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Using Perlite Based Sodium Silicate for Obliteration Feculent Water by Leachate Percolation

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Abstract
This paper presents the study of synthetic perlite sodium silicate to reduce suspended solid and remove turbidity of mud water. Laboratory procedure were designed to quantify the suspended solids removal efficiency and variation in height of modified Secchi disk. 4 samples have been exposed to experiments containing sand, perlite sieved by mesh no. 8, SC (sodium silicate) perlite and micronized perlite. The tests manifest the use of SC perlite can exceedingly enhance the turbidity removal efficiency from muddy water. The modified Secchi disk has been devised by author to facilitate the experiments, in addition the quality index has been created by author to equilibrate quality and price. After much struggling, SC perlite has been introduced for having optimum performance.
Keywords: Sodium Silicate, Perlite, Expanded Perlite, Filtration, Secchi Disc

Introduction

Growing population, improving of living standards, urbanization, industrial development and agriculture are the main factors that dramatically increased water consumption and wastewater production in the community, consequently causing to environmental pollution.[1,2]

Filtration is a separation process that consists of passing a solid-liquid mixture through a porous material (filter) which retains the solids and allows the liquid to pass through [3,4] . Removing suspended solids by high-rate granular filtration is a complex process involving a number of phenomena. Attempts to develop theories that quantitatively predict solids removal performance with sufficient precision and versatility to be of use in practical filter design have met with relatively little success. Consequently, filter media selection is often an empirical process. Pilot investigations are common tools for assessing the performance of a particular filter design.[5-7]

The used process for water treatment depends on the quality of water resource. Surface water normally has more variable pollutants compared with underground water, despite the fact this surface water needs more complex treatment process [8,9].

The first extensive use of perlite was for filtration of raw cane sugar liquor as early as 1876 [10] Today the primary industrial application of sand is as an industrial filtration medium for liquids ranging from municipal water supplies to alcoholic beverages. In contrast, substantial commercial production of perlite did not begin until 184 6. In 1963 only 15 percent of the perlite produced in the United States was used as filter media [11]

Lightweight expanded perlite structures are milled and classified using strictly defined processes to produce perlite filter aids with specific flow characteristics. The various grades utilize the jagged interlocking structure to create billions of micro-scopic channels between the filter aid particles to produce optimum flow rates and clarification ability for a wide variety of applications. [12]

Perlite filter aids are lightweight, inert, impart no taste or odor to liquids being filtered and are virtually insoluble in mineral and organic acids at all temperatures, solubility in strong alkaline solutions varies depending on temperature and contact time.[13] Without using the filter aids the solid particles in liquid will soon accumulate on filtering surfaces and block them. A perlite filter aid makes a filtering layer that transfers the actual filtering from the septum to the whole mass of filter aid. Filtration occurs in the tiny pores formed by the fine particles of filter aid [14].

This article presents an investigation of SC perlite as an alternative porous media to be used in turbid water filter devices, which aids to reduce suspended solids loads and concentrations. The paper is organized as follows. The first section describes the filters used in this study, the reasons supporting this selection. The next section presents the experimental measurements, depiction of the main variables that characterize the performance of the filters, analysis of the experiments results via modified Secchi disc, and a comparison of different design alternatives [15].

Several materials have been reported as filter media in the literature. Clark and Pitt (1999) summarize the most current and widely used media, including sand, activated carbon, and peat moss.

Each has advantages and limitations, and the selection depends on the desired pollutant removal performance and associated conditions, such as land use (Clark and Pitt, 1999). Most of these filters must be built in situ because of the amount of material needed to reach good performance and because of the large concrete structures involved in the construction [16].

An alternative approach can be the design of small, easy-to-install filter devices that do not require a complicated building process and are used to treat smaller draining areas. Additionally, a filter device should be

designed to achieve high filtration rates and removal efficiency. From that point-of view, it is very important to select a filter media that meets the following properties: (1) high specific surface area; (2) low mass density, allowing an easy installation and transportation of the filter and/or the filter media; and (3) structural resistance to handle typical installation and operation loads.

A material that satisfies these characteristics is expanded perlite.

Perlite is a natural siliceous rock that, when heated to a suitable point in its softening range (760 to 11008C), expands 4 to 20 times its original volume, reaching an extremely light weight and a high specific surface area (Purchas, 1997). This expansion is the result of the presence of a significant percentage of combined water in the crude rock [17].

Expanded perlite has already been used and studied as a filter media to treat residential and industrial wastewater (Demirbas et al., 2002; Dogan and Alkan, 2003; Dogan et al., 2004;

Joseph and Rodier, 1994; Uluatam, 1991). Additionally, perlite and expanded perlite have also been used as water filter media or as a component with other materials (Adriasola, 2003)

This study aims to find effective factors on efficiency of filtration in order to enhance efficiency of physical and chemical parameter and most importantly reducing turbidity.

Materials

Expanded perlite:

Perlite is a hydrated volcanic glass composed chiefly of amorphous silica with 12–18% aluminum oxide, minus the oxides of potassium and sodium, and with small amounts of iron, magnesium, calcium, and titanium [18]. As most perlites have a high silica content, usually greater than 70%, and are adsorptive, they are chemically inert in many environments and hence are excellent filter aids and fillers used in various processes and materials [19].

Because of the 2–5% water content, this rock is commercially valuable and most of the perlite used commercially is in expanded form. Upon heating above 870 °C contained water is removed, low density particles with cellular interiors are formed. These particles are used due to their chemical inertness, physical resilience and water retention ability [20].

Sodium silicate:

Liquid sodium silicates are manufactured in various molar ratios. Molar ratios (MR) define the ratio of SiO2 versus Na2O in the substance. The higher the molor ratio, the less sodium ions are present in the silica network and consequently the less alkaline the silicates are. Therefore, classification and labeling depends on the molor ratio. Varying the ratio of SiO2 to Na2O and the solids content results in solutions with differing properties. Silmaco's standard commercial grades range in molar ratio from 1,6 towards 3,5.

Quartz sand:

Sand filters are used as a step in the water treatment process of water purification.

There are three main types; rapid (gravity) sand filters, upward flow sand filters and slow sand filters. All three methods are used extensively in the water industry throughout the world. The first two require the use of flocculants chemicals to work effectively while slow sand filters can produce very high quality water free from pathogens, taste and odor without the need for chemical aids.[21] Sand filters can, apart from being used in water treatment plants, be used for water purification in singular households as they use materials which are available for most people.[22]

Method

Sodium silicate with the amount of 150 gr was mixed with perlite 50 gr, 150 ml water was added in order to harden the sodium silicate, afterward the synthetic placed in oven at 100 degree Celsius for 24 hours so as to dry sodium silicate and create new material for filtration purpose.

The mud water was artificially made by adding clay powder which had been sieved by mesh number 0.074 mm as well as rotten leaves.

The filtration experiments have been conducted with 4 materials respectively; sand (sieved 8), perlite (sieved 8), perlite based sodium silicate, micronized perlite (sieved 200).

All 4 samples have been obtained from filtration process through a tube filled with certain materials, and the experiments have been repeated for 10 times to attain results. The material is shown in figure1. And the water is shown in figure 2.

Fig1. The perlite with sodium silicate

Fig2. The artificial dirty water

Result

The results is shown according to Secchi disk which has been used to measure water transparency in bodies of water, the disc is mounted on pole or line. The method which is used for this experiment was the modification state of Secchi disk made by author with using a text with the font size 6 and print it out to use it instead of Secci disk but the same application.

The tube size was 100 cm, and the text disk was placed on the bottom and output water from each experiments were poured into it in order to perform modified Secchi disk experiment.

The results are shown in figure 3, and chart 1.

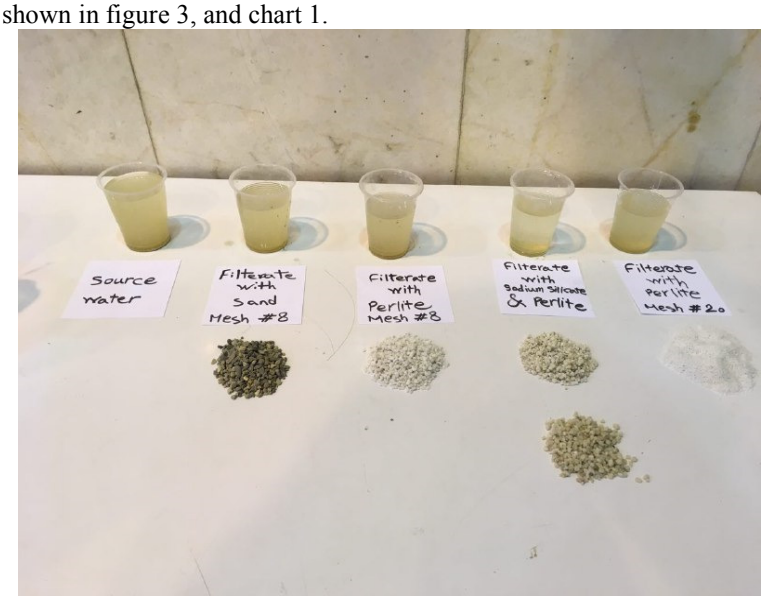

Fig3. The schematic of results derived from each material

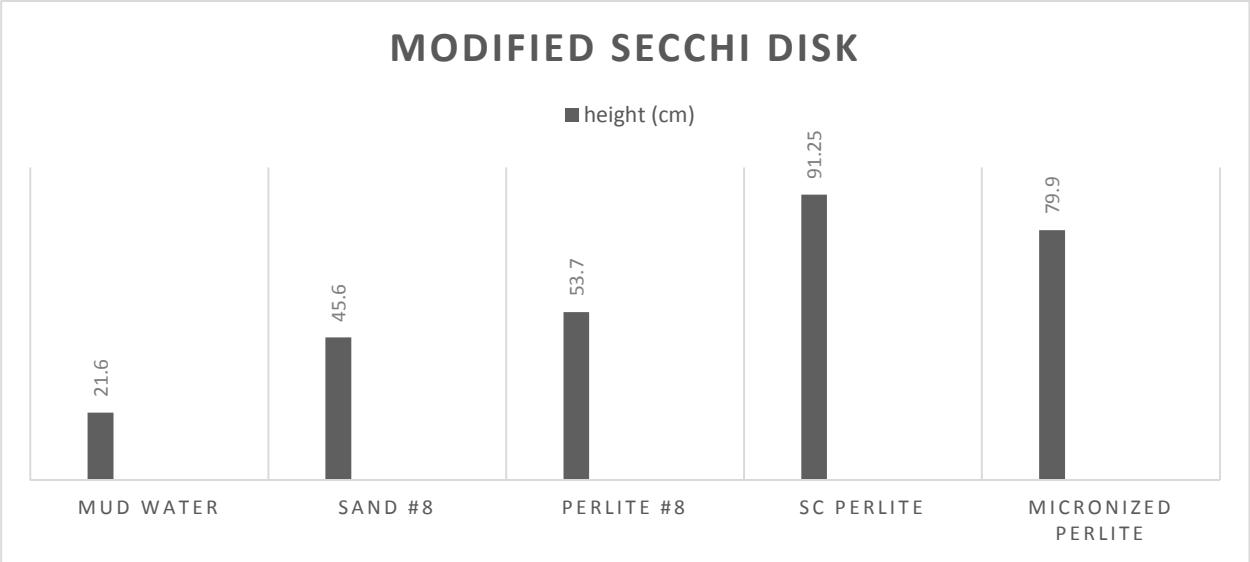

Chart1. The result of each filtration with Secchi disk method

Quality index:

Regarding price of each material in order to consider the matter of cost, quality index is created for offset the price and quality. In this case, the usage of materials for filtration is reliant upon cost effective material. Therefore, the desirable number placed on above and the number which should be less placed on below. Each material is regarded as the used weight for filtration.

The formula of quality index which we propose is shown below:

Quality index = $\frac{Height^2\ (cm)}{\sqrt{Price}\$}$

	Weight (gr)	Price $	Height (cm)	Quality Index
Sand	600	8	45.6	735.16
Perlite #8	50	30	53.7	526.48
SC Perlite	150	80	91.25	930.93
Micronized perlite	90	90	79.9	672.94

Discussion

Inspection demonstrated that the perlite based sodium silicate have shown optimum performance among materials which in this experiment, modified Secchi disk was observed 91.25 cm of water. According to our observation and the patent number US3441515 A which indicates Method for manufacturing improved perlite filteraid products, the flow rate of perlite based sodium silicate was the best among them. Pursuant to Secchi disk experiment, sand is unable to remove turbidity of dirty water considerably. In other word, to compare with materials in used nowadays, the sodium silicate synthetic perlite proved the best index regarding quality of having material used. The quality index is a new method to compare between the materials in industrial's purpose to justify the cost and quality.

Conclusion

After much deliberation on results, the data exposes that the new material which has formed from mixing perlite and sodium silicate in definite heating system boosts extremely the performance of removing turbidity.

Moreover, in the matter of cost, we ought to ponder not only the price of the material but also should we consider the quality too, thus, the formula has been devised to check the quality index considering both price and performance.

Perlite based sodium silicate has revealed the optimum performance among other material, in addition, the micronized perlite has also shown excellent performance due to its tiny pores, although, this is not excellent based on quality index,.

Using sand which is widely used nowadays for filtration has shown us fairly high quality index compared to expanded perlite.

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