[PS]Treatment of Grey Water Using Jordanian Natural Zeolites*

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Abstract

A system of a series five columns was designed to treat and purify effluent grey water generated from washing rock samples from the laboratory of the Jordanian Oil Shale Company (JOSCO). Each column was loaded with a bed of either white sand or faujasite-phillipsite tuff (Zeolite) or charcoal. The faujasite-phillipsite tuff from Jabal Hannoun of Northeast Jordanian Badia was selected because it has suitable mineralogical and technical properties that enable it to be used as an ion-exchanger and adsorbent. These include suitable grain size, total cation exchange capacity, and total zeolite grade. The JOSCO labs grey water has very high turbidity (3714 NTU) and electrical conductivity (EC) (1200 µs/ cm) and is contaminated with Cu and Fe compared with tap water, where the turbidity is 2.29 NTU and the EC is 796 µs/ cm. The grey water was treated by percolation through specially designed treatment columns as a whole system. The zeolite bed loaded in the column has an acceptable efficiency to remove Ca and Na, and an excellent efficiency to remove Fe, Cu, and Cd from the grey water. A beds of zeolite, white sand and coal loaded in separated columns are capable of cleaning the effluent from the lab at a cost of less than 200 JD/ ton of zeolite and 160 JD/ ton of white sand and 385 JD/ ton of charcoal.

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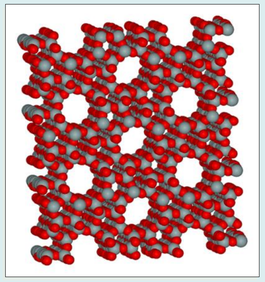
BACKGROUND

What is Zeolites?

Zeolites are of the largest mineral groups. They are characterized by an Ability to lose and gin water molecules reversibly and to exchange cations without a major change in structure.



The micro molecular structure of a Zeolite

OBJECTIVE

Water consumption in the oil shale preparation labs is very high, where large quantities of water is used for washing oil shale cutting samples before being processed. A recycling system is needed to be applied on the grey water in which recycled/ treated water can be used for washing samples or cleaning purposes. Since Jordan has limited sources of water and therefore is facing water shortage.

Recycling system design needs to be efficient, simple with low costs. It should remove the suspended solids, hydrocarbons, odor, and colors. Natural zeolites occur in northeast Jordan in huge quantities associated with the volcanic tuff. They are mined and utilized at low cost.

METHODS

Four experiments were applied to the grey water with zeolite.

- Experiment 1
  To determine suitable effluent volume of grey water that can be treated.
- Experiment 2
  To determine bed mass of zeolite that can clean the water.
- Experiment 3
  To determine contact time between the influent volume and zeolite.
- Experiment 4
  To determine flow rate of the water in ion exchange and adsorption columns.

Operational conditions of the used columns in experiment 4

	Column A White sand	Column B White sand	Column C Zeolite	Column D Zeolite	Column E Coal
Internal radius (cm)	1	1	1	1	1
Bed length (cm)	15	15	15	15	15
Bed volume (cm^3)	47.14	47.14	47.14	47.14	47.14
Bed weight (g)	90.5	90.5	47.14	47.14	39.12
Flow rate (mL/min.)	62	60	15	10	10.5

Chemical and Physical characterization of the water samples (grey water & tap water) was carried out including:

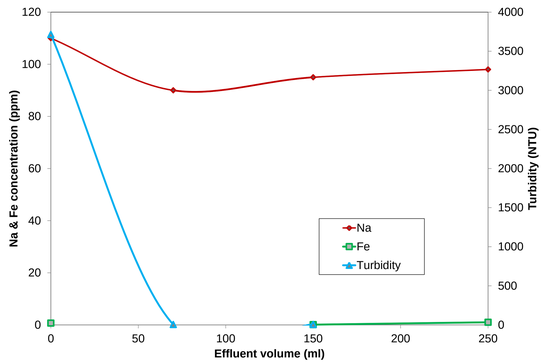
- Analysis of major cations, anions, and trace elements.
- Determination of total dissolved solids (TDS) and total carbon (TC).
- Determination of EC, pH, turbidity and color was carried out.
- Comparison between the treated water with the grey and tap water from the company was carried out.

Experiment 1

RESULTS

Chemical and physical characteristics of grey water, tab water, and Jordanian drinking water standards.

	Tap water	Grey water	Jordanian drinking water standards
Chemical Composition (ppm)			
$SO4^{-2}$	40	118	<200-500
F^{-}	0.18	0.5	1.5
$HCO3^{-}$	144	175	Not available
$NO3^{-}$	37	36	<50-70
Cl^{-}	92	154	<200-500
Cd^{+2}	0.13	0.16	0.003
Cr^{+3}	<<0.1	0.01	0.05
Ni^{+2}	<<0.5	<<0.5	0.02
Pb^{+2}	<0.5	<0.5	0.01
Mg^{+2}	4.7	5.5	Not available
Fe^{+2}	0.008	0.696	< 0.3 -1.0
K^{+}	1.8	4	Not available
Ca^{+2}	102	109	Not available
Na^{+}	34	110	<200-400
Cu^{+2}	0.008	0.018	< 1.0-1.5
Physical Properties			
Taste	Acceptable	Not acceptable	Acceptable for majority of people
Odor	Acceptable	Not acceptable	Acceptable for majority of people
Color	colorless	Grey to dark grey	<10-15 units
TC*	40.03	63.78	Not available
TDS*/ppm	509.44	768	<500- 1500
Turbidity/ NTU*	2.29	3714	<1-5
EC µs/ cm	796	1200	Not available
pH	6.842	6.891	6.5-8.5



Relationship between effluent volume from coal column and concentration of Fe & Na with turbidity value

RESULTS

Side view of the final practical columns system for out-lab using

Analysis results of the treated water

Na+ (ppm)	Ca^{+2} (ppm)	Fe^{+2} (ppm)	pH	EC (µS/cm)	Turbidity (NTU)
95	27	Below detection limit	7.9	777	4

CONCLUSIONS

- The Jordanian faujasite-phillipsite tuffs from Jabal Hannoun volcanoes have suitable mineralogical and technical properties that enable them to be used for ion-exchanger processes.
- The faujasite-phillipsite tuff has an acceptable efficiency to remove Ca and Na, and an excellent efficiency to remove Fe, Cu, and Cd from effluent grey water of JOSCO's washing samples laboratory.
- The zeolite will have a high efficiency to remove Na (110 ppm), Fe (0.696 ppm), Cu (0.018 ppm), Cd (0.16 ppm), Ca (109 ppm), k (4 ppm), and Mg (5.5 ppm) from the grey water from JOSCO labs.
- The expected cost of one ton of zeolite tuff from local market is less than US $200, and the cost of 1 ton of white sand coal is US $160, and the cost of 1 ton of coal is US $385.

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