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Enhancing the Quality of "Produced Water" by Activated Carbon

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Abstract

The main objective is to contribute via this study, in solving an environmental issue and helping Qatar in finding suitable water resources; useful in agriculture. Qatar faces diverse water challenges; the number one that threats here is scarcity as water is not renewable. Due to scarcity of good quality water, reusing of low quality and contaminated water is highly increasing in Qatar. The main source of water in Qatar is desalination stations. Most of the desalinated water is for human usage. Agriculture in Qatar depends mainly on underground water; it is available but always saline and found in insufficient quantities. Due to the increasing demand for water among industries and irrigation, using other alternative water resources such as produced water during oil and gas extraction would be of importance. Generally, produced water is the water that exists in subsurface and is moved to the surface through oil and gas processes. The volume of produced water and pollutants concentration vary depending on the nature and location of the oil products. It represents the major waste stream related to oil and gas processes. Large volume of produced water generated in Qatar has the potential to enhance the water resources. The crucial goal of produced water management is to eliminate dissolved harmful components and use it for beneficial uses that can efficiently improve environmental impact and water shortage. An exclusive characteristic of produced water comparing to other wastewater resources is the large variation and complexity in water chemistry. This would play a vital role in the remediation processes.

Remediating produced water for irrigating use has been explored as a substitute to conventional disposal and discharge processes. Produced water is described by high concentrations of heavy metals, salts, toxic organic

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components, and total dissolved solids (TDS). Consequently, the produced water need to be remediated to meet the Qatari and international standards appropriate for the anticipated end use and to have a valuable resource rather than a waste.

However, the objective of this study was mainly dealing with using the adsorption technique in remediating benzene, toluene, ethyl-benzene, and xylenes (BTEX) and heavy metals from the produced water, After a fully determination of the quality of the produced water, the first part of the project was emphasized on remediation of BTEX and heavy metals to facilitate it to use for beneficial areas such as irrigation. In this study, activated carbon (AC) was used to remediated the soluble organics from the produced water and heavy metals. In addition, microemulsions was also used to modify the AC to selectivity remediate different types of pollutants. AC and microemulsions modified AC was used for effectively remediate BTEX and heavy metals from the produced water under specific conditions.

A representative sample of the produced water was collected from different sources at different times; the samples were collected in 20 liters container where two samples was collected per day,6 days $\times$ 20 litters $\times$ 2 = approximately 240 litters were mixed together and stored in a big storage container. A local sand sample (10 Kg) mixed with raw clay (2%) was used for the preparation of the sand filtration column (length 120 cm and 10 inches diameter), which was needed for the pretreatment step of the produced water. The produced water sample was then filtered and collected from the column with rate 12 ml/min. Different experiment parameters such as the effect of activated carbon mass (50, 35 and 20 g), particle size, pH (4, 6 and 8) and the temperature on metal and BTEX remediation were investigated. Glass columns with length 15 cm and 3 cm diameter were used for the experiments. One liter of the filtered produced water samples were filtered from each column with a rate of 2 ml/min. Microemulsion modified AC was prepared by mixing AC with surfactant Triton 100, then the mixture was shaked and dried at 80°C for 48 h.

A comprehensive chemical and physical characterizations of the produced water was conducted; namely pH (4.78), COD (6760 ppm), TOC (1550 ppm), TN (45.45 ppm), TDS (4490 ppm), conductivity (6800 µs/m), alkalinity (124 ppm, Hardness (1060 ppm). Several metals concentration was determined such as Ag, Al, As , B, Cd, Cr, Li, Mn, Sb, and Sr and the result were 0.31, 28.54, 0.00, 4363.76, 0.29, 16.97, 2231.59, 263.87, and 134.87 ppb; respectively.

The Fourier transform infrared (FTIR) spectra of sand filter, AC, and microemulsion modified AC were recorded using the FTIR Perkin Elmer. The FTIR analysis was carried out to interpret the functional groups which occurred in the AC and the modified form. The FTIR measurements was performed over 4000–400 cm^{-1}. Scanning electron microscope (SEM) was also used to evaluate the surface morphology of the adsorbents using the JEOL model JSM-6390LV.

The overall of the results were extremely excellent in which the metals concentration and BTEX was dramatically reduced when activated carbon was used as an adsorbent. According to the results, the activated carbon with of the different ranges and concentrations had been extremely efficient in removing benzene and toluene from the produced water. It can also be noted that with the increase of AC concentration, contaminants removal efficiency becomes higher up to a level were no BTEX compounds can be detected anymore.

The future work of the study will be designed to adopt environment-friendly method, such as phytoremediation to remove contaminants from water and soil to reuse that water in landscape and biofuel plantation. Three crop plant species Helianthus annuus (sunflower), Zea mays (maize) and Medicago sativa (alfalfa) in addition to Qatari endemic desert plants that are known to be salt tolerant and survive under contaminated soils such as Atri[lex leucoclda Bioss (Raghl)], Cyperus jeminicus Rottab (Rukbah), Tamarix aucherana (Decne) Baum (Tarfa), Phragmites australis (cav.) ex Steud (Ghab) will be used in this study and their associated microbes will be utilized to develop an effective cost method to remove contaminants from such polluted water and reuse it.

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