THE OHIO STATE UNIVERSITY EXTENSION

FACT SHEET

Agriculture and Natural Resources

AEX-757-08

Sand Size Analysis for Onsite Wastewater Treatment Systems

Determination of Sand Effective Size and Uniformity Coefficient

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Introduction

In many areas of Ohio, natural soil is not deep enough to completely treat wastewater. Rural homes and businesses may need to install an onsite wastewater treatment system if a septic tank-leach line system cannot be used. Sand bioreactors are one option. To learn more, consult Bulletin 876, *Sand Bioreactors for Wastewater Treatment for Ohio Communities* at the web site http://setll.osu.edu or a local OSU Extension office.

Size distribution is one of the most important characteristics of sand treatment media. Sand bioreactor clogging is usually the result of using sand that is too fine, has too many fines, or has a weak or platey structure. The most important feature of the sand is not the grains, but rather the pores the sand creates. The treatment of wastewater occurs in the pores, where suspended solids are trapped, microorganisms grow, and air and water flow. Determination of size distribution of sand particles is a direct measurement of sand media structure. It is usually measured as the effective size and the uniformity coefficient. For example, ideal sands for intermittent bioreactors are a medium to coarse sand with an effective size between 0.3 mm and 1.5 mm. The uniformity coefficient should be less than 4.0.

Ohio EPA requires that owners and operators of sand bioreactors use certified sand, which is tested through a sieve analysis and met the criteria of one of the following standards:

(a) ASTM C136, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates;" or

(b) ASTM D451, "Standard Method for Sieve Analysis of Granular Mineral Surfacing for Asphalt Roofing Products"

How Is a Sieve Analysis Conducted?

Apparatus

- Scale (or balance)—0.1 g accuracy
- No. 200 sieve
- A set of sieves, lid, and receiver
- Select suitable sieve sizes (table 1) to obtain the required information as specified, for example Nos. 3/8", 4, 10, 20, 40, and 60
- Drying oven 110 +/−5°C (230 +/−9°F)
- Metal pans—one for each sieve size, plus one for sample
- Mechanical sieve shaker—optional

Method

1. Label with sieve number or size and weigh metal sample pans (W_P), and set aside.
2. Begin with about a 100-gram sample of sand. Put sand in a metal pan and dry it in 105–115°C oven for two

Table 1. Sieve number (ASTM – E11) and mesh size.

No.	Mesh Size (mm)	No.	Mesh Size (mm)	No.	Mesh Size (mm)	No.	Mesh Size (mm)
1"	25.0	7	2.80	20	0.85	60	0.250
3/4"	19.0	8	2.36	25	0.71	80	0.180
1/2"	12.5	10	2.00	30	0.60	100	0.150
3/8"	9.5	12	1.70	35	0.50	120	0.125
4	4.75	14	1.40	40	0.425	140	0.106
5	4.00	16	1.18	45	0.355	170	0.090
6	3.35	18	1.00	50	0.300	200	0.075

hours. Weigh dry sand sample with pan (W_0). Then subtract the weight of the pan: $W_{DS0} = W_0 - W_{P0}$.

3. Fill the pan and sand sample with tap water, shake and decant wash water through No. 200 sieve. Wash material retained on sieve back into the pan. Repeat several times until wash water is clear. Dry the sample again in 105–115°C oven for two hours. Weigh dry washed sand with pan (W_1). Then subtract the weight of pan: $W_{DS} = W_1 - W_{P0}$. Subtract from W_{DS0} to determine weight of fines: $W_F = W_{DS0} - W_{DS}$.
4. Arrange a set of sieves from largest opening to smallest with the pan below the bottom sieve (figure 1). Place the sample on the top sieve. Place lid over top sieve.
5. Shake stacked sieves, vibrating, jogging, and jolting them by hand or by mechanical apparatus. Keep the sand in continuous motion for a sufficient period such that not more than 1% by weight of the residue on any individual sieve will pass that sieve during 1 minute of additional hand sieving. Five to ten minutes of original sieving will usually accomplish this criterion.
6. Pour the sand off each sieve into labeled, weighed pans. Weigh and determine the sample weight (W_S) by subtracting the weight of the pan: $W_S = W - W_P$.

Record and Calculation

Record all the weights in the "Report" section of this fact sheet and determine the percent passing to 0.1% for each sieve by:

$$\text{Percent of material retained on the sieve} = \frac{W_S}{W_{DS}} \times 100\%$$

Percent passing = percent passing the next largest sieve – percent retained on sieve

Graph the percent passing result for each sieve (blue shaded sections in the table) on semilog paper as shown in figure 2. From the graph, find the Effective Size as D10, where only 10% of the sample is a smaller size. Also from the graph, find D60, where 60% of the sample is a smaller size. The Uniformity Coefficent is D60/D10.

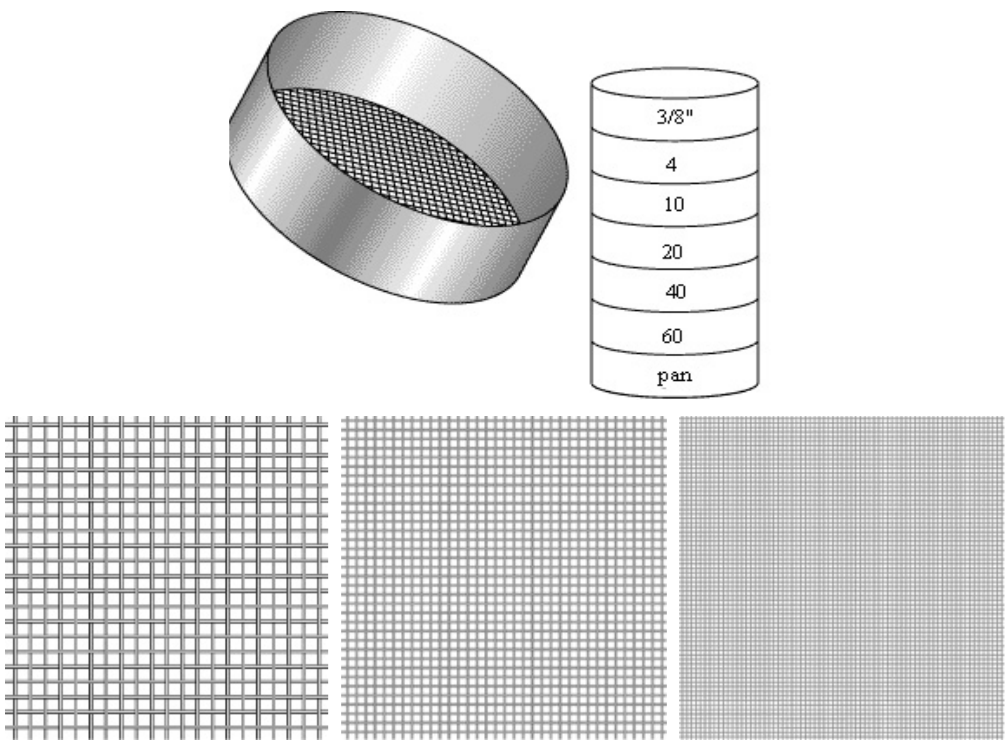


Figure 1. Sieves with various-sized openings are used for sand analysis. The sieves are arranged largest to smallest from top to bottom.

REPORT

Project: Date: Test by:

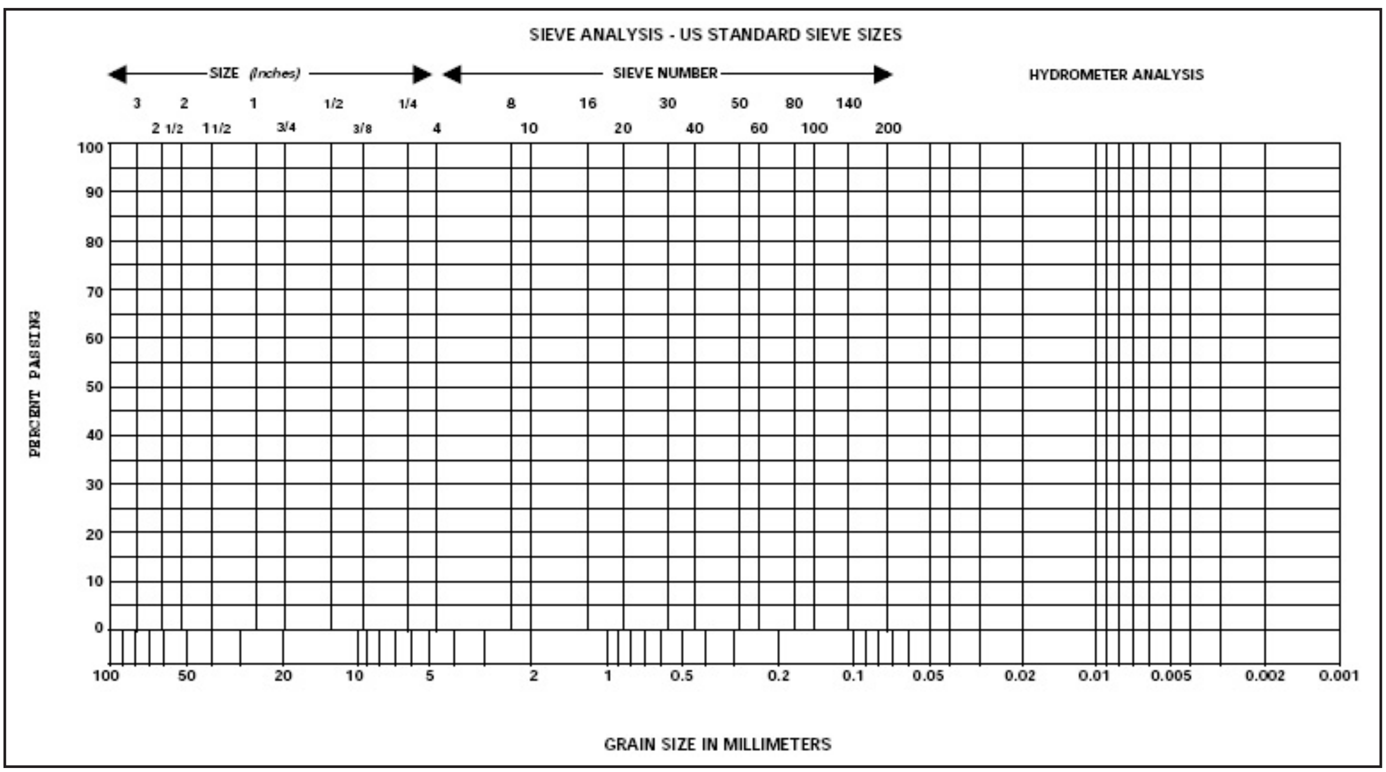
Sample Material: Sample I.D. :

Pan Weight, W_{P0} (g): Total dry sand with pan, W_0 (g): Total dry washed sand with pan, W_1 (g):

Total dry washed sand, W_{DS} (g): Total dry sand, W_{DS0} (g): Weight of fines, W_F (g):

Sieve No.	Sieve Size (mm)	Pan W_p (g)	Sample + Pan W(g)	Sample Weight W_S (g) = $W - W_p$	% retained = $W_S \times 100 / W_{DS}$	% passing last larger size	% passing = % passing last larger size – % retained
						100	

Effective Size = D10 =
Uniformity Coefficient = D60 / D10 =



EXAMPLE

Table 2. Sand Particle Size Analysis—Calculating Percent Passing Selected Sieves.

Sieve No.	Sieve size	Sample weight (g) W_S (g) = W – W_p	% retained $W_S \times 100 / W_{DS}$	% passing last larger sieve	% passing = % passing last larger size – % retained
3.5	5.60	6.00	6.0 × 100/120 = 5	100	**95** = 100 – 5
10	2.00	8.40	8.4 × 100/120 = 7	95	**88** = 95 – 7
20	0.85	57.60	57.6 × 100/120 = 48	88	**40** = 88 – 48
30	0.425	14.40	14.4 × 100/120 = 12	40	**28** = 40 – 12
40	0.425	12.00	12.0 × 100/120 = 10	28	**18** = 28 – 10
60	0.25	15.60	15.6 × 100/120 = 13	18	**5** = 18 – 13
pan	—	6.00	6.0 × 100/120 = 5	5	—
Total dry washed sand, $\mathbf{W_{DS}}$: 120.00 g					

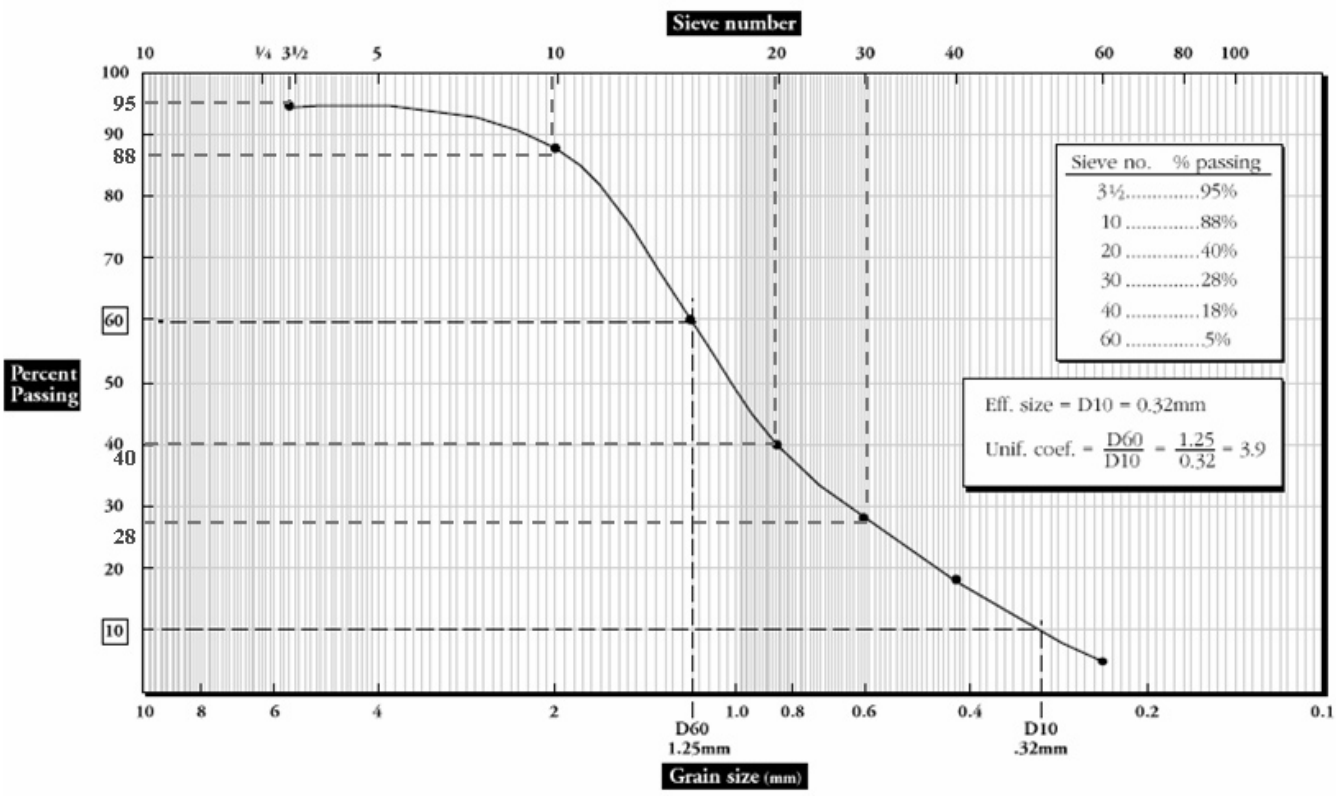


Figure 2. Graph of sand sieve analysis to determine effective size and uniformity coefficient.

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