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Utilization of Needle Felt in Slow Sand Filters. Part II. Role of Nonwovens out of Textile Waste.

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UTILIZATION OF NEEDLE FELT IN SLOW SAND FILTERS. PART II. ROLE OF NONWOVENS OUT OF TEXTILE WASTE

استخدام لباد الابر فى مرشحات الرمل البطيئه

الجــزء الثانى : الدور الذى تلعبه الاقمشه الغير منسوجه فى العوادم فى مرشحات الرمل البطيئه

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ملخص الدراسة:

إن إستخدام الأقمشه الغير منسوجه والمجمعه من فاقد مصانع النسيج كطبقه توضع على سطح المرشحات الرمليه البطيئه لمعالجة مياه الشرب يعتبر إضافه علميه جديده يتم تجربتها لأول مره

فلقد أثبتت الدراسه أن القماش يزيد من فترة تشغيل المرشح البطئ بنسبه تصل إلى ٧٠٪. كما أثبتت الدراسه أنه لاحاجه للعمق الكبير للرمل بالمرشح لأن الفاقد من عملية غسيل المرشح لايتعدى النصف سنتيمتر ولقد أورى القماش متانه عاليه وكفاءه ممتازه فى ترشيح المياه حيث لم تتغير خواص المياه المعالجه فى وجود القماش كما أن القماش لم تتغير خواصه أو تقل درجة متانته مع تكرار الاستعمال.

ABSTRACT

The use of needle felted nonwoven from textile wastes over the sand surface is a new era in slow sand filtration. It increases the run length by 72%, and also leads to no need for the large depth of the sand which means a great cost reduction because of the very little sand wasted when cleaning the textile layer. The fabric showed high efficiency and durability when used for several times. There was no significant change in fabric characteristics. On the other hand, the fabric material "polyester" caused no deterioration to the filtered water quality.

INTRODUCTION

The incidence of water borne diseases in many rural Egyptian Villages is at unacceptable levels. This fact indicates a need for changes and improvements in the method of treatment and distribution of potable water. Given the limited financial and technical resources of the typical rural village, a low cost system easy to operate and maintain, could improve the health conditions, and the quality of life in these areas.

Kawata et al (1989) reported that the use of slow sand filters, utilizing locally available material has been demonstrated to be less expensive, easier to operate and maintain, do not require importations of any equipment, and can consistently produce good quality water.

One major disadvantage of slow sand filtration is the need for intensive laboring for cleaning. This can be overcome by covering the sand bed by certain type of textile. This textile must durable, low cost and must be made of inert material.

The textile hold on its surface and through its pores the SchumitZdeck. When the filter is cologged, the textile then removed washed by water jet and then placed on the filter surface El-Hadidy and Fadel (1992) Previous studies on the use of textile proved that the thickness of removed sand from the filter decreased to 0.5 cm when cleaning the filter El-Hadidi and Fadel (1992).

The aim of this part of the project is to study the use of needle felted nonwoven from textile wastes over the sand surface with regard to performance and durability.

MATERIALS AND METHODS

PILOT PLANT:

The pilot plant consists of an Upflow Roughing Filter (URF) followed by four slow Sand Filter, (SSF) Fig .1. The filters are reinforced concrete pipes 3.25 m in height and 2.25 m in diameter. The URF and SSF media is a graded gravel and sand as shown in Fig.2, and 3.

During operation raw water flows upward through the URF bed, where solids and algae are partially removed from the water and accumulated within the voids and on the filter media. The pretreated water then distributed to the SSF's.

RAW WATER:

During the study, raw water was obtained from El-Mansouria canal. The raw water quality was determined using several parameters, turbidity, pH, alkalinity, algae, total bacterial count, total and faecal coliform count. Table 1 represents the characteristics of the raw water as measured during the study and the sampling interval.

Table 1 : Raw Water Characteristics and Sampling Intervals and Volumes

Parameter	Unit	Max. Value	Min. Value	Sampling Period	Sample Volume
Turbidity	(NTU)	26.5	5.6	2/day	1000 cm^3
pH		8.5	6.6	1/day	500 cm^3
alkalinity	mg/l as $CaCo_3$	140	65	1/week	500 cm^3
algae	Total number of units/litre x 10^{-4}	3945	491	1/week	1000 cm^3
	Biomass of algae (mg fresh weight/m^3)	48835	13151	1/week	1000 cm^3
Total bacteria	Most Probable MPN/ml	3600	1000		
Total coliform	MPN/ml	1200	15.5		

TEXTILE EMPLOYED.

Three types of nonwoven fabrics are employed and tested. Table 2. presents the three textile types characteristics.

Table 2: Textile Characteristics.

Textile Name	Textile material	Thick. in mm	Sp. wt gm/m^3	Packing density
1- Batt on Base BOB.	Made of two preneedled felts and one scrim which was sandwiched between the two layers. The scrim was made from cotton and the two felt layer made of polyester.	1.9	367.8	0.140
2- Needle Felted (NF)	Formed by mechanical interlacing between polyester fibers without any chemical or heat curing.	3.3		0.047
3- Needle punched nonwoven. (NF)w	Made from the hard and soft textile wastes after processes.	12.4		0.065

Tests determining fabric characteristics were carried on fabric samples of square shape with 10 cm side length. These samples were attached to the fabric surface by the beginning of the run. Five samples were used for each test, and their average was calculated.

Data were analyzed after each run, with the fabric carefully checked so that appropriate changes could be monitered in the following run.

Standard Method used during textile characterization were as follows

Basic weight	According to BS 3432 (1980)
Thickness	According to BS 4817 (1972)
Tensile strength	According to BS 4415 (1986)
Pore size	According to Ref. [1]
Packing density	According to Ref. [1]

EXPERIMENTAL WORK

Six runs were conducted during the period of May. 1992 to may 1993. The conditions monitered execusion of these summarized during the runs are in table 3.

Table 3: Runs Conditions.

Run #	Sand depth "m"	Filtration rate "$m^3/m^2/d$"	Operating head "m"	Run length "day"	Fabric employed
1	0.40* + 0.20**	6.50	1.30	13	BOB nonwoven fabric
2	0.40* + 0.20**	6.50	1.30	14	needle felted nonwoven
3	0.40* + 0.20**	6.50	1.30	20	out of waste nonwoven fabric
control run	0.40* + 0.20**	6.50	1.30	12	no fabric
4	0.40* + 0.20**	6.50	1.30	22	reuse the out of waste nonwoven
5	0.40* + 0.20**	6.50	1.30	24	reuse the out of waste nonwoven

* Fine Sand

** Coarse Sand

Results and Discussion

Run No. 1

During the run, turbidity removal reached 95% in average with 0.5 NTU effluent turbidity. The filter was capable in removing algae and bacteria with percent removal up to 96 and 92 respectively. The run showed no significant effect of the water pH and alkalinity.

In comparison with the control run # 6, it was clear that the Batt on Base nonwoven did not affect neither the effluent water quality nor the run length. This may be refered to the small thickness of the fabric which in turn means low holding capacity of the shmiutzdicke. The only benefit of B.O.B nonwoven was its complete retention of impurities that leads to clean sand surface through the entire run. Laboratory tests showed no changes in fabric weight and thickness in relation to the virgin fabric.

Run No. 2

In this run, the needle filter of nonwoven fabric was used. Turbidity removal was 90% in average, with the effluent turbidity about 0.7 NTU. A 100% removal of algae was achieved. Bacterial removal was 96% in average. The effluent was 100% free from total and faecal coliform. No change was notice in both the values of the water pH and alkalinity.

A remarkable effect of using the nonwoven fabric was the increase of the run length. A 27% increase in run length when compared to the filters operated without fabric was recorded. On the other hand, it is noteworthy to mention that the use of this kind of nonwoven made no meaningful effect to the filtered water quality. The increase in run length may be due to the fabric thickness which is larger than the B.O.B nonwoven fabric.

The greatest part of the "Schmutzdecke" was retained over and included through the fabric with the sand surface being relatively clean. The fabric showed ease in washing by water jet. Laboratory tests did not showed any remarkable changes in the fabric weight, and thickness after being washed.

Run No. 3

In this run, the third fabric was used. Turbidity removal was 95% in average, with effluent turbidity of about 0.4 NTU. Algae removal of 99.7% in average was reached. Bacterial removal was 95% in average. While the effluent water 100% free from total and fecal coliform as in the previous runs.

The use of needle punched nonwoven from textile wastes increased the run length, to about 72% in relation to filter without fabric. Again, the increase in the run length may be due to the high thickness of the fabric. The gratest part of the "Schmutzdecke" was retained on and included within fabric pores. When removing the fabric, it was observed that the sand was cleaner than that in the previous runs. Also, the "Schmutzdecke". After washing, laboratory tests showed no significant changes in fabric weight and thickness.

Control runs:

These runs were performed with the same filter media used in the three previous runs, but without the use of any textile. The runs aimed to assure the effect of using textile on slow sand filter run length.

The three runs extended for twelve days only during this period the filtration rate remained constant (6.5 m^3/m^2/day).

Turbidity removal was in the average of 97% and the filter showed great efficiency concerning the removal of algae and bacteria, 97% and 91% respectively. The filtered water was 100% free from total and fecal coliform.

RUN NO.4

From the forecited runs it was clear that no meaningful differences existed in filtered water quality from run to other. The results of the previous four run proved that the use of needle-punched nonwoven from textile wastes as a filter media above the sand increase the run length significantly. An average increase of 72% in run length, in relation to the control run with no textile was observed.

As a result, it was decided to reuse this fabric to study its durability under different operating condition.

The run extended for twenty-two days, during which the filtration rate was constant. During the run, turbidity removal was 96%. Algae and bacteria removal were 98% and 92.6% respectively. The effluent was 100% free from total and faecal coliform.

It was found visually, that no degradation occurred to polyester fibers forming the fabric. The fabric showed great efficiency in containing the "Schmutzdece" and keeping the sand surface in good condition.

RUN NO. 5

This run was conducted for two purposes, the first was to study the effect of reusing the needle-punched nonwoven from textile waste for the third time on the durability of the fabric, the second was to study the effect of reducing the depth of the filter sand.

The run extended for twenty - three days, during which the filtration rate remained constant. During the run, turbidity removal was around 96.7%, removal efficiency of algae and bacteria was 98% and 93.2% respectively, and effluent was 100% free from total and faecal coliform.

Compared to the previous run, it was clear that the removal of the coarse sand did not affect the run length. It was clear that decreasing the sand depth "to 40 cm of natural sand" did not deteriorated the filtered water quality. Again, no deterioration of the fabric.

General Discussion.

Several factors were monitered during this phase of the SSF project studies. Filter fabrics (woven and nonwoven); turbidity; ph; alkalinity; total bacterial count; total and faecal coliform; total hiomass of algae; filter sand size and depth; operation head; and rate of filtration.

The use of plain and satin cotton fabric was not successful,this is because the cotton fibers were decomposed in water. This may be refered to the degradation of the cellulose which represents its major constituent. The cellulose is easily affected by bacteria and other organisms existing in row water. The polyester fibres came to the fore as a highly resistance material, and it showed no deterioration after being submersed in raw water for long time.

The needle felted nonwoven from textile wastes showed "what we can call for a new era in slow sand filtration", when used over sand surface. It increases the run length up to 70% and also leads to no need for larger depth of sand layer. This means a great cost reduction. This fabric showed high efficiency and durability when used for several times. There was no significant change in fabric characteristics once the fabric was washed and dried by the end of each run. Also the use of fabric material "polyester"caused no deterioration to the filtered water quality.

CONCLUSION

1-Textile utilization especially the needle punched nonwoven from textile waste was found to be very effective when used as a filter media over the filter sand surface. The fabric increased the run length by at least 70 percent.

2-With the use of nonwoven out of waste, it is possible to use "natural sand" this will save the neediness of the special "sieved" sand,which is relatively expensive.

3-The use of natural fibre fabric such as cotton fibre was not successful due to its low resistance to bacterial effects and its rapid decomposition once submersed in raw water.

4- The use of needle felt from textile wastes reduced the required depth of sand to be skimmed from about 5 to 0.5 cm.

5- Removing and washing the fabric was found to be easier and more economic than the skimming of the filter sand surface.

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