Reuse of Iraqi Agricultural Drainage Water Using Nanofiltration

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Abstract: Irrigated areas between Euphrates and Tigris rivers in Iraq suffer from salinity buildup in the root zone of corps. Agricultural drain water (ADW) from these areas is collected in a single main drain canal, in an annual flow rate of about 6 billion cubic meter. In the present work, a pilot-scale nanofiltration membranes unit was used to evaluate the feasibility of desalinating ADW from the main drain canal for further reuse. Bench scale experiments were conducted to determine the optimum anti-scale dosage values in the unit. These values were verified in a plate type laboratory scale NF membrane to visually monitor the onset of crystal appearance behavior. A method for calcium sulfate precipitation control is presented and an empirical correlation of anti-scale dosage as a function of concentration factor (CF) was obtained. A pilot-scale unit was used to investigate the performance of NF membrane. High rejection values for both cations and anions indicate that the use of NF membrane in desalinating ADW from the Iraqi main drain canal is promising. The treated drainage water is considered good for irrigation when classified according to Wilcox classification.

Keyword: Agricultural water, Revers osmosis, Nanofiltration, Salinity, Antiscalant, Water reuse.

1. INTRODUCTION

Many agricultural parts of the word, especially in arid and semiarid regions, suffer from adverse effects of irrigation, such as water logging and soil salinity. Concurrently, fresh water resources continue to dwindle either from excessive use or from deterioration of water quality due to contamination [1]. The agricultural sector is the largest user, and consumer, of water in Iraq, with its share exceeding 75% of the total gross demand for water [2]. On a consumptive use basis (the water fraction that evapotranspires during use), the share of irrigation water is even higher at more than 80% [2]. Future increase in overall irrigation supply will depend on changes in the (priorities) demands for the municipal and industrial sectors, development of new groundwater resources and measures to reduce the outflow (terminal drainage) from the Euphrates-Tigris system.

Agricultural drainage water (ADW) is a complex mixture of dissolved and suspended organic and inorganic components as well as a wide variety of microorganisms [3]. The feasibility of membranes for drainage water reclamation was first demonstrated in 1971 at Firebaugh, California ([4, 5]). Since then, serious consideration has been given to membrane technology for reclamation and reuse of agricultural drainage water in the one of the largest agricultural centers of the word, the San Joaquin Valley, CA [6].

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Interruption of drainage has created a severe hardship for the farming community. If not resumed, a gradual salinity build–up will necessitate the retirement of large areas of fertile agricultural land. Consideration of water quality in relation to optimization of the desalination process is especially critical with agricultural drainage water. Authors, such as Le Gouellec and Elimelech [3], have studied experimentally the conditions for gypsum scale formation on nanofiltration (NF) membrane surfaces for the reclamation of ADW. They reported that scaling occurred at low water recoveries, and was mostly due to calcium sulfate (gypsum) formation of the membrane surface. Applications of water and wastewater treatments by nanofiltration membrane are not well-known in Iraq [7]. In the present work, a laboratory and a pilot investigation was carried out to evaluate the feasibility of (NF) membrane desalination of agricultural drainage water in the Euphrates and Tigris rivers in Iraq. The treated water will be evaluated for its salts concentration and classified by applying Wilcox diagram [8] to judge its suitability for irrigation.

1.1. Description of the Field

In Iraq, the construction of the main drain canal (MDC) began in 1953 to drain saline water used for irrigation and was completed in 1993, and its functions are as follows:

1. To receive water drained from irrigated areas between Euphrates and Tigris Rivers which will lead to decrease soil salinity and increase land productivity.

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