LABORATORY TESTES ON USING LOCAL ROCK MATERIALS FOR FILTRATION MEDIA OF MICRO IRRIGATION SYSTEMS

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ABSTRACT

The present study aimed to study the possibility of using some local rock material as a filtration media. These rock materials are available in Egypt desert and waste of granite factories instead of the expensive imported media used for filtration unit in pressurized irrigation systems. Ten local and one imported media sample were surveyed and tested.

The Laboratory experiment tests showed that, four local samples can be selected as a filtration media due to similarity of its mechanical, chemical and physical specifications with the same specification of the foreign basalt (standard measurements).

INTRODUCTION

The agricultural irrigated area under pressurized irrigation systems in Egypt was increased in the last years especially in new areas. 1.6 million feddan were reclaimed, most of this new land is irrigated by pressurized irrigation systems, 30% of the new land are drip irrigated system, (El - Gindy 1997). 96% of total area of Egypt is desert, several stonepites, in addition to large huge amount of waste marble factories; most of them may be using as media in filtration process. Media filters are using for most modern irrigation systems especially micro irrigation systems (drip mini sprinkler,…) so, imported media demand still increased with the increasing of micro irrigation systems. Therefore the main objective of this study is an attempting for and evaluating the local cheeps types of media from the available material gravel comparing with imported media.

Hegazi (1994) stated that the main criteria of evaluating selected available media are; $CaCo_3$ content should be less 5%; Size of pores must be enough to prevent contamination of particles from water sources; The permeability tends to maintain a relatively high hydraulic conductivity with optimum losses in pressure; Proper selection of media is important to allow the system to operate with excessive back washing.

Boswell (1990) reported that, suspended solids in the water supply include soil particles ranging in size from coarse sand to find clays, living organisms including algae, bacteria, and wide variety of miscellaneous water. Irrigation water having an E.C value of (0.75) mmhos/cm and the p^H of source water used for irrigation is normally within a range of 6.5 to 8.5 and seldom presents a problem

Metwali (1994) reported that. Water quality for irrigation system depended on the electrical conductivity (E.C), p^H, and dissolved salts in the irrigation water and nutrient.

Anter et al. (1987) reported that calcium carbonate content of filtration media is calculated through Gasometrical apparatus by measuring Co2 equivalent practically $CaCo_3$% of the media samples enters the reaction. Therefore the main criteria of evaluating selected media CaCO3% should be less than 5% aimed to avoid plugging of the emitter.

Russel (1976 I, II, and III) reported that, properties of gravel media are influenced by the size of particles is an extremely important factor in their behavior. The samples were from surface rock., profile core stones, and disintegrating rock at the base of the soil profile, particle size distribution were obtained using the standard sieving and pipette method.

Henderson and Perry (1976) reported that the size and the shape of individual grains in any mass of material depend upon the physical characteristics of the material its previous history, and the method of reduction.

MATERIALS AND METHODS

The technical of the present study is to test some local rock materials and the possibility of using this material as the filtration media for micro irrigation systems. The research depends on the comparison of chemical, mechanical and physical properties for foreign standard media and the same properties of local rock samples with certain mean effective diameter.

Ten local rock samples surveyed and collected from different locations in Egypt. These samples were available on local market with low cost without processing and mainly used for building construction. The collected information of local samples and foreign basalt are shown in Table (1).

Table (1): Samples information of the collected rocks samples

Media No	Media	Location of the samples	Price (L.E./T.
1	Local basalt	Abo-Zaable, Qaluibia	60.00
2	Red granite.	Aswan	220.0
3	Alabaster Misr Bank	Malawi	130.0
4	Krara marble	Red Sea side	130.0
5	Red zaffran	Korymatt- Giza	100.0
6	Ward el- Nile Zaffran	Korymatt- Giza	100.0
7	Salad	Sohag	65.0
8	Bitchino	Pyramides- Giza	80.0
9	Brechia	Assiut- Sohag	80.0
10	Black Sinai	Sinai	120.0
11	Foreign Basalt	U.S.A	1000.0
12	Mix. 1	Egypt	140.0
13	Mix.2	Egypt	130.0
14	Mix.3	Egypt	135.0

Mix.1= Local Basalt + Red granite by ratio 1:1
Mix.2= Alabaster Misr Bank + Krara Marble by ratio 1: 1
Mix.3= Local Basalt +Red Granite + Alabaster Misr Bank + Krara Marble 1:1:1:1

Table (2): Standard specification of the foreign filtration media

Chemical analysis				Mechanical analysis	
			Media	Mean effective diameter	
p^H	E.C. (P.PM.)	S.S%	$CaCo_3$ %	mm.	percent
7-8	480	0.5	0-5%	1	75-81

*S.S % =soluble salt percentage *$CaCo_3$%=calcium carbonate content.
*The total of mean effective diameter = 75-81 %from the total samples.

Physical analysis			
Bulk density (g/cm^3)	Particle density (g/cm^3)	porosity %	Void ratio %
1.67-1.75	2.94-3.15	43-45	55-57

The laboratory tests of local samples and foreign media treated with two water qualities pure and Nile water and compared with the standards specifications of the foreign one were measured as shown in Table (2).

Different laboratory investigations were executed on the all samples (local and foreign) with the following procedures.

2-1 Mechanical analyses

Mechanical of media samples were done according to (st ASAE 1990). The mass of material on all sieves was determined and recorded. These weights are expressed as a percentage of the total weight of the samples and a graph is plotted of the cumulative percent of the samples retained on a given sieve above it versus the size of the given sieve, expressed in millimeters. The percent retained ‘is plotted on the y-axis and the size of sieve opening or particle size is plotted on the x-axis Micheal, 1978).

2-2 Chemical analysis

The collected local and foreign media samples were treated with pure and Nile water by ratio 1:5 according to Anter et al. (1987). The water due to treated with media samples by pure and Nile water were used to measured directly p^H and electrical conductivity (E.C) mmhos/cm. Soluble salt percentage of tested media samples was calculated as follow:

Soluble salt % for media samples = (Wb – Wa) / Wb x 100

Wb = The sample weight before treated with pure and Nile water (g).
Wa = The sample weight after treated with pure and Nile water (g).

The previous process repeated many times until the measurement nearly fixed. The fourth parameter for selecting media samples was calculated $caco_3$ % through gasometrically meter by weight 0.2 g. of the prepared samples and mixed with 5 cm^3 of HCL with 98% concentration by 1.916 to find $CaCo_3$ % in the different types of media samples as follow:

- put 5 cm^3 of acid HCL with 0.2 g. of crushing filtration media in the tube and connect with the apparatus.
- open the valve of apparatus, the colored liquid in the apparatus decreases according to the volume of the Co_2 of filtration media due to reaction.

At the end of the reaction when the Co_2 finished, take the apparatus measurement and multiplying by 1.996 (constant of apparatus) to gave $CaCo_2$% in the samples.

2-3 Physical analysis

This analysis is considered a good indicator for selecting the media types similar to the standards media specification from the collected samples. This occurred through the following parameters.

According to Anter et al. (1987) and Carig (1993) explained that some physical properties of gravel samples were determined as follow:

A-Bulk density "P" = M/V

B-Particle density "GS" = M/Vs

C-Porosity "n" = Vv/V

D-Void ratio "e" = Vv/Vs

Where:

V = is the total volume of the particles.

M = is the total mass of the samples.

Vv = is the volume of void.

Vs = is the volume of solids.

Permeability measurement

Michael (1978), Singh and Singh, and Bruce (1986) diffident the effective size (D90), the term effective size is defined as the particles size where 10 percent of the sand is finer and 90 percent coarser, and defined uniformity coefficient (cu), this a ratio expressing the variation in grain size of a granule material Cu = D60/D10.

Smith (1985), Hassan (1990) and Bader (1990) reported that the permeability of gravel material can be calculated using Darcy's flow equation as follow:

Q/AT = KH/L

where:

Q = quantity of water flow (cm^3).

T = time for quantity of water flow (sec).

A = area of cross-section through which the water flows (cm^2).

K = Coefficient of permeability for the gravel media.

H = Hydraulic head across gravel media (cm).

L = Length of flow path through gravel media (cm).

RESULTS AND DISCUSSION

The main objective of the laboratory planed tests was to select local rock samples, similar in its specification (chemical, mechanical, and physical) to the media standard, for using as a media of sand filter for micro irrigation system.

1- Mechanical analyses of the collected media samples:

Mechanical analyses for different types of media samples was evaluated through the relationship between particle size and accumulated total weight percentage.

Data in Table (4) indicates that, the weight percentage per total weight to calculate mean effective diameter after crushing the media samples by the same methods as in the stonepits.

Data in Fig. (1) show the distribution particles sizes and accumulated total weight percentage after treated by Nile water (Final preparation). One mill meter mean effective diameter of the particle size of these types is recommended for filtration process in the micro irrigation system. The acceptable mean effective diameter was ranged from 75% to 81% of the total samples weight of collected local samples (Local Basalt, Red Granite, Alabaster Misr Bank and Krara Marble) in addition to the foreign one, while the other six types (Black Sinai, Bitchino, Brechia, Red Zaffaran, Salad and Ward el-Nile Zaffaran (unacceptable types) have wide ranges less than 75% of mean effective diameter.

Table (3) Results of chemical analysis of tested samples with pure and Nile water

NO	Sample Names	p^H		E.C. (mmhos/cm)		S.S (%)		CaCo3 (%)
		Pure water	Nile water	Pure water	Nile water	Pure water	Nile water	
1	Foreign Bazlet	7.0	7.3	0.08	0.40	0.11	0.42	0.00
2	Local Bazlet	7.1	7.4	0.10	0.42	0.22	0.45	0.40
3	Red Granite	7.2	7.4	0.11	0.42	0.24	0.48	1.98
4	Al-abaster Misr Bank	7.3	7.6	0.13	0.43	0.27	0.55	33.50
5	Krara	7.4	7.7	0.14	0.46	0.35	0.65	39.50
6	Blachk Sinai	7.8	8.5	0.23	0.68	2.01	2.10	48.00
7	Bitchino	7.6	8.5	0.51	0.76	1.96	2.30	76.50
8	Brechia	8.6	8.8	0.78	1.30	4.23	4.65	89.80
9	Red Zaffaran	7.6	8.4	0.18	0.68	1.12	1.85	46.60
10	Salad	7.7	8.2	0.19	0.60	1.15	1.75	46.40
11	Ward El-Nile Zaffaran	7.8	8.3	0.29	0.66	1.08	1.68	46.30

* S.S. % : Soluble salt percentage per total weight.

Table (4): Results of mechanical and physical analysis

NO	Sample Names	Mechanical tests	Physical tests			
		Mean effective diameter (%)	Bulk density (g/cm^3)	Particle density (g/cm^3)	Porosity (%)	Void ratio (%)
1	Foreign Bazlet	80.18	1.67	2.94	43.20	56.80
2	Local Bazlet	79.79	1.70	3.00	43.33	56.67
3	Red Granite	79.65	1.71	3.03	43.57	56.43
4	Al-abaster Misr Bank	78.99	1.74	3.10	43.87	56.13
5	Krara	78.95	1.76	3.15	44.13	55.87
6	Blachk Sinai	73.16	1.80	3.60	50.00	50.00
7	Bitchino	57.44	1.85	3.99	46.37	53.63
8	Brechia	58.78	1.85	3.97	46.60	53.40
9	Red Zaffaran	74.67	1.79	3.56	50.28	49.72
10	Salad	67.98	1.82	3.67	49.59	50.41
11	Ward El-Nile Zaffaran	66.33	1.81	3.62	49.86	50.14

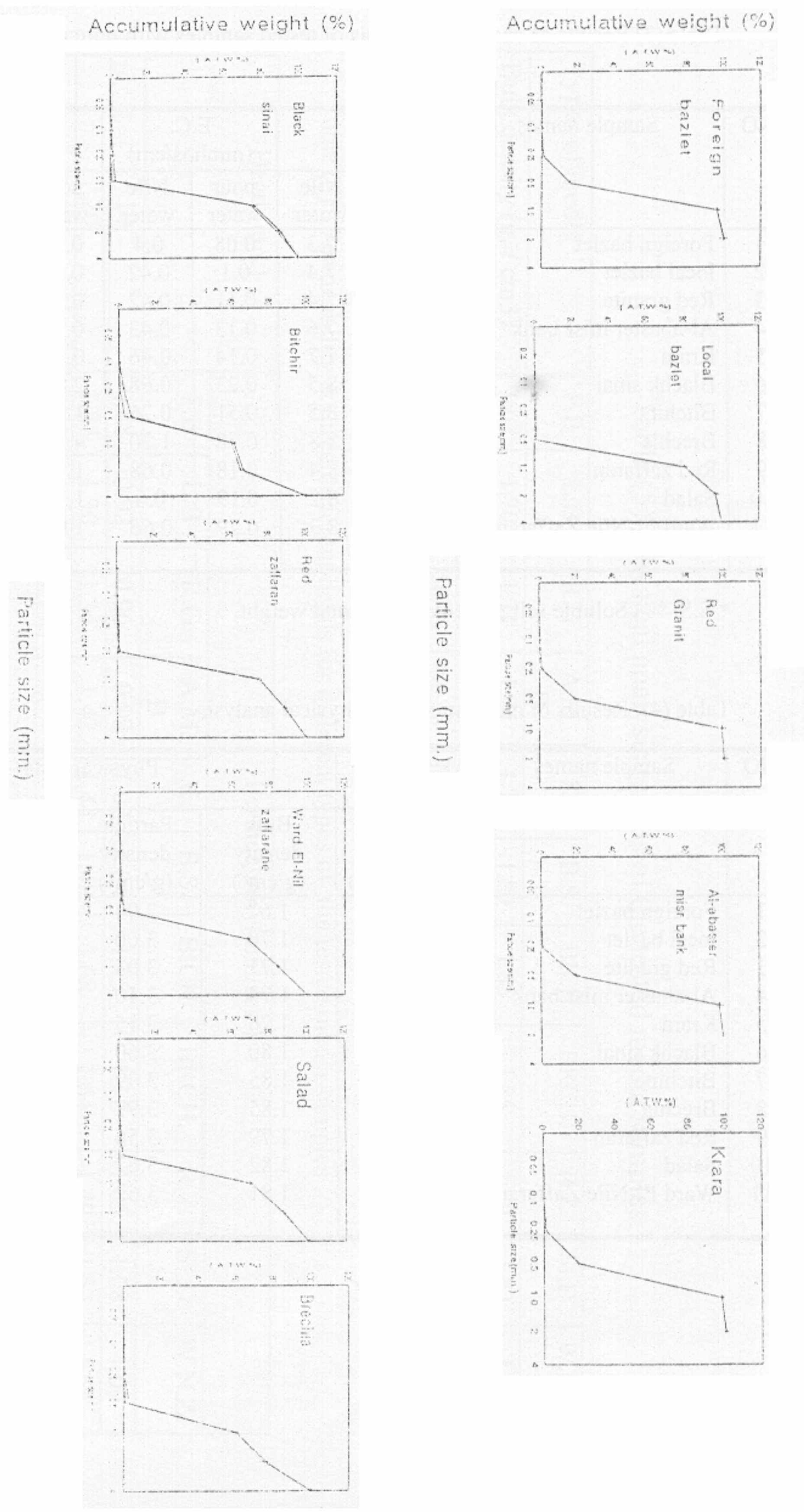

Fig (1):Distribution of particle size and accumulation total weight(%) of tested media samples compared to foreign basalt.

2- Chemical analyses

Irrigation water before and after the media was analyzed to measure PH,E.C. and soluble salt percentage per total weight (S.S%) for filtered water, also calcium carbonate content ($CaCo_3$ %) was determined for media particle size, main indicators for the chemical analysis of the eleven samples.

The data in Table (3) represent the p^H of the filtered water after passing through media samples treated by pure water. p^H of pure water was 7.0 before treated as a reference, while the p^H of the Nile water was 7.3 before treated too. Representation after three treatments, the media was already prepared to use. For the two cases, pure and Nile water the p^H value the same trend, the irrigation water p^H before and after media in case of foreign (imported) media and four types of local media as (Local Basalt, Red Granite, Alabaster Misr Bank and Krara Marble) is unchangeable, on the other hand six local types already changed the irrigation water p^H after treated with pure and Nile water. These types (Black Sinai, Bitchino, Brechia, Red Zaffaran, Salad and Ward el-Nile Zaffaran), so these samples were unacceptable in this indicator.

The electrical conductivity (E.C)) changes for the filtered water due to treated tested media samples with pure and Nile water. The E.C. of extract pure and Nile water before treated were zero and 0.32 mmhos/cm respectively.

The acceptable media must not change the E.C. of filtered water (before treated). The data indicate that the four types of local media were nearly almost unchangeable in E.C. of the filtered water, both in the pure and Nile water. The four types (Local Basalt, Red Granite, Alabaster Misr Bank and Krara Marble in addition to the foreign one related to the standard specification of the media samples (Keller and Bresler 1990). The other six types were not acceptable where change the filtered water in two cases. The acceptable media must not change the E.C. of filtered water (before treated). The soluble salt percentage per total weight for different types of rock samples compared to foreign basalt in case of pure and Nile water. The data indicated that, there were four types of local samples have the almost nearest S.S% values to their values of media standards in addition to foreign basalt, so these types of five samples insoluble and did not change the chemical properties after the final preparation. These types were Foreign Basalt, Local Basalt, Red Granite, Alabaster Misr Bank and Krara Marble, respectively. Otherwise, there are six types dissimilar to the standard values change the proprieties of filtered water. There were Black Sinai, Bitchino, Brechia, Red Zaffaran, Salad, and Ward el-Nile zaffaran.

The calcium carbonate content ($CaCo_3$ %) of different types of tested media. The results revealed that, two types of tested local samples (Local Basalt and Red granite) have $CaCo_3$ % less than 5% (perferoble types), two types of local media samples (Alabaster MisrBank and Krara Marable) have ($CaCo_3$ %) values less than 40 % (acceptable types) and six types of local media samples containing more than 40.0% of caco3, there were (Black Sinai, Bitchino, Brechia, Red Zaffaran, Salad and Ward el-Nile Zaffaran).

3- Physical analysis

The main parameter in case of physical analysis of surveyed and collected samples and foreign basalt were bulk density, particle density, void ratio percentage and porosity percentage in addition to the water permeability through the samples. All these parameter were considered for choosing the best local samples compared to the foreign one.

Tables (5) and (6) show the physical analyses of all the tested samples it is clear that, only the nearest four samples of the ten local samples have physical parameters values more near to the standard values in addition to the foreign one These four local samples were, Local Basalt, Red Granite, Alabaster Misr Bank and Krara Marble Also, the water permeability through the local samples had the same trend under three different water heads.

Permeability was less than or equal to 1 cm/sec at 10cm water head in case of mentioned samples. Mean while the permeability values were more than 1.0 cm/sec for the other six local samples.

In general it can be mentioned from the laboratory tests that the same four local samples (local basalt, red granite, Alabaster Misr Bank and Karara Marble) have mechanical, chemical, and physical specification closed to their standard values and the same specification in addition to the foreign samples. According to the results of the laboratory tests, only four local samples for the tenth collected samples were selected to use as a media for media filter of micro irrigation systems.

Table (5): Physical analysis results of the tested media samples.

Types of media	**F.B**	**L.B**	**R.G**	**A.M.B**	**K.**	**B.S.**	**BICH**	**BRCH.**	**R.Z.**	**SLD.**	**W.N.Z.**
Bulk density (g./cm^3)	1.67	1.70	1.71	1.74	1.76	1.80	1.85	1.85	1.79	1.82	1.81
Particle density (g./cm^3)	2.94	3.0	3.03	3.10	3.15	3.60	3.99	3.97	3.56	3.67	3.62
Void ratio (%)	56.8	56.67	56.43	56.13	55.87	50.0	46.37	46.60	50.28	89.59	49.86
Porosity (%)	43.2	43.45	43.33	43.87	44.1	50.0	53.63	53.40	49.72	50.51	50.14

Table (6): Permeability at three different heads for different types of the tested media samples

Head (cm.)	Permeability (cm/sec.)										
	F.B	L.B	R.G	A.M.B	K.	B.S.	BICH	BRCH.	R.Z.	SLD.	W.N.Z.
10	0.88	0.92	0.96	0.98	1.02	1.04	1.15	1.12	1.05	1.08	1.09
20	1.25	1.30	1.36	1.42	1.44	1.48	1.68	1.64	1.49	1.52	1.54
30	1.53	1.60	1.66	1.70	1.77	1.80	1.98	1.95	1.82	1.86	1.88

* F.B. : Foreign Bazlet. * L.B. : Local Bazlet. * R.G. : Red Granite
* A.M.B. : Al-baster Misr Bank. * K . : Krara. * B.S. : Black Sinai.
* BICH. : Bitchino * BRCH. : Brechia. * R.Z. : Red Zaffaran.
* Sld. : Salad. * W.N.Z. : Ward El-Nile Zaffaran.

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