

FILTRATION MEDIA

MAKING THE RIGHT CHOICE

This discussion of filter media is intended to be a comparative summary of the products commonly used in residential and commercial pressure filtration. The topics covered here include descriptions, applications and operation guidelines. For basic principles of filter media, see Figure 1. For a comparison of filter media, see Table 1. There are other media that could be included in this list, but it offers a basic understanding of the principles involved.

Anthracite

Anthracite coal when crushed and graded makes an ideal medium weight filter media. Because of its irregular shape, sediment penetrates deeper into the bed resulting in longer service runs. In recent times, anthracite has been primarily used in dual or multi-media filters.

Density	(kg/dm ³):	0,80
Bed depth	(mm):	600 – 900
Service flow	(m/h):	12,5
Backwash flow	(m/h):	30 - 45

Birm®

Birm is a plastic filter media (see Filter AG) coated with magnesium oxide. The result is a lightweight product that has catalytic oxidizing capabilities. The catalytic activity is between dissolved oxygen in water and iron, and manganese in the water supply. The chemical relation causes the iron and / or manganese to precipitate (change from dissolved to a particulate) and the particulate then adsorbs to the surface of the media.

Density	(kg/dm ³):	0,75
Bed depth	(mm):	750 - 900
Service flow	(m/h):	8 - 13
Backwash flow	(m/h):	25 - 30

Manganese Greensand

Manganese greensand is naturally occurring glauconitic greensand coated with manganese resulting in a purple-black media. The intended use is as a catalyst to precipitation of iron, manganese and hydrogen sulfide. Greensand is continuously regenerated (CR) with KMnO_4 (potassium permanganate) and/or chlorine. Greensand may also be intermittently regenerated (IR) with KMnO_4 . CR capacity is 350 parts per million (ppm) per liter when regenerated with 50 – 100g of potassium permanganate per cft. and is calculated by KMnO_4 demand; where iron = 1:1, manganese = 1:2, and hydrogen sulfide = 1:4 ppm. That translates as removal of 350 ppm iron alone, 175 ppm manganese alone, or 90 ppm hydrogen sulfide alone. IR has half the capacity of CR or 175 ppm. It's common practice to place a 400 mm layer of anthracite on top of the greensand in CR applications.

<i>Density</i>	<i>(kg/dm³):</i>	1,35
<i>Bed depth</i>	<i>(mm):</i>	750 - 900
<i>Service flow</i>	<i>(m/h):</i>	5 - 12
<i>Backwash flow</i>	<i>(m/h):</i>	30 - 35
<i>Reg. Level</i>		1,5 – 3 g KMnO_4 / ltr MG

MTM[®]

MTM is a granular manganese dioxide filtering media used for reducing iron manganese and hydrogen sulfide from water. MTM works in the same fashion as greensand including regeneration with KMnO_4 and/or chlorine. The primary difference between MTM and greensand is MTM manufactured with a lightweight (plastic) core. This lightweight property reduces backwash rates and pressure drop of service flow.

<i>Density</i>	<i>(kg/dm³):</i>	0,44
<i>Bed depth</i>	<i>(mm):</i>	600 - 900
<i>Service flow</i>	<i>(m/h):</i>	7,5 – 12,5
<i>Backwash flow</i>	<i>(m/h):</i>	20 - 25

Corosex[®]

Corosex is a highly reactive magnesium oxide used to neutralize free carbon dioxide in water. Corosex is used in high flow and / or high pH correction situations. Limitations include the propensity to overcorrect in low flow or intermittent use applications. In waters containing medium to high hardness, calcium may precipitate resulting in cementing of the media.

<i>Density</i>	<i>(kg/dm³):</i>	1,60
<i>Bed depth</i>	<i>(mm):</i>	600 - 700
<i>Service flow</i>	<i>(m/h):</i>	12 - 15
<i>Backwash flow</i>	<i>(m/h):</i>	25 – 30

Table 1. Filtermedia Comparison

Media	Density kg/dm ³	Service m/h	Delta p bar	Peak Service m/h	Delta p bar	Bed depth mm	Back wash m/h*	Use	Limits
Anthracite	0,80	12	0,1	12,5	0,1	600-900	35	Sediment	Dissolved oxygen Hardness & alkalinity Alkalinity Chlorine Large particles Flow rate TDS>150, BW GPM TDS>150, BW GPM Regenerant Regenerant Dissolved oxygen BW GPM
Birm	0,75	8	0,1	13	0,1	750-900	25	Fe, Mn, H ₂ S	
Corosex	1,60	12	0,1	15	0,15	600-700	25	Neutralization	
Calcite	1,60	7,5	0,1	15	0,15	600-700	25	Neutralization	
Filter AG	0,40	8	0,1	12	0,2	600-900	20	Sediment	
Garnet	2,25	12	0,15	25	0,1	250+	65	Sediment	
GAC CI	0,40	8	0,1	13	0,1	600+	20	Chlorine	
GAC Organ	0,40	2,5	0,1	7,5	0,1	900+	20	Organics VOCs	
KDF 55	2,75	35	0,1	75		250+	70	Chlorine, H.	
KDF 85	2,75	18		35		250+	70	metals	
Greensand	1,35	5	0,15	12	0,3	750-900	30	Fe, Mn, H ₂ S	
MTM	0,44	7,5	0,1	12,5	0,1	600-900	20	Fe, Mn, H ₂ S	
Multi-media	1,47	25	0,4	40	0,8	900+	35	Fe, Mn, H ₂ S	
Pyrolox	2,0	12	0,1	15	0,1	600+	65	Sediment	
Sand	1,6	7,5	0,1	12	0,1	450-700	45	Fe, Mn, H ₂ S Sediment	

* For 15°C water. Warmer water requires smaller flow rate, colder requires a higher rate.
 Note: All flow rates are per m² of filter surface area. Multiply all values given by the filter tank m² value

Figure 1. The Basic Mechanisms

Filtration occurs in two mechanisms. The first is simply a sieving action for removal of suspended matter. Anything larger than the spaces between grains of media is trapped. Filter media removes suspended particles but also filter to a smaller micron size than the spaces between granules. Grains of filter media are typically in the 300-1.700 micron size with spaces between them of 25 - 500 microns. The ability to filter to below the actual inter-particle space size is due to the surface of the filter media. This process is influenced by a number of variables including gravitational setting, diffusion, interception and hydrodynamics. These variables are in turn affected by physical properties such as filter size, filtrate rate, fluid temperature, density, size and shape of suspended matter. Also, don't forget electrostatic repulsive forces and Van der Waal's forces, whereby electrons correlate dipolar movement of subatomic particles affecting attraction. In addition, we use filter media that's formulated with additional characteristics including oxidation, reduction and neutralization. All filter media requires backwashing, some utilize a regenerant and many have water constituent limitations or requirements.

As a consequence of the complexity of the filtration process, the service flow rates on product literature are estimates at best. Service flow must be matched to the adsorption criteria. Contaminants in water may have a low, medium or high surface area, thus affecting its ability to adsorb certain constituents. If the flow rate exceeds the design rate, poor filtration is likely. Backwash rates are designed to fluidize (lift) the filter bed based on the density of the filter media. Low backwash rates result in incomplete cleaning of the bed and premature failure of the filter. Backwash rates that are too high can result in the loss of filter media.

Pyrolox®

Pyrolox is a mined ore (manganese dioxide) used for iron, manganese and hydrogen sulfide reduction. Pyrolox – like Birm, greensand and MTM – acts as a catalyst to oxidation. Waters low in dissolved oxygen cannot use the catalytic properties of Pyrolox. It doesn't require a regenerant but must be backwashed aggressively. Backwashing causes the media to abrade itself resulting in a new exposed surface. Inadequate backwash rates and low dissolved oxygen are the two primary causes of filter failure when using Pyrolox.

<i>Density</i>	<i>(kg/dm³):</i>	2,0
<i>Bed depth</i>	<i>(mm):</i>	600+
<i>Service flow</i>	<i>(m/h):</i>	12
<i>Backwash flow</i>	<i>(m/h):</i>	60 - 75

Filter-Ag® (Ag)

Filter-Ag is a non hydrous silicon dioxide material designed to be a lightweight "sand". Ag weighs 0,40 kg/dm³ vs. Sand at 1,60 kg/dm³. It has an irregular surface, which increases surface area over many natural silica products. Ag is intended for removal of suspended solids (turbidity).

<i>Density</i>	<i>(kg/dm³):</i>	0,40
<i>Bed depth</i>	<i>(mm):</i>	600 - 900
<i>Service flow</i>	<i>(m/h):</i>	12
<i>Backwash flow</i>	<i>(m/h):</i>	20 - 25

Garnet

Garnet is a high density and small mesh size filter media. Due to its density, it classifies with the media fines on the top, resulting in very fine filtration in the 10-20 micron range. Because of this fine top layer, filtration garnet is seldom used alone as filter runs would be very short. Garnet is used in dual or multi-media filters where larger particles are filtered by larger mesh media.

<i>Density</i>	<i>(kg/dm³):</i>	2,25
<i>Bed depth</i>	<i>(mm):</i>	250+
<i>Service flow</i>	<i>(m/h):</i>	25
<i>Backwash flow</i>	<i>(m/h):</i>	60 - 75

Multi-media (multi-layer)

The practice of layering several different media (usually 3 or 5) results in higher service flow rates and finer filtration down to 10 micron. The media are loaded by density and reverse grading. The most dense media with the smallest mesh size is loaded first and the least dense with the largest mesh size is loaded last with intervening media layered in the same manner. As a result, larger particles are filtered in the first of top layer and

successively smaller particles are adsorbed in succeeding layers. The most common media mix from top to bottom is: anthracite, filter sand, garnet 30x40 (0,4 – 0,6 mm), garnet 8x12 (1,7 – 2,4 mm), gravel 1/8 x 1/16 (1,6 – 3,2 mm), and gravel 1/4 x 1/8 (3,2 – 6,3 mm). While any combination of media can be labeled multi-media, the above section has come to be called multi-media.

<i>Density</i>	<i>(kg/dm³):</i>	<i>1,47</i>
<i>Bed depth</i>	<i>(mm):</i>	<i>900</i>
<i>Service flow</i>	<i>(m/h):</i>	<i>25</i>
<i>Backwash flow</i>	<i>(m/h):</i>	<i>35</i>

Sand

Filter sand is naturally occurring, graded and washed sand that's high in silica and low in calcium. It's used for sediment filtration and is often part of a multi-media mix. Sand filters may be the oldest man-made filters and they mimic nature's filtration.

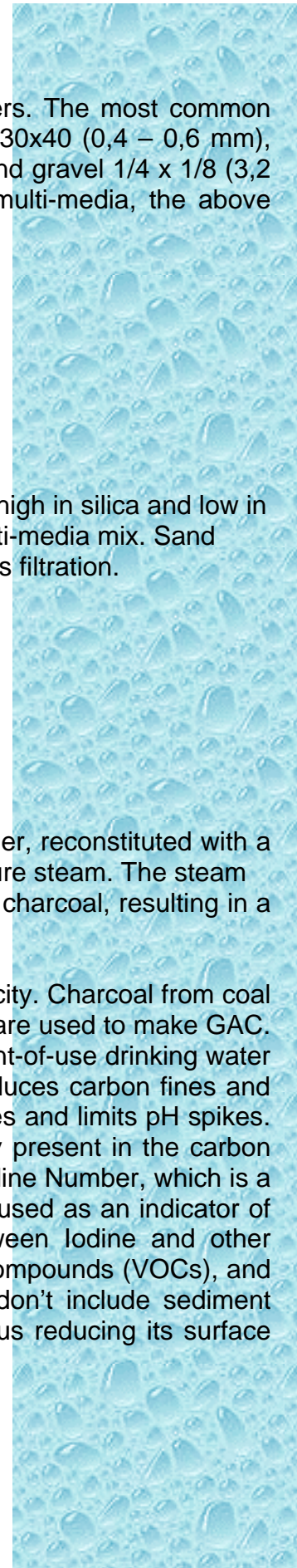
<i>Density</i>	<i>(kg/dm³):</i>	<i>1,60</i>
<i>Bed depth</i>	<i>(mm):</i>	<i>450 - 750</i>
<i>Service flow</i>	<i>(m/h):</i>	<i>7 - 12</i>
<i>Backwash flow</i>	<i>(m/h):</i>	<i>35 - 50</i>

Granular activated carbon (GAC)

To manufacture activated carbon, charcoal is crushed to a powder, reconstituted with a binder to the desired mesh size, then treated with high temperature steam. The steam treatment is the activation process, which creates cavities in the charcoal, resulting in a high surface area to volume ratio.

The high surface area gives GAC much greater adsorptive capacity. Charcoal from coal (anthracite), petroleum, animal bones, wood and coconut shells are used to make GAC. Bituminous coal accounts for most of the GAC being used in point-of-use drinking water applications. Acid washing is an optional preparation, which reduces carbon fines and limits pH spikes. Acid or water washing also reduces carbon fines and limits pH spikes. Acid or water washing also reduces any contaminants naturally present in the carbon source. There are several measures of GAC quality including Iodine Number, which is a measure of the amount of iodine adsorbed by weight. Iodine is used as an indicator of the adsorptive capacity but there's no direct correlation between Iodine and other constituents. GAC is used to reduce organics, volatile organic compounds (VOCs), and taste and odor causing constituents. The best uses of GAC don't include sediment removal. Most suspended solids will fill the cavities in GAC, thus reducing its surface area and adsorptive capacity.

<i>Density</i>	<i>(kg/dm³):</i>	<i>0,40</i>
<i>Bed depth</i>	<i>(mm):</i>	<i>600 - 900</i>
<i>Chlorine removal service flow</i>	<i>(m/h):</i>	<i>8 - 13</i>
<i>Backwash flow</i>	<i>(m/h):</i>	<i>20 - 25</i>



KDF55

KDF process media are high purity copper-zinc granules (50 percent Cu; 50 percent Zn) that use the redox (the exchange of electrons) to remove chlorine, heavy metals and is bacteriostatic. KDF has an unusually high service flow rate compared to other filter media. KDF cannot be used in aggressive water and is often preceded by some form of neutralization.

<i>Density</i>	<i>(kg/dm³):</i>	2,75
<i>Bed depth</i>	<i>(mm):</i>	250+
<i>Service flow</i>	<i>(m/h):</i>	75
<i>Backwash flow</i>	<i>(m/h):</i>	75

KDF85

KDF process media are high purity copper-zinc (85 percent Cu; 15 percent Zn) granules that use the redox (the exchange of electrons) in products to remove iron, manganese, hydrogen sulfide and is bacteriostatic. KDF has an unusually high service flow rate compared to other filter media. KDF cannot be used in aggressive water and is often preceded by some form of neutralization.

<i>Density</i>	<i>(kg/dm³):</i>	2,75
<i>Bed depth</i>	<i>(mm):</i>	250+
<i>Service flow</i>	<i>(m/h):</i>	35
<i>Backwash flow</i>	<i>(m/h):</i>	75

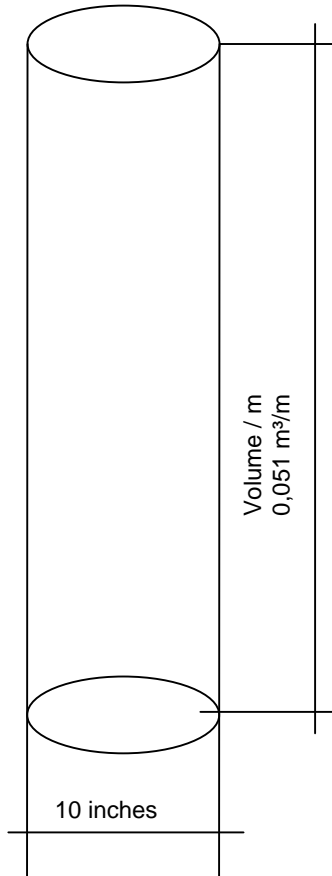
Figure 2. Sizing Calculations

In addition to selecting appropriate media for a filter application, sizing cannot be ignored. Obviously, one must size for normal service flow but peak flow and backwashing requirements must also be considered. Most filter media have negligible pressure drop at the recommended service flow rate and can easily handle peak loads up to double the service flow rate without pressure loss concerns. There are exceptions, however, as evidenced by multi-media where double the service flow rate of 2,5 m³/h would result in a pressure loss of 1,25 bar.

In some water, chemistry quality suffers with any flow disruption. Peak flows should be limited to the gallons of the empty bed volume (EBV) of the filter. In other words, if you have a 10x54-inch filter tank, the peak flow shouldn't last longer than 18,36 gallons (see Table 2).

Backwash rates are often double the service flow rate causing problems if the filter was sized to handle the total available flow from a well pump. If the well pump delivers 2,2 m³/h it's sized for such, it will require 4,5 m³/h for backwash but the well pump is still limited to 2,2 m³/h.

Table 2. Tank Formula Chart



Square Area = ((D)² x 3,14 / 4)

Example Tanktyp 10 x 54 :
 D = Diameter in inches
 H = Height in inches
 1" = 2,54 mm

$$(10 \times 2,54 / 100) \times (10 \times 2,54 / 100) = 0,0645$$

$$0,0645 \times 3,14 / 4 = 0,0506 \text{ m}^2$$

Liter Volume per Meter = ((D)² x 3,14 / 4) x H

Example Tanktyp 10 x 54 :
 D = Diameter in inches
 H = Height = 1,0 m
 1" = 2,54 mm

$$((10 \times 2,54/100) ^2 \times 3,14/4) \times 1 = 0,051 \text{ m}^3$$

Volume of a tank = D² x H (inches)

Example Tanktyp 10 x 54
 10 x 10 = 100 x 54 = 5400 x 0.0034 = 18.36 gal
 1" = 2,54 mm

$$((10 \times 2,54/100) ^2 \times 54 \times 2,54/100) = 0,088 \text{ m}^3$$

Diameter (inch)	S.A. m²	Volume / m m³/m	Vol / H Ltr / inch
8	0.032	0.032	0,8
9	0.041	0.041	1,0
10	0.051	0.051	1,2
12	0.073	0.073	1,8
14	0,099	0,099	2,5
16	0.129	0.129	3,3
20	0,203	0,203	5,1
22	0,245	0,245	6,2
24	0,291	0,291	7,4
30	0,456	0,456	11,6
36	0,656	0,656	16,6
42	0,892	0,892	22,7
48	1,166	1,166	29,6
54	1,476	1,476	37,5
60	1,823	1,823	46,3