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Short Communication

Chemical Evaluation and Treatment of Ground Water for University Town Peshawar, Pakistan by Reverse Osmosis Technology

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Abstract. Present study is focused on the ground water treatment for the University Town Peshawar by reverse osmosis technology, based on the principle of reverse-osmosis pure water and ultra pure water filtration. Water collected from three locations was analyzed. The results showed that the first two water samples were neutral having pH 7.09 and 7.16 comparable with the range (6.50-8.50), while the pH for the water sample getting purified and passed from RO process was 5.33 i.e. slightly acidic. The ionic content of the water sample was low, whereas the conductivity ranged from 624-634μS/cm for the first two samples and reduced to 1.37 μS/cm. The parameters investigated are below the safety baseline levels of the national and international standards with the exception of Pb.

Keywords: water analysis, filtration, reverse osmosis

In many areas of Peshawar, ground water is the sole source of raw water for households (Zuane, 1990). Chemical evaluation of ground water for University Town Peshawar along with the whole treatment by reverse osmosis technology has been carried out at Pakistan Council of Scientific and Industrial Research (PCSIR) Labs. Complex, Peshawar.

Water samples for chemical analysis were collected from three different points. One from tube well exit point (sample 1) before distribution to the various sections, second was from the exit point of the water conditioner after conditioning operation (sample 2), third from the exit of the RO system completing the purification processes (sample 3). Each sample was collected in polyethylene bottles, which were previously soaked in 10% nitric acid and thoroughly rinsed with deionized, distilled water. All chemicals used were purchased from the local market and various parameters were determined using standard procedures and WHO standards (WHO, 1993) and standard methods of (APHA, 1985). The pH (The pH meter model 4500 –H+, China) conductivity (conductivity meter, Model 2510.B, U.K.), chloride as Cl^{-1} (Mohr's method No. 4500-Cl.B), sulphate as SO_4^{-2} (Turbidimetry method No. 329), nitrite as NO_2^{-1} (Method No. 4500-NO_2^{-1}.B), NO^{-3} (Chromo tropic acid method), sodium as Na^{+1}(Method No. 3500-Na), potassium as K^{+1} (Method No. 3500-K), P-alkalinity as $CaCO_3$ (Method No. 2320.B), total alkalinity as $CaCO_3$, total suspended solids as TSS (Method No. 4540.D), total dissolved solids as TDS (Method No. 2540.C), were determined after filtration of the water samples using recommended procedures mentioned by Van der Gaag *et al*. (1991).

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According to the international and national standards of (WHO, 1993) for drinking water (Farouk *et al*., 1995), the parameters investigated are below the safety baseline levels of the national and international standards with the exception of Pb. The level of Pb concentrations in ground water samples ranged between 0.06 and 0.17 mg/L compared with the allowable values (0.01-0.05 mg/L).

Table 1 shows the most important and erroneous properties of silent reverse osmosis (RO) system and it reveals that the mentioned parameters and specifications for any type of water could be achieved. The organic matters can be completely removed from water passing this system.

The chemical compositions of the water samples taken from three points are given in Tables 2, 3 and 4. The following ionic dominance order mostly prevailed: $Cl^{-1} > HCO^{-3} > SO_2^{-4}$: NaC > Ca_2C > Mg_2C > KC. The dominance order resembles that of the leachable ions from the soils. This indicates that the minerals in the ground water samples are of lithogenic origin (Miller *et al*., 1985).Variations in the ionic content and the chemical analysis for the three samples are shown in tabulated form (Tables 2 - 4).

Relatively high concentrations of the mentioned parameters are due to the mobility of trace metals in the presence of high concentrations of chloride ions.

Table 1. Specifications of the Silent RO system

Parameters	Specifications
Inorganic compound	99.9% removal
Organic compounds	99.9%
Total organic carbon (TOC)	40 µg/L
Bacteria	99.9%
Product rate at room temprature	400 L/h
Power	220V,50Hz,1.5kw

Table 2. Chemical evaluation results of the ground water (Well sample)

Parameters	Water sample	WHO limits
pH	7.16	6.50-8.50
Conductivity (µS/cm)	634.00	-
Total dissolved solids (TDS) (mg/L)	410.00	1000.00
Total suspended solids TSS (mg/L)	4.00	5.00
Total hardness as $CaCO_3$ (mg/L)	272.00	500.00
Calcium as $CaCO_3$ (mg/L)	140.00	250.00
Magnesium as $MgCO_3$ (mg/L)	132.00	150.00
Total alkalinity as $CaCO_3$ (mg/L)	228.00	500.00
P-Alkalinity as $CaCO_3$ (mg/L)	Nil	30.00
Chloride as Cl^{-1} (mg/L)	30.00	250.00
Sulphate as SO_4^{-2} (mg/L)	124.00	250.00
Sodium as Na^{+1} (mg/L)	27.10	200.00
Potassium as K^{+1} (mg/L)	4.60	75.00

Table 3. Chemical evaluation results of the water sample passed from water conditioner (Second sample)

Parameters	Water sample	WHO limits
pH	7.09	6.50-8.50
Conductivity (µS/cm)	624.00	-
Total dissolved solids (mg/L)	400.00	1000.00
Total suspended solids (mg/L)	3.00	5.00
Total hardness as $CaCO_3$ (mg/L)	268.00	500.00
Calcium as $CaCO_3$ (mg/L)	96.00	250.00
Magnesium as $MgCO_3$ (mg/L)	172.00	150.00
Total alkalinity as $CaCO_3$ (mg/L)	236.00	500.00
P-Alkalinity as $CaCO_3$ (mg/L)	Nil	30.00
Chloride as Cl^{-1} (mg/L)	30.00	250.00
Sulphate as SO_4^{-2} (mg/L)	119.00	250.00
Sodium as Na^{+1} (mg/L)	28.90	200.00
Potassium as K^{+1} (mg/L)	4.40	75.00

Chloride complexation increases metal mobility (Doner, 1978) and decreases adsorption iron (0.04–0.3 mg/L), and manganese (0.17–0.45 mg/L) concentrations of the examined ground water sample are within the permissible limit. The study clearly indicates that most of the ground water of Peshawar University town is free from any

Table 4. Chemical evaluation results of the water sample passed from reverse osmosis system (Third sample)

Parameters	Water sample	WHO limits
pH	5.33	6.50-8.50
Conductivity (µS/cm)	1.37	-
Total dissolved solids (mg/L)	1.00	1000.00
Total Suspended Solids (mg/L)	0.00	5.00
Total Hardness as $CaCO_3$ (mg/L)	8.00	500.00
Calcium as $CaCO_3$ (mg/L)	4.00	250.00
Magnesium as $MgCO_3$ (mg/L)	4.00	150.00
Total Alkalinity as $CaCO_3$ (mg/L)	8.00	500.00
P-Alkalinity as $CaCO_3$ (mg/L)	Nil	30.00
Chloride as Cl^{-1} (mg/L)	14.00	250.00
Sulphate as SO_4^{-2} (mg/L)	0.00	250.00
Sodium as Na^{+1} (mg/L)	0.80	200.00
Potassium as K^{+1} (mg/L)	0.00	75.00

obvious pollution exception of Pb which may cause some problems if used for human consumption. Ground water samples can be used for industrial purposes, and for different analytical uses. The result showed that RO system purified water 99% free from pollutants.

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