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Treatment of Domestic Wastewater Using Chemical Coagulation Followed by Geotextile Filtration

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Abstract: **The emphasis of this paper is on the filtration performance of geotextiles. As we know treatment of wastewater has become an absolute necessity. An innovative cheap and effective method of purifying and cleaning wastewater before discharging into any other water systems is needed. Coagulation-flocculation is a chemical water treatment technique typically applied prior to sedimentation and filtration to enhance the ability of a treatment process to remove particles. Filtration is considered the most important solid-liquid separation process in water treatment, as well as in wastewater treatment. Geotextile are indeed textiles in the traditional sense, but they consist of synthetic fibers rather than natural ones such as cotton, wool, or silk. Thus bio degradation and subsequent short lifetime is not a problem. These synthetic fibers are made into flexible, porous fabrics by standard weaving machinery or are matted together in a random non-woven manner. Proper selection of geotextile filters plays a key role in achieving satisfactory filtration performance.**

Keywords: **wastewater, coagulation-flocculation, geotextile.**

1. INTRODUCTION

Wastewater arises from both industrial and domestic activities and their Treatment, Management and Reuse are one of the key issues of the day that demands high technical know-how, energy and infrastructure to achieve a better treatment goal. Industrially discarded water is specific to the nature of industry and hence type of treatment adopted might be unique but domestic wastewater or sewerage is consistent in nature. As known, there are a lot of known and unknown contaminants in wastewater that has to be effectively removed to get good quality treated water. Contaminant removal technologies occupy a central role in the primary treatment mechanisms of any wastewater treatment. With an efficient contaminant removal system, most of the parameters in the wastewater could be cracked. Effective wastewater treatment is essential to protect both human and environmental health, regardless of the size of the community. Potential contaminants in domestic wastewater include disease-causing bacteria, infectious viruses, household chemicals and excess nutrients such as ammonia, along with the more traditional suspended solids and biochemical oxygen demand.

2. FILTRATION

Filtration is considered the most important solid-liquid separation process in water treatment, as well as in tertiary wastewater treatment (Zouboulis *et al*., 2002; Ngo and Vigneswaran, 1995). It is currently being evaluated for additional applications to domestic wastewater treatment and is gaining attention as an alternate technology for secondary clarification of wastewater. Filtration allows an increased level of design control to the engineer as compared to sedimentation (Svarovsky, 1977).

A filter should prevent excessive migration of soil particles, while at the same time allowing liquid to flow freely through the filter layer, before the introduction of geotextiles, granular materials were widely used as filters for geotechnical engineering applications. Geotextile materials, when selected appropriately, allow for the replacement of traditional

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granular filter and drainage layers, providing a significant environmental and economic benefit. Geotextiles are a relatively inexpensive product, that when designed and installed correctly can replace traditional granular treatments with significant cost savings, both in aggregate quantities used and traditional labor costs to install such aggregate systems.

3. GEOTEXTILE

Geotextiles form one of the largest groups of geosynthetics material. Most important factor that makes it prominent is its longer life and resistance to biodegradation because of its synthetic fiber content rather than natural content like jute, cotton, wool, or silk. Unlike natural fibers like cotton, jute etc. synthetic fibers which are constituent of geosynthetics, have higher strength and not prone to degradation under soil condition and hence have longer life. The synthetic fibers are made into porous structure of woven, non-woven or knitted.

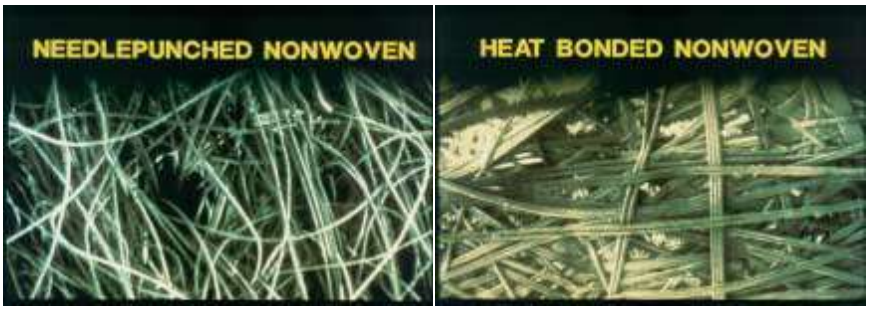
There are two principal geotextile types, or structures: woven and nonwovens. Other manufacturing techniques, for example knitting and stitch bonding are occasionally used in the manufacture of specialty products.

4. NON-WOVEN

Nonwoven geotextiles are manufactured from either staple fibers (staple fibers are short, usually 1 to 4 inches in length) or continuous filaments randomly distributed in layers onto a moving belt to form a felt-like "web". The web then passes through a needle loom and/or other bonding machine interlocking the fibers/filaments. Nonwoven geotextiles are highly desirable for subsurface drainage and erosion control applications as well as for road stabilization over wet moisture sensitive soils.

5. WOVEN

Weaving is a process of interlacing yarns to make a fabric. Woven geotextiles are made from weaving monofilament, multifilament, or slit film yarns. Slit film yarns can be further sub-divided into flat tapes and fibrillated (or spider web-like) yarns. There are two steps in this process of making a woven geotextile: first, manufacture of the filaments or slitting the film to create yarns; and second, weaving the yarns to form the geotextile.



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6. METHODOLOGY

A laboratory test program was undertaken to evaluate the filtration performance of four different woven/nonwoven geotextile combinations with fly ash and bottom-sea dredged sediments. For comparison, these geomaterials were also tested d with two single-woven geotextiles. The results indicated that both fly ash and dredged sediments could be successfully filtered by a variety of woven geotextiles and nonwoven/woven combinations. Results also showed that use of a two-layer geotextile system, rather than a single-woven geotextile, significantly increased the filtration capacity. Higher amounts of fines accumulated at the sediment-geotextile interface than the fly ash-geotextile interfaces, indicating that geotextiles are more prone to clogging during filtering dredged sediments. **Kutay et al., (2005)**

In this study, column tests were conducted to examine the effects of negative-ion treatment by using various types of ion-treated nonwoven geotextile filters. It was found that the negative ion treatment gave apparent increase of drainage capacity after long time as describe on this paper. Clogging effects of two nonwoven geotextile filters treated by negative ion (10 %; NI-10 and 20 %; NI-20) were compared to non-ion treated one (control) by long term filtration test. Finally, the highest drainage capacity was obtained by NI-20 followed by NI-10. **Lee et al., (2008)**

The laboratory portion of the study included a series of filtration tests with different nonwoven geotextiles. Filtration performance of the sludge–nonwoven-geotextile systems was also observed in field test cells by exhuming geotextile samples from the cells after exposure followed by analysis. The results indicated that the sludge's could be filtered with nonwoven geotextiles selected on the basis of geotextile permittivity. The standard gradient ratio test did not always reflect the filtration performance, and therefore other clogging ratios should be considered. Two commonly used geotextile constriction sizes, O_{95} and O_{50}, could not be related to either clogging or piping. Additionally, ratios of geotextile constriction size to soil particle size in the existing filter criteria did not always predict the observed filtration performance. **Aydilek et al., (2003)**

Wastes contained in the micro screen backwash discharged from intensive recirculating aquaculture systems were removed and dewatered in simple geotextile bag filters. Three chemical coagulation aids (aluminum sulfate (alum), ferric chloride, and calcium hydroxide (hydrated lime)), were tested in combination with a long-chain polymer flocculation aid (HyChem CE 1950 at 25 mg/L) to determine the most cost effective and efficient treatment combination. Results from replicate geotextile bag filter tests indicate that when alum, ferric chloride, and hydrated lime (plus a polymer) were amended to a backwash flow, both suspended solids capture and solids thickening were improved; i.e., total suspended solids removal rates of 95.8, 95.1, and 96.0%, respectively, were achieved along with final dewatered filter cake percent solids concentrations of 22.1, 19.3, and 20.9%, respectively. Alum, ferric chloride, and hydrated lime (plus a polymer) amended geotextile bags were not as effective in chemical oxygen demand (COD) and cBOD5 removal, resulting in removal rates of 69.6, 67.2, and 35.3%, respectively, and 56.6, 9.3, and 47.4%, respectively. **Mark et al., (2009)**

The three filter rigs were packed with alternating layers of filter media consisting of gravel, pea gravel, sand and either a single, double or no layer of geotextile membrane. A nonwoven geotextile was layered within the filter media. The hydraulic loading capacity for the three filters matched that commonly used with conventional sand filters systems. Water quality parameters were quantified by measuring suspended solids, chemical oxygen demand, dissolved oxygen, pH, nitrate-nitrogen, and phosphate concentrations. It was found that Filter Rig No. 3 (upper and lower geotextile membrane) and Filter Rig No. 2 (single geotextile membrane) had a significant statistical difference in treatment performance from Filter Rig No. 1(no geotextile membrane). **Paul et al., (2015)**

The laboratory portion of the program included a series of filtration tests with different woven geotextiles. Filtration performance of the sludge-woven geotextile systems was also observed in field test cells. Geotextile samples were exhumed from the cells after exposure and analyzed in the laboratory. The results indicate that the sludge's can be filtered using woven geotextiles and the selection of a proper filter can be made on the basis of geotextile pore structure parameters, i.e. percent open area and pore opening size distribution. The standard gradient ratio test did not always reflect the filtration performance and, therefore, other clogging ratios need to be considered. A commonly used geotextile pore opening size-to-soil particle ratio in the existing filter criteria, O_{95}/D_{85}, did not predict the filtration behavior displayed by the sludge; however, another ratio, O_{50}/D_{50}, showed general correlation to clogging and retention. **Edil et al., (2002)**

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7. CONCLUSION

From the literature as discussed above, it is observed that less work is carried out on filtration of domestic wastewater using geotextile filter. Use of geotextiles has been found very effective solution in the treatment of wastewater. Geotextiles provide more strength, flexibility, durability and controlled degradation compared to sand filters. As geotextiles consist of synthetic fibers, bio degradation and subsequent short lifetime is not a problem. Geotextile filters improve the reliability and performance of traditional graded soil filters and are easier to construct. The low thickness of geotextile, as compared to their natural soil counterparts, is an advantage insofar as light weight on the subgrade, less airspace used, and avoidance of quarried sand, gravel, and clay soil materials. The ease of geotextiles installation is significant in comparison to thick soil layers (sands, gravels, or clays)

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