	0.45–0.55	**
Sphericity ψ	0.7–0.8	0.46–0.60	0.75	0.60	**

Yatak Malzemesi Seçimi

- Difüzör üzerine gelen en alt tabaka dane çapı > 2-3 * (drenaj sistemi orifis çapı)
- En üst tabaka en düşük dane çapı > 4-4.5 Efektif Çap
- UC <= (2)^0.5

Yatak Malzemesi Çeşitleri

- d10 (Efektif Çap) =0.35-0.6 mm (sade kum yatağı)
- d10 (Efektif Çap) = 0.4-0.55 mm kum ve 0.8-0.11 mm antrasit (çift yatak)

Yatak Malzemesi Çeşitleri

- Kum dane çapı sınırları: (0.3 mm) ile (1.18 mm) arası (tek yataklı kum)
- Kaba kum sınırları (0.5 mm ile 6.0 mm arası) derin yataklı kum filtrelerinde

Yatak derinliği/Efektif çap

- Normal kum

$L/d_e >= 1000$, (1mm→1m)

3- yataklı Filtre: Antrasit, Kum, Garnet

- $L/d_e >= 1250$Tek kum yatak:

$L/d_e >= 1250$, ($1.0 \text{ mm} < d_e < 1.5 \text{ mm}$)

- Tek yatak, kaba kum:

$L/d_e >= 1250$, ($1.5 \text{ mm} < d_e < 2.0 \text{ mm}$)

Filtre Hızları

TABLE 8.4 Full-Scale Results at Three Filtration Rates (Brown, 1955)*

Item	Filter no. 12 (2 gpm/ft^2) (4.9 m/h)	13 (3 gpm/ft^2) (7.3 m/h)	14 (4 gpm/ft^2) (9.8 m/h)
Length of run, h	135.2	116.7	81.3
Wash water, %	1.21	0.89	0.99
Turbidity, ppm	0.34	0.38	0.43
Bacteria, colonies/mL	0.32	0.42	0.36
Coliform organisms	Negative	Negative	Negative

Filtre Çıkış Kalitesi ve Yük Kaybı

Çıkış Bulanıklığı

Yük Kaybı

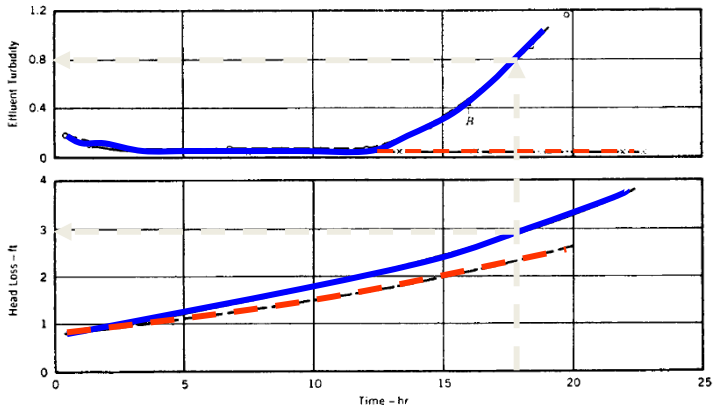


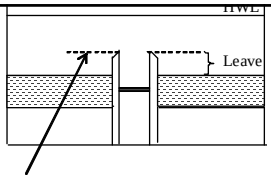
FIGURE 8.6 Effect of polyelectrolyte on length of run. The data shown were obtained under the fol-

Filtre Yatakları

- UC=1.3-1.8 (tek yataklı filtreler)
- UC= 1.2-1.3 (1.5 a kadar çıkabilir) (derin yataklı filtreler)
- Kaba kömür dane boyu/ince kum dane boyu = 3
- Polimer =0.02-0.05 mg/L (cazibeli filtreler)
- Basınçlı filtreler için daha fazla dozlar mümkündür.

FILTER DESIGN CRITERIA

Parameter	AWWA/ASCE, Third Edition (1988)
Rate	5 m/hr typical 24-37 m/hr for deep-bed uniform anthracite filters
Bed depth	0.6-0.9 m (single medium sand) 0.15-0.3 m sand and 0.46-0.76 m anthracite (dual media) 1.2-1.8 m (up to 2.4 m) in uniform deep-bed filters
Backwash	20-50 % expansion with 37-56 m/hr for 3-15 minutes (for "water wash only")
18-36 m/h	British practice: 18-36 $m^3/h/m^2$ air for 3-5 min followed by 12-18 m/hr water for single-medium sand media with ES=0.6-1.2 mm (air and water applied seperately)
36-90 m/h	US practice: 36-90 $m^3/h/m^2$ air followed by 37-56 m/hr water for dual-media or multimedia (air and water applied seperately)
108-144 m/h	Concurrent air/water wash for deep-bed filters: (36-72mg/L) 0.6-1.2 $m^3/min/m^2$ air and 1.4 m/h water (ES = 1.2 mm) and 1.8-2.4 $m^3/min/m^2$ air and 15.4-18.3 m/hr water (ES = 2.6 mm). Concurrent wash for 5-10 minutes followed by water wash for 5-10 minutes. Final water wash rate is 1 or 2 times that used with air. 2x 18.3=36.6 0 37 m/h.
d_{10} (ES)	0.35-0.6 mm (single medium sand) 0.4-0.55 mm sand and 0.8-1.1 mm anthracite (dual media)
Size limits	50 sieve (0.3 mm) to 16 sieve (1.18 mm) (single medium sand) Relatively coarse (from 0.5 mm to 6.0 mm) in uniform deep-bed filters
UC	1.3-1.8 (single medium sand) 1.2-1.3 with values up to 1.5 (deep-bed filters)
Mixing	Coarse coal size/fine sand size = 3
Primary coagulant	Metal salts Cationic polymer
Filter aid	Nonionic or anionic polymers (for coarse-to-fine media only) 0.02-0.05 mg/L for gravity filters
Coagulant aid	Nonionic or anionic polymers
Head losses	Clean bed = 0.3-0.6 m Clogging head loss = 2.4 to 3.0 m
Inlet/Outlet velocities	Influent conduits = 0.6 m/sec Filtered water and washwater = 0.9-1.8 m/sec
Water depth	Minimum 1 m above media to avoid air binding High filtration rates necessitate 1.5 m or more

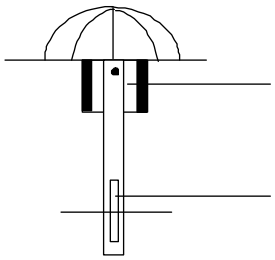


The air should be stopped when water level during B/W reaches this level not to loose sand into B/W trough.

0.5 between B/W channel & sand level for easy B/W of solids.(AWWA advises 0.75-0.90m for sand only. 1.1-1.3m if anthracite is used) AWWA: "Water Quality and Treatment", p. 522. "Vertical Distance from the fixed bed surface up to the top edge of the troughs ... Vertical dist to the trough edges should be increased when anthracite is used above the traditional 0.75-0.90 m. to 1.1 – 1.2 m".

B/W water velocities of 50-60 m/h (more than the fluidization velocity of ~ 45m/h for 0.8-1.2 mm sand) is required to release air from sand after B/W.

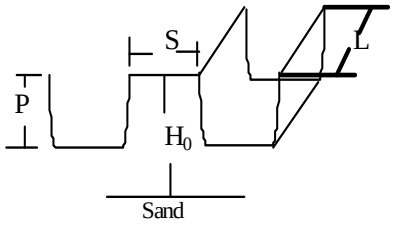
Nozzle



Air release hole to release trapped air so that slime growth in this part of nozzle not encouraged

Long air slot to account for mistakes in filter battom leveling

1) AWWA: "Water Quality and Treatment", p. 522. Vertical Distance from the fixed bed surface up to the top edge of the troughs ... Vertical dist to the trough edges should be increased when anthracite is used above the traditional 0.75-0.90 m. to 1.1 – 1.2 m.
2) Montgomery, p. 540-541. Fig. 21-35. Height (0.75L +P) H_0 (L+ PP; 1.5 H_0 < S < 2 H_0



FILTER BACKWASH

BRITISH PRACTICE

- ***Seperate Air & Water B/W***

	AIR ONLY	WATER ONLY	ES, mm
V, m/h	18 – 36	12 – 18 (no fluidiz)	0.6 – 1.2
t, min	3 – 5	10	

US PRACTICE

- ***Seperate Air & Water B/W***
  For Dual Media or Multimedia

	AIR ONLY	WATER ONLY	ES, mm
V, m/h	36 – 90	37 – 56(fluidiz)	06 – 1.2
t, min	3 – 5	10	

- ***Concurrent B/W***

	AIR & WATER		WATER ONLY	ES, mm
	AIR	WATER		
V, m/h	36 – 72	15	15 – 30	1.2
V, m/h	108 – 144	15 – 18	30 – 36	2.6
t, min	5 – 10		5 – 10	

ISTANBUL FILTERS

	AIR ONLY	AIR & WATER		WATER ONLY	ES, mm
		AIR	WATER		
V, m/h					
V, m/h					

Basınçlı Filtreler

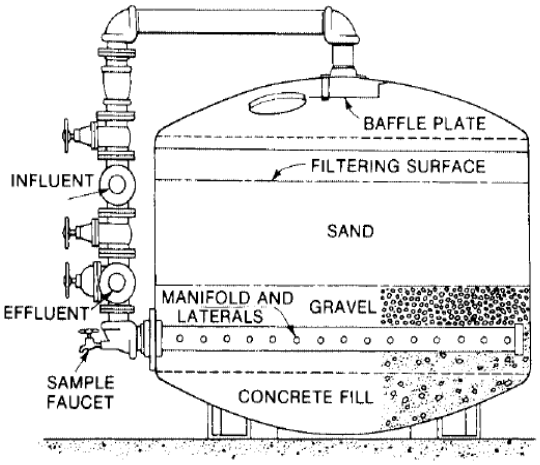


FIGURE 8.31 Cross section of typical pressure filter.

Filtre Tabanı (ABD Tipi)

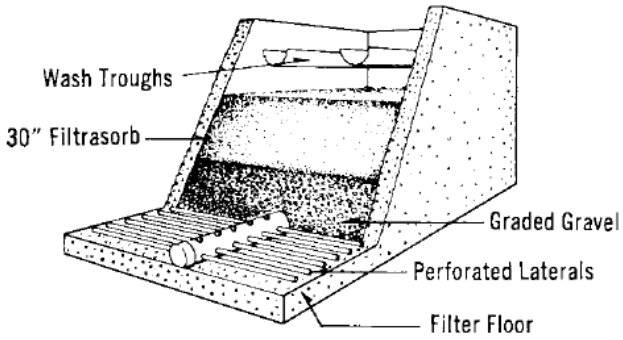


FIGURE 8.8 Rapid gravity filter with manifold and lateral underdrain system. (*Source:* After C. P. Hoover, Water Supply & Treatment, National Lime Assoc.)

Rapid Sand Filter Design

http://www.nptel.iitm.ac.in/courses/Webcourse-contents/IIT-KANPUR/wasteWater/design%20problem.htm

- ***Rapid Sand Filter Design***
- **Problem:** Design a rapid sand filter to treat 10 million litres of raw water per day allowing 0.5% of filtered water for backwashing. Half hour per day is used for bakwashing. Assume necessary data.
- **Solution:** Total filtered water = $\frac{10.05 \times 24 \times 10^6}{24 \times 23.5}$ = 0.42766 Ml / h
- Let the rate of filtration be 5000 l / h / m^2 of bed.
- Area of filter = $\frac{10.05 \times 10^6}{23.5} \times \frac{1}{5000}$ = 85.5 m^2
- Provide two units. Each bed area 85.5/2 = 42.77. L/B = 1.3; $1.3B^2$ = 42.77
- B = 5.75 m ; L = 5.75 x 1.3 = 7.5 m
- Assume depth of sand = 50 to 75 cm.

- Underdrainage system:
- Total area of holes = 0.2 to 0.5% of bed area.
- Assume 0.2% of bed area = $\frac{0.2}{100} \times 42.77 = 0.086\ m^2$
- Area of lateral = 2 (Area of holes of lateral)
- Area of manifold = 2 (Area of laterals)
- So, area of manifold = 4 x area of holes = 4 x 0.086 = 0.344 = 0.35 m^2 .
- Diameter of manifold = $(4 \times 0.35 / pi)^{1/2} = 66$ cm
- Assume c/c of lateral = 30 cm. Total numbers = 7.5/ 0.3 = 25 on either side.
- Length of lateral = 5.75/2 - 0.66/2 = 2.545 m.
- C.S. area of lateral = 2 x area of perforations per lateral.
- Take dia of holes = 13 mm
- Number of holes: $n \frac{pi}{4} (1.3)^2 = 0.086 \times 10^4 = 860\ cm^2$
- $n = \frac{4 \times 860}{3.14(1.3)^2} = 648$, say 650

- Number of holes per lateral = 650/50 = 13
- Area of perforations per lateral = 13 x p $(1.3)^2$ /4 = 17.24 cm^2
- Spacing of holes = 2.545/13 = 19.5 cm.
- C.S. area of lateral = 2 x area of perforations per lateral = 2 x 17.24 = 34.5 cm^2.
- \ Diameter of lateral = $(4 \times 34.5/p)^{1/2} = 6.63$ cm
- Check: Length of lateral < 60 d = 60 x 6.63 = 3.98 m. l = 2.545 m (Hence acceptable).
- Rising washwater velocity in bed = 50 cm/min.
- Washwater discharge per bed = (0.5/60) x 5.75 x 7.5 = 0.36 m^3/s.
- Velocity of flow through lateral = $\frac{0.36}{\text{Total lateral area}} = \frac{0.36 \times 10^4}{50 \times 34.5} = 2.08$ m/s (ok)
- Manifold velocity = $\frac{0.36}{0.345} = 1.04$ m/s < 2.25 m/s (ok)

- Washwater gutter
- Discharge of washwater per bed = 0.36 m^3/s. Size of bed = 7.5 x 5.75 m.
- Assume 3 troughs running lengthwise at 5.75/3 = 1.9 m c/c.
- Discharge of each trough = Q/3 = 0.36/3 = 0.12 m^3/s.
- $Q = 1.71 \times b \times h^{3/2}$
- Assume b =0.3 m
- $h^{3/2} = \frac{0.12}{1.71 \times 0.3} = 0.234$
- \ h = 0.378 m = 37.8 cm = 40 cm
- = 40 + (free board) 5 cm = 45 cm; slope 1 in 40

- Clear water reservoir for backwashing
- For 4 h filter capacity, Capacity of tank = $\frac{4 \times 5000 \times 7.5 \times 5.75 \times 2}{1000} = 1725\ m^3$
- Assume depth d = 5 m. Surface area = 1725/5 = 345 m^2
- L/B = 2; $2B^2 = 345$; B = 13 m & L = 26 m.
- Dia of inlet pipe coming from two filter = 50 cm.
- Velocity <0.6 m/s. Diameter of washwater pipe to overhead tank = 67.5 cm.
- Air compressor unit = 1000 l of air/ min/ m^2 bed area.
- For 5 min, air required = 1000 x 5 x 7.5 x 5.77 x 2 = 4.32 m^3 of air.

Yavaş Kum Filtreleri

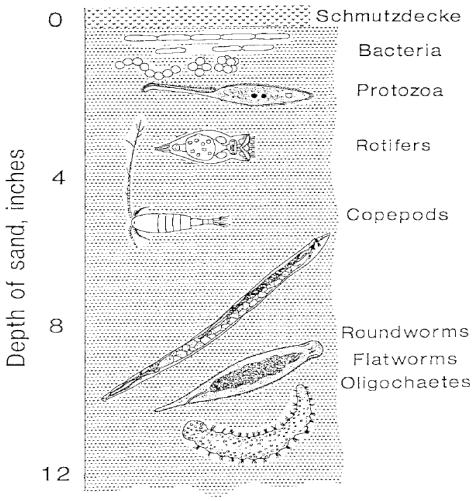


FIGURE 8.32 Typical slow sand filter biota at different depths. (*Source:* American Public Health Association, American Water Works Association, and Water Environment Federation. 1995. *Standard Methods for the Examination of Water and Wastewater,* 19th ed. Washington, D.C.: APHA.)

Yavaş Kum Filtresi Yatak Malzemesi

- Efektif Çap = 0.15-0.40 mm (tipik:0.30)
- UC= 1.5-3.6 (tipik:2)
- Kum Yatağı Derinliği,X= 0.5-1.5 (tipik:0.9 m)
- Taban Çakılı= 0.15-0.90 (tipik:0.45-0.60 m)