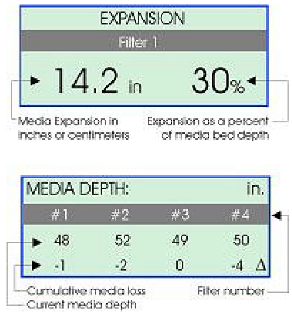
Entech Design, Inc.

Bed Filter Expansion Measurement

Entech Design Inc. is an innovative manufacturer of quality sonar interface detection instruments. Our equipment uses fixed-point transducers (in single and multiple sensor configurations) for simple sediment level, blanket level and liquid level detection and employs remotely controlled scanning transducers to produce three dimensional images of sediment in power industry bottom ash hoppers and slag tanks. Systems are designed specifically for harsh industrial applications for exposure to high temperatures, harsh chemicals and a wide range of physical properties of materials in process liquors.

Online Measurements are Continuously Updated in Easy to Read Views



Systems are engineered to meet the unique requirements of the industries in which they are applied. System operating frequencies are selected for the specific requirements of light-density suspended solids typical to Water and Wastewater clarifiers and thickeners. Lower frequency systems are applied in industrial applications with greater solids concentrations and agitation in the settling zone.

Superior signal analysis and tracking intelligence is engineered into every system, and performance is proven in extensive field installations. Contact us for a product demonstration in your application!

The Expansion Pro Analyzer is an application specific instrument designed to measure media expansion in granular media filters. **EPA 2000™** also monitors media level between backwash cycles - i.e. while the filter is in service. **EPA 2000™** employs EDI's highly effective underwater acoustic sensing technology to provide an accurate and cost-effective solution to this critical measurement requirement.

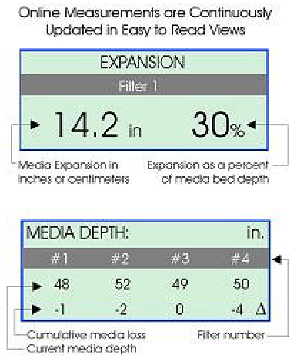
Municipal surface water plants typically have from 4-40 filters at one site with perhaps 6-12 as a reasonable range of average number. It is important to note that in surface water treatment plants, filtration is the primary treatment process - and backwashing is the primary means to keep the filters functioning properly. These are not ancillary or secondary processes. They are absolutely fundamental to production of the final product - safe drinking water!

Granular Gravity Filters

As the name states, these filters use a granular media to filter impurities and sediment from raw water. Filter media is typically sand, anthracite or granular activated carbon (GAC). Often two types of media are layered in the filter, for example: anthracite or GAC over sand. Media expansion varies with size and type of media, uniformity of grain size and backwash water temperature. Media size and uniformity changes over time as the media grains break down or "wear" from use and frequent backwashing. Backwashing frequency varies widely across plants and even across filters within a particular plant, typically ranging from once in 12 hours to once in 120 hours. However, experts recommend backwashing at least once every 60 hours regardless of other factors. Filters are typically washed when head pressure exceeds established norms or when turbidity "breakthrough" is noted.

Bed Filter Expansion Measurement

A granular filter, water softener or anion exchanger should have a bed expansion of approximately 50% during backwash to most efficiently rid the bed of collected particulate matter and filtered material and to loosen the bed to prevent channeling. The bed expansion during backwash should not be significantly greater than 50% to prevent filter media going over the top of the tank and out to the drain.



Important Points to Note:

1. Inadequate filter backwashing is a costly mistake - results in not getting the filter clean and/or washing out costly media.

2. Filter media should be expanded 50% of the bed depth to rid |the bed of collected particulate matter and to prevent channeling.

3. Increasing backwash duration will not produce the desired washing effect - adequate media expansion is required to get the filter cleaned.

4. Calculating theoretical flow rates to achieve desired expansion is tedious and must be re-calculated for changing water temperatures.

Field Experience has Found:

1. Plants typically do not know how much expansion they are achieving, and when we measure it online - it is always less than they expect and virtually NEVER 50%.

2. Expansion Pro Analyzer 2000 provides accurate, easy to use and reliable on-line measurements to assure optimal, consistent filter backwashing. It can be used to support and/or control automatic backwashing or as a tool to optimize operator control.

3. Expansion Pro Analyzer 2000 eliminates the need for tedious and difficult flow calculations. On-line measurement takes the guesswork and uncertainty out of this critical function.

50% Bed Expansion = Optimum filter operation

less than 50% = performance loss

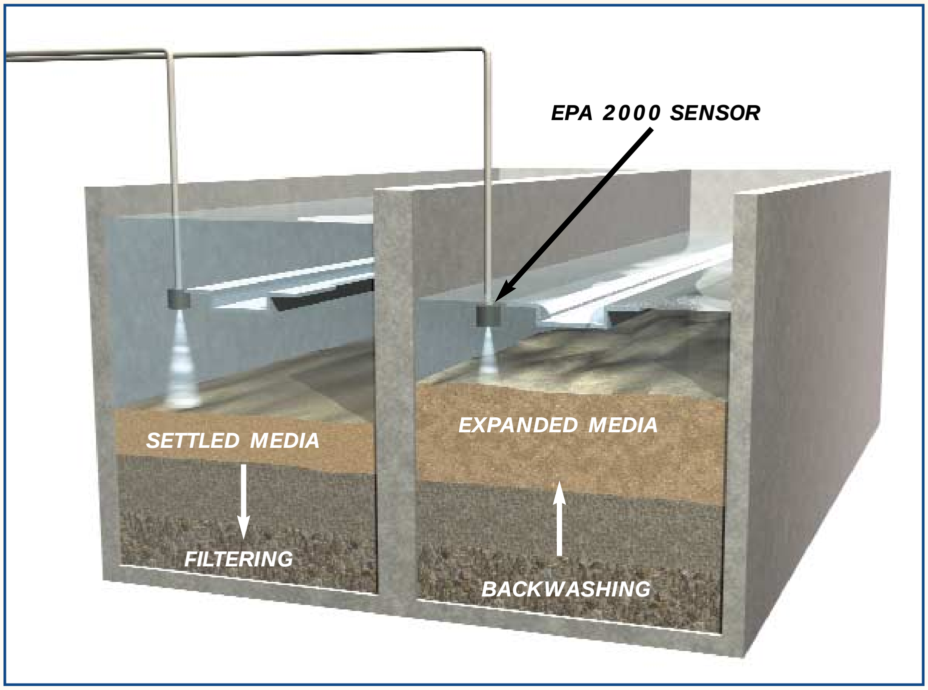
more than 50% = media loss

Optimize Filter Cleaning Through *Expansion Pro Analyzer - EPA 2000*™

Media expansion measurement takes guesswork out of gravity filter backwashing

Primary Benefits

- ***Improve Filter Cleaning***
- ***Extend Filter Run Time***
- ***Reduce Turbidity***
- ***Reduce Media Loss***
- ***Promote Even Media Re-stratification***



Measurements:

- *Measures media expansion while backwashing filter*
- *Measures settled media level between backwash cycles*

Features:

- *Cost effective single & multi-sensor systems*
- *No moving parts, no maintenance required*
- *Multi-function LCD & operator control panel*
- *Simple set-up and operation*
- *Automatic initialization & calibration*

Expansion Pro Analyzer - EPA 2000™

Installation:

- Threaded transducer housings provide simple connection to standard conduit or pipe.
- Mounting brackets and hardware are available for transducers and processors.
- Engineered installation systems fabricated for tanks with special requirements.
- Approvals -

  CE, including Low Voltage Directive, Transducers certified to VDE standards for use in Zone 1 hazardous areas are available.

Specifications:

- Measurement Type - single beam, underwater acoustic sensor, 6˚ full beam.
- Measurement Range - minimum range: 1 ft., maximum range: 328 ft., accuracy: 0.1 ft.
- Distance of Transducer from Processor - 1500 ft.
- Outputs - 4-20mA Current Loop (4), 10 amp contact relays (4), Serial Port for RS232 and RS485 interface.
- Power Requirements - 110/220 VAC, 50/60 Hz, 100 Watts
- Temperature Range - Processor: -40˚ to +140˚F (-40˚ to +60˚C)

  Standard Transducer: -40˚ to +120˚F (-40˚ to +50˚C)
- Mechanical -

  Processor:

  Housing - molded fiberglass polyester, NEMA type 4X, Weight - 8lbs. Size (nominal) -10” x 8” x 6”

  Standard Transducer: Material - PVC and epoxy, Weight - 1lb.

Also Available - BinMinder 9300™ Sludge Blanket Level Detector

- Primary, secondary and raw water (alum) clarifiers
- Gravity thickeners and dissolved air flotation thickeners
- Round and rectangular tanks
- Handles surface skimmer and bottom rake
- Cost effective single and multi-sensor systems
- Entech Design, Inc. Brochure No. BMN0998 for complete details

Superior Performance at Industry Leading Low Cost

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Entech Design, Inc.

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Expansion Pro Analyzer Transducer
Part No. 2006-49

Measurement Type
Single beam, underwater acoustic sensor
6° full beam
Operating frequency: 657 KHz

Dimensions (nominal)
1.5" diameter x 1.75" height
Wt. 0.25 lb.

Connections
Mechanical: ½ inch NPT female thread integral to transducer housing.
Electrical: Two conductor, shielded 22 gauge stranded cable integral to transducer. Standard cable length: 20 ft. May be extended to 1000 ft. by field connection using Belden 9461 cable.

Materials of Construction
Housing: PVC
Encapsulating material: 20AC-7V epoxy

Process Water Temperature Range
+35°F to +120°F

TECHNICAL PAGES

Water treatment Q&A

Understanding critical bed expansion for softeners and filters.

By David M. Bauman | Technical Editor

Q: I usually buy completed softeners and filters for resale but now I have so many used components in my shop that I'm starting to assemble them to make equipment for rental.

I have a variety of control valves with identifying numbers for the backwash (drain line) flow controls. I have the flow rates for some of these flow controls but I'm not sure how to use them.

What is the principle or theory behind this?

A: It's easy to make a costly mistake if you don't understand the important principle of backwash flow rate and bed expansion in water softener and filter design.

The basis for all the following technical information is the general rule of thumb: A water softener, anion exchanger or filter shall have a bed expansion of approximately 50 percent during backwash to rid the bed of collected particulate matter and filtered material, and to loosen the bed to prevent channeling.

The principles that control bed expansion are:

- Density of the medium;
- Particle size;
- Temperature; and
- Backwash flow rate per square foot.

Don't worry about the density or particle size because the media manufacturers incorporate these into the performance data sheets' bed expansion curves.

In addition, temperature can't be controlled but you must know what it is.

You can control the backwash rate. The goal is to provide a backwash that will yield a 50 percent bed expansion without the media going over the top of the tank and out to the drain.

Understanding freeboard

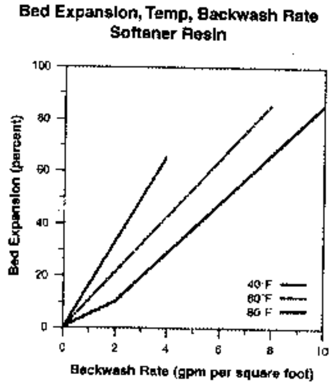
Freeboard is the space allowed above the media bed for expansion. It may be expressed in inches, such as 12.75" of freeboard, or as a percent calculated by dividing the freeboard inches by the bed depth in inches. For example, 12.75" / 24" = 0.53, or 53 percent freeboard.

Freeboard should be equal to or greater than the bed expansion. For instance, freeboard might be 53 percent while bed expansion might be 50 percent.

Let's get started

First, obtain the flow rate for each of the drain line flow controls and the performance data sheets for the softener or filter media from the manufacturers or wholesalers. These media data are called bed expansion curves.

Figure 1



What you will find is the bed expansion, in percentage, at different temperatures and backwash flow rates. If a 50 percent expansion is shown and the bed is 24" deep, the expanded bed is 36" (24 x 1.5).

To use this data, simply estimate the water temperature and then look it up on the graph to find the flow rate that provides 50 percent bed expansion (See Figure 1). The flow rate will be expressed as gpm per square foot.

To convert this information to the actual backwash rate (drain line flow control rate) in gpm, multiply the gpm per square foot from the graph times the square feet of the tank you are using. For reference, square feet of a tank = [diameter/2^2] x 3.14.

Also, for reference, see the tank area table (see Table 1).

Example: Your temperature is estimated at 60 degrees Fahrenheit and a softening resin bed expansion graph (see Figure 1) indicates that a backwash of 4.5 gpm per square foot is needed to achieve a 50 percent bed expansion. You want to make a 10" diameter softener.

Multiply 4.5 gpm times the area of a 10" tank (0.546 square feet), and you

Using water temperature

To use water temperature in the backwash calculation, do not take the temperature of each installation. However, you should know the temperature of typical well water and typical municipal water.

Because these values can change seasonally, it's best to know and use the lowest temperature. Doing so will yield the lowest and safest backwash rate.

— D.B.

(2)

get 2.46 gpm. This is the calculated backwash rate.

Look at the flow rates of the available backwash flow controls to find one that is close to 2.46. You may have to settle for 2.0, 2.25 or 2.5 gpm. This will be the actual backwash rate.

Table 1: Tank areas for calculating backwash rates

Tank diameter	7"	8"	9"	10"	12"	14"
Area (sq. ft)	0.267	0.349	0.441	0.546	0.785	1.07

Considerations

Now that you have chosen the correct drain line flow control, there are a few other considerations to keep in mind.

Media volume

A manufacturer's media volume may not always allow for a 50 percent freeboard. The media depth and the freeboard can be checked using the volume table shown (see Table 2).

If a 12" diameter tank contains 2.0 cubic feet, its bed depth is 2.0/0.065 = 30.78". If the tank is 48" high, and 45" is considered the usable height, then the freeboard is 45" – 30.78", or 14.22".

In percentages the freeboard is 14.22/30.78, or 46 percent — a little less than the target 50 percent.

Well water

When using private well water it is important the well pump is at least equal to the drain line flow control. This is especially important for filters because they require a much greater backwash rate than a softener.

Don't be deceived by what comes from the pressure tank — it can empty within a few minutes, leaving you with several more minutes of backwash at a much lower well pump rate.

(Concluded on next page)

Table 2: Volume in cubic feet per inch of tank height

Tank diameter	7"	8"	9"	10"	12"	14"
Cubic feet per in. of height	0.022	0.029	0.037	0.046	0.0650	0.089

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Water temperature

Because equipment manufacturers don't know what the water temperature will be, their choice of drain line flow controls is usually not proper for both cold and warm waters.

If the softeners and filters are designed for Florida water temperatures (high backwash rates), the bed expansion in Wisconsin is likely to be too great, resulting in resin or filter media loss. If the drain line flow controls are designed for Wisconsin (low backwash rates), the bed expansion in Florida will be inadequate to clean the bed.

These are both subtle types of failures that wouldn't cause immediate attention, but will cause service headaches later on. It's probably a good idea to check the freeboard, backwash rate and bed expansion of each of the models you sell to be sure it fits your situation.

Losing resin

For a 10" x 44" softener tank a 2.4 gpm drain line flow control is chosen for a high seasonal summer temperature of 60 degrees Fahrenheit. The 50 percent bed expansion of this 26" deep bed (1.2 cubic feet) is 39".

Forty inches is the usable height since the top and bottom 2" of the tank can't be utilized because of the reduced diameter of the domes.

In winter the water temperature falls to 40 degrees Fahrenheit. The resin manufacturer's graph says that at 40 degrees Fahrenheit the bed expansion will be 75 percent — 5.5" over the usable 40".

Resin will be lost to the drain and capacity will be lost, causing hardness leakage before each future regeneration.

— D.B.

Having the proper backwash rate is equally important for filters, as it is for softeners. Since filters are usually loaded with iron or other problem contaminants, the backwash rate and duration are more critical than with a softener used on clean, iron free water.

Don't try to correct for an inadequate well pump by increasing the backwash duration — you will not get the necessary bed expansion.

David M. Bauman is technical editor of Water Technology *and a water treatment consultant in Manitowoc, WI.*