International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

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Use of Filter Media Made from Vetiver Grass Root Ash for Water Treatment

Krittiya Lertpocasombut [a*] and Maruay Onsod [a, b]

[a] *Department of Civil Engineering, Faculty of Engineering, Thammasat University Rangsit Campus, Pathumtani 12120, THAILAND*
[b] *Quality System & Product Auditing Manager, Goodyear (Thailand) Public Co. Ltd., Pathumtani, 12120, THAILAND*

ARTICLEINFO

Article history:
Received 18 June 2014
Received in revised form 06 July 2014
Accepted 09 July 2014
Available online 11 July 2014

Keywords:
natural material;
polyvinyl alcohol;
pellet;
turbidity;

ABSTRACT

Vetiver grass and its usages have been widely reported in many researches. This research aimed to use the vetiver grass root ash (VGRA) to filter water to improve its quality. The investigation of the physical and chemical properties of the VGRA indicated the product from natural material ash could be used as a filter medium. The distribution of particle size, the specific gravity, and the Iodine number of the VGRA were determined as well as the ratio of the VGRA to polyvinyl alcohol (PVA) as a binding polymer were analyzed. The results revealed that the best mold of the VGRA pellet as a filter media was a circular shape. The ratio of the VGRA to PVA was 7.33 to 1. This was consistent with the results of the linear shrinkage that were 13.35 ± 2.10 which was the best form of the VGRA product to be used as a filter medium for water turbidity treatment.

1. Introduction

The water used must be safe and free from dangerous bacteria. It is necessary to have the water quality meet the required standard. The use of plants to improve water quality is one method that has received considerable attention. In general, natural materials are cheap and readily available in every country. Many researchers [1][2][3] have reported both viable or nonviable properties of vetiver grass and its usages. Vetiver grass is regarded as a miracle plant that is the subject of ongoing research. This research focuses on studying the properties of vetiver grass root ash to produce the filter material suitable for improving water quality. The filter material was formed with polyvinyl alcohol at various

*Corresponding author (Krittiya Lertpocasombut). Tel: +66-2-5643005 x3109. E-mail: lkrittiy@engr.tu.ac.th. ©2014. International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies. Volume 5 No.4 ISSN 2228-9860 eISSN 1906-9642. Online Available at http://tuengr.com/V05/0247.pdf.

percentages for the purpose of studying the performance of the filter media produced in terms of the linear shrinkage, the porosity and the apparent density of the product. Then the product selected was used as a filter media for water turbidity treatment.

2. Materials and Methods

2.1 Materials and Chemicals

The vetiver grass used was grown for at least 18 months with a length of root not less than 0.50 m. The polyvinyl alcohol (PVA) used was commercial grade with the molecular weight of 30,000 – 50,000. Water used for the experiment was deionized water.

2.2 Preparation of the Vetiver Grass Root

Root of vetiver grass of *Nakhon Sawan* species was chosen due to its availability and abundance. It was washed thoroughly five times with clean water and then dried under the sun for at least 48 hours. The dried root was burned at 550 ºC for 15 to 30 minutes and ground for size reduction in a laboratory blender at a speed of 3,000 rpm for 15 minutes. At this stage, the properties of the vetiver grass root ash (VGRA) were determined for the particle size distribution following the ASTM D2862 Standard test method, the specific gravity of soil solid by water pycnometer following the standard ASTM 854, and the Iodine number following the standard ASTM D4607.

2.3 The VGRA Pellet

The VGRA particles were sifted through a sieve of 50, 100 and 200 mesh sizes, divided into 3 sieve sizes and combined with PVA in ratios varying from 6 to 18 % wt. by wt. The slip behavior flow of the 3 sieve sizes of the VGRA with various percentages of PVA was determined. The linear shrinkage of the VGRA pellet formed was taken into account after drying at 125 ºC for 2 hours.

2.4 Experimental Setup for Water Turbidity Removal

Figure 1 shows a schematic diagram of the experimental set up. It was comprised of 3-filter units, and a receiving vessel attached to available suction pump.

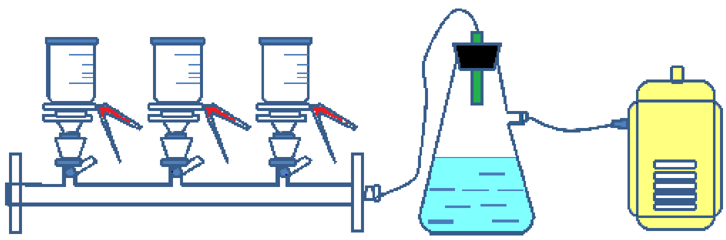

Figure 1: The schematic diagram of the experimental unit.

The raw water sample was taken from the natural river source at the intake of the water supply plant located in Pathum Thani province in Thailand. The inlet and exit water turbidity of the filtration unit was measured by UV spectrophotometer. The pressure, the flow rate and the particles capture performances were measured under the experimental conditions.

3. Results and Discussions

3.1 The Physical and Chemical Properties of the VGRA

After grinding, the composition of the ash of the vetiver grass root was determined by XRF following the Standard ASTM C114 and results are shown in Table 1.

Table 1 The chemical composition of the VGRA.

Chemical Composition	% Weight	% Standard Error
Carbon Dioxide (CO_2)	52.67	0.16
Silicon Dioxide (SiO_2)	44.10	0.14
Aluminum Oxide (Al_2O_3)	1.03	0.17
Iron Oxide (Fe_2O_3)	2.11	0.14
Other	0.10	0.21

It was found that the vetiver grass root ash (VGRA) contained 44.10 % silicon dioxide which was similar to that of the results from AIT research group [3] on the use of vetiver grass ash to replace cement in which composition of silicon dioxide in the ash of the vetiver grass up to 57.48 % was reported. The silica content in the VGRA makes it feasible to further study of the use of roots of vetiver grass as a filter material when combined with a polymer such as polyvinyl alcohol (PVA), which was selected for this study.

The mean particle size is useful when determining the specific gravity of the substance. Root of the vetiver grass after burning at 550 °C was crushed in a laboratory blender to a mean particle size of 0.068 ± 0.003 mm by sieve analysis. This size is similar to fine sand (0.05-0.25 mm).

The specific gravity of the VGRA by the ASTM standards for classification was found to be in the range of 2.26 to 2.60. It was comparable to the compounds like carbon (2.26), gypsum (2.3), clays (2.6), sand and silica (2.6), with a similar specific gravity.

Three sieve sizes (50, 100 and 200 mesh) of VGRA were evaluated for Iodine number according to the ASTM standards. This value was considered to examine the assumption that the VGRA has the ability to adsorb. The results showed that the Iodine number of the VGRA (36 - 46 g/kg) was comparable to the standard carbon N550 and N660. The VGRA of 200

*Corresponding author (Krittiya Lertpocasombut). Tel: +66-2-5643005 x3109. E-mail: lkrittiy@engr.tu.ac.th.

mesh sieve size, which was comprised mostly of the smallest particle size, gave the highest Iodine adsorption number.

3.2 The Ratio of the VGRA to PVA

Pellets of VGRA were formed by casting. The VGRA of sieve sizes 50, 100 and 200 mesh were combined with the PVA to give concentrations of 6, 8, 12 and 18 % in order to measure the flow behavior and stability of the slip. The results are shown in Figure 2.

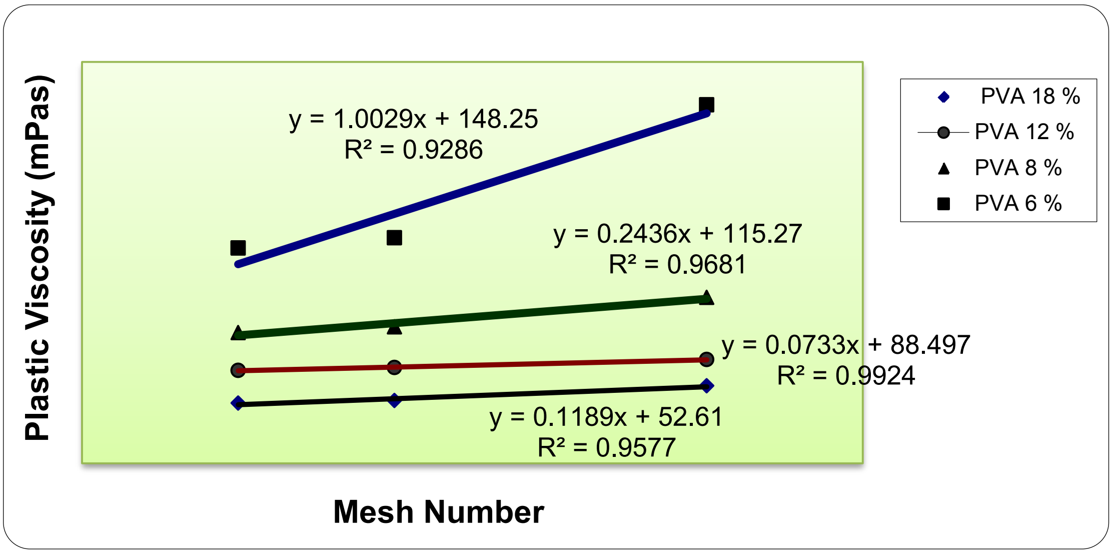

Figure 2: Plastic viscosity values of the VGRA slip at different ratios of PVA.

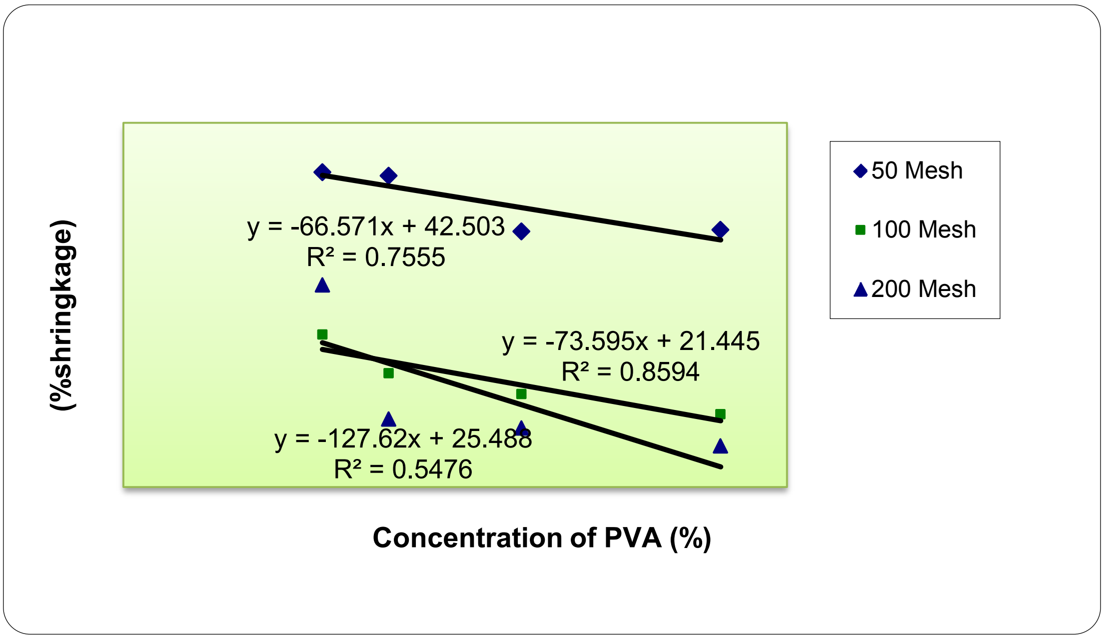

Figure 3: The linear shrinkage of the VGRA of 3 sieve sizes at different ratios of PVA.

R^2 values ranging from 93 to 99 % were obtained for all ratios of the VGRA to PVA. The maximum R^2 value was found with the mixture of 12 % PVA producing the optimum flow and stability of the slip.

3.3 The Linear Shrinkage of the VGRA Pellet

Hollow casting was used to test for the linear and volumetric shrinkages of the VGRA which had been combined with PVA in different ratios to form a pellet. The results are shown in Fig. 3.

The VGRA of 100 mesh sieve size showed the highest coefficient of determination with 86 % corresponding to the VGRA to PVA ratio of 7.33 to 1.

3.4 The Capability of the VGRA Filter Media

A water volume of 0.25 L was filtered through the VGRA pellets produced from 50, 100 and 200 mesh sieve sizes with the PVA content of 12 % and a constant pressure of 2 bars.

With the filtration pressure constant, the flow rates of water filtered through the 3 sets of VGRA pellets declined as the mesh number of the VGRA pellets increased from 50, 100 and 200 mesh. The flow rates were 444, 309 and 151 $L/m^2 \cdot h$, respectively. On comparing these values with the flow rates of microfiltration membrane (10 – 20 $L/m^2 \cdot h$) [4], they were about 10 times higher. The flow rate decreased similarly when the water was filtered through the VGRA pellets under a constant pressure of 7 bars as well. However, all VGRA pellets produced from 50 mesh were cracked as were some of the 100 and 200 mesh pellets also.

The efficiency of particles capture was 67, 73 and 73 % and their residual values were 67, 55 and 54 ppm respectively under a pressure of 2 bars. No similar research on filter media has been found to make a comparison. One explanation of the effect of removal of coliform bacteria (as suspended solid) with modified homemade filter media could be that as the treatment time progressed, the adsorbent sites of the media had a tendency towards saturation [5].

3.5 The Effects of Turbidity on the VGRA Filter Media

With the constant pressure of 2 bars and the water sample used from the natural river source, the effluent turbidity reached a steady value of 30 ± 1 NTU when flowing through the VGRA pellet of 100 mesh sieve size, whereas, the VGRA pellet of 50 mesh sieve size exhibited lower efficiency of removal turbidity (up to 50 NTU) as shown in Table 2.

Table 2 Turbidity of the water before and after passed through the VGRA pellet.

Turbidity (NTU)	Mesh Number		
	50	100	200
Inlet	122	122	122
Exit	50	31	30

From these results, removal efficiency of 75 % was obtained for inlet turbidity of 122 NTU and a flow rate of 309 $L/m^2 \cdot h$ for filtration using the 100-mesh VGRA pellet with PVA 12 % as the filter media.

*Corresponding author (Krittiya Lertpocasombut). Tel: +66-2-5643005 x3109. E-mail: lkrittiy@engr.tu.ac.th.

4. Conclusions

The vetiver grass root ash (VGRA) containing up to 44.10 % of silicon oxide with a mean particle size of 0.068 mm was used as a filter material. Its specific gravity was in the range of 2.26 to 2.60, similar to silt and fine sand. The VGRA with 200 mesh sieve size showed acceptable results with the maximum Iodine number of adsorption, the flow behavior of slip in forming, and a suitable PVA ratio. However, the linear shrinkage of the VGRA pellet formed with 100 mesh sieve size resulted in the best coefficient of determination compared to the VGRA pellet with 200 mesh and 50 mesh sieve sizes, respectively. The filtration experiment confirmed that the 100-mesh VGRA pellet formed with PVA content of 12 % was the optimal composition as a filter media under 2-bar pressure for water turbidity removal.

5. References

[1] Thiramongkol, V., & Baebprasert, B. The vetiver grass pot: Production and use. Department of Science Service, Bangkok, Thailand, pp.350-352, www.prvn.rdpb.go.th/files/CP-4-6.pdf, [18 July 2012].

[2] Ash, R., & Truong, P. (2004). The use of vetiver grass for sewage treatment. Sewage Management QEPA Conference, Cairns, Australia, April 5-7, 2004. www.vetiver.com/AUS_ekeshire01.pdf, [18 July 2012].

[3] Nimityongskul, P. & Chomchalow, N. Utilization of vetiver grass as construction materials. AIT. www.prvn.rdpb.go.th/files/7-05.pdf, [18 July 2012].

[4] Lertpocasombut, K. (2004). Hollow fiber microfiltration membrane in activated sludge and its chemical cleaning for water reuse. Proceedings of the International Symposium on the Development of Water Resource Management System in Mekong Watershed, Hanoi, Vietnam, December 3-4, 2004, 46-52.

[5] Devi, R., Alemayehu, E., Singh, V., Kumar, A., & Mengistie, E. (2008). Removal of fluoride, arsenic and coliform bacteria from drinking water by modified homemade filter media. *Bioresource technology*, *99*(7), 2269-2274.

Dr.Krittiya Lertpocasombut is an Associate Professor in the Department of Civil Engineering, Faculty of Engineering, Thammasat University, Thailand. She received a B.Sc. in Chemistry from Chulalongkorn University, Thailand, an M.Sc. in Environmental Engineering, Asian Institute of Technology (A.I.T.), D.E.A. Diplome d'Etudes Approfondies in Water Purification and Treatment Engineering from INSA de Toulouse, France, and a PhD in Water Purification and Treatment Engineering, Institut National des Sciences Appliquees (INSA), Toulouse, France. Dr. Lertpocasombut is interested in water and wastewater treatment; wastewater recycled by membrane technology; water supply sludge treatment and its reuse/recycle.

Maruay Onsod is Quality System & Product Auditing Manager, Goodyear (Thailand) Public Co. Ltd., Thailand. She obtained a B.Sc (Chemistry) from Rajamagala University of Technology (Thanyaburi). She is a master candidate in the Department of Civil Engineering, Faculty of Engineering, Thammasat University. She is interested in water treatment technologies.

Peer Review: This article has been internationally peer-reviewed and accepted for publication according to the guidelines in the journal's website.