Pumice as a Filtration Media

As a filtration media, pumice is an aggressively-filtering alternative to sand (and other filtration media). The low specific gravity and high porosity of pumice make it ideal for irrigation filtration systems and other water treatment processes and provides several advantages over other filtration media such as sand, expanded clay, and anthracite.

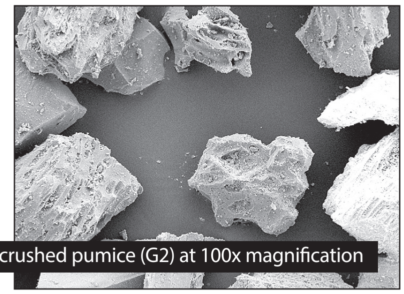

close-up of a 1-inch pumice stone

BENEFITS OF PUMICE FOR WATER TREATMENT APPLICATIONS INCLUDE:

- Improved filtration rates
- Less energy consumption
- Less intensive backwash requirements
- Better filtration bed expansion
- Larger effective surface area
- Low-cost filter refurbishment

KEY PUMICE CHARACTERISTICS:

- Specific gravity weight of 2.35 g/cc
- Low unit weight: 40 - 50 lbs cubic foot (depending on grade)
- MOHS-scale hardness: 6 (reference: feldspar is a 6 and quartz is a 7)
- Due to its amorphous characteristics, pumice is not considered a health risk to the workers who handle it.
- Chemically, pumice is primarily Silicon Dioxide (Amorphous Aluminum Silicate), some Aluminum Oxide, and trace amounts of other oxides.


crushed pumice (G2) at 100x magnification

RESEARCH STUDIES

The information that follows, from a pair of research studies, examines the performance of pumice as a granular media to replace or supplement common sand media in agriculture irrigation filtration media tank systems such as those used to protect drip and micro-irrigation systems from fine particle and organic solids.

TITLE: **The performance of pumice as a filter bed material under rapid filtration conditions***.

ABSTRACT: Deep bed sand filters are used extensively in drinking water and wastewater treatment. In this study, sand and pumice were used as a filtration media under rapid filtration conditions and performance results for both were compared. Turbidity removal performance and head losses were investigated as functions of filtration rate, bed depth and particle size. Under the same experimental conditions such as 750 mm bed depth, 7.64m3/m2.h flow rate and, 0.5-1.0 mm grain size, turbidity removal rates for sand and pumice were found to be 85-90% and 98-99%, respectively. Furthermore, the head loss for sand and pumice were found to be 460 mm and 215 mm, respectively. The results obtained have shown that pumice has a high potential for use as a filter bed material.

* Burhanettin Farizoglu, Bulent Keskinler. Published in *Filtration and Separation*, April 2003

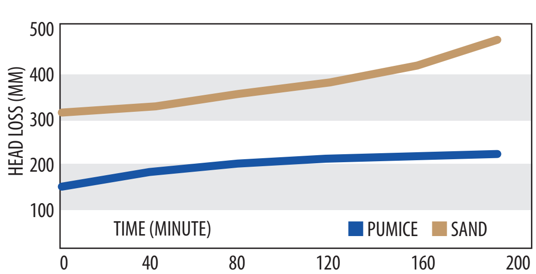


FIGURE 9: The comparison of head loss values with time for the sand and pumice bed (750 mm bed depth, 7.64 ma/m~.h flow rate & 0.5-1.0 mm grain size).

EXCERPTS FROM PUBLISHED RESEARCH: "Due to the high porosity of pumice, a filter bed consisting of pumice retains more suspended solids than a sand filter bed (head loss 0~ e-4). Thus, the clogging observed in the pumice bed is smaller than a sand filter bed with a similar grain size. The increase in head loss over time for pumice progresses more slowly than with sand media." (FIGURE 9)

Pumice is, at its essence, foamed glass, formed by the expansion of trapped gases when molten lava rapidly cools. When crushed, pumice still retains its frothy structure, making it effective at any filtration grade.

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RESEARCH STUDIES (continued)

CONTINUED: **The performance of pumice as a filter bed material under rapid filtration conditions**

"Sand is not a porous material and particulate material can only be retained in the spaces between the grains in the filter bed, so smaller particulate matter can more easily drain through the sand media and escape in the effluent water." (FIGURE 10)

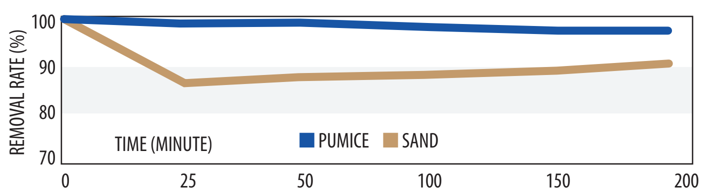

FIGURE 10: The comparison of turbidity removal ratios with time for the pumice and sand bed (750 mm bed depth, 7.64 m3/m2.h flow rate & 0.5-1.0 mm grain size).

"When pumice is used as filter bed material it is possible to distinguish between two levels of porosity, one of the pumice itself and the other of the filter bed. Thus, while bigger particles are retained in the filter bed, smaller particles are retained inside the pores of the pumice. Consequently, in a pumice bed clogging progresses more slowly, and the volume of the bed is used more efficiently than in a sand bed. Backwashing effectively cleans the pumice."

"For a pumice bed, smaller head loss and greater turbidity removal efficiency was observed in comparison to a sand bed under the same experimental conditions."

"A pumice bed has a greater porosity and higher deposition capacity of particulate compared to sand bed, so pumice bed filters have longer periods between backwashes."

"Pumice is resistant to acid and base solutions. No deformation because of the water was observed during the study."

TITLE: **A comparison study on the removal of suspended solids from irrigation water with pumice and sand–gravel media filters in the laboratory scale***.

ABSTRACT: In this study, different bed materials in media filter systems were examined to determine the solids removal efficiency, total outlet flow volume, and outlet flow velocity of pumice (with its numerous open spaces, vesicles and irregular cavities) sand–gravel, and combination of pumice and sand–gravel. Two different filter column diameters (150 and 200mm) and two different inlet flow pressures (100 and 150 kPa) were used. The results show that the total outlet flow volumes increased logarithmically as the filtration test period progressed, while the outlet flow velocities and the outlet concentrations of suspended solids decreased logarithmically for all filter types. Pumice media filters provided higher total outlet flow volumes and lower solid removal efficiency in comparison with sand–gravel media filters. However, the highest average solid removal efficiency was determined by pumice plus a sand–gravel media filter at 90.5%.

TABLE: The Properties of Different Filter Layers

Number of Layers	Layer Depth (mm)	Material Sizes (mm)	Effective Diameter (mm)		Uniformity Coefficient		Porosity Values of Granular Medium (%)	
			Pumice	Sand-Gravel	Pumice	Sand-Gravel	Pumice	Sand-Gravel
1–7	64	8–12.5	8.80	8.60	0.92	0.90	80.3	41.1
2–6	64	4–8	5.03	5.00	0.83	0.83	77.4	43.6
3–5	128	2–4	2.42	2.42	0.81	0.82	74.6	45.0
4	340	0.5–1	0.58	0.61	0.97	0.85	71.7	46.4

* Yasemin Kuslu & Ustun Sahin (2013). Agricultural Structures and Irrigation Department, Ataturk University Faculty of Agriculture, Erzurum 25240, Turkey. Published in *Desalination and Water Treatment*, 51:10-12, 2047-2054, DOI: 10.1080/19443994.2013.734492

EXCERPTS FROM PUBLISHED RESEARCH: "In the beginning hours of the filtration test period, the outlet flow velocities of pumice media filters were lower than sand–gravel media filters. This is because pumice is a material with very rough grains that increase resistance to flow, and after the first few hours of the test period, the outlet flow velocities of the pumice media filters were higher than sand–gravel media filters because of its highly porous nature."

"When the pumice media was subjected to pressure, suspense solids retained in irregular cavities went out at higher concentration than the sand–gravel media."

"... the outlet concentration of suspended solids for pumice media filters was lower than that of sand–gravel media filters without pressure flow conditions."

"The average removal efficiencies of the different filter types were calculated at 74.9% for pumice in 200mm diameter column at 100 kPa inlet flow pressure, 73.0% for pumice in 200mm column at 150 kPa inlet flow pressure, and 90.5% for pumice plus sand-gravel in 200mm diameter column at 150 kPa inlet flow pressure."

"The pumice media filter, due to its higher total outlet flow volumes, can be used for the filtration of waters with a high suspended solid concentration."

"... both pumice and pumice plus sand–gravel media filters are suitable for lower pressure micro-irrigation [systems]"