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Measuring and Evaluating the Performance of a Wastewater Treatment Plant

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Abstract - The main concept of wastewater treatment is to remove or reduce the excessive amounts of contaminants from the wastewater. This performance study was needed to evaluate the efficiency of a wastewater treatment plant in decreasing the pollutants level, to meet with the governmental environmental standards. Also, the wastewater re-use for irrigation approaches must be in accordance with the criteria along with indicators should be monitored also impended up on a complying basis, and necessity at the stage of assessing and development to give top precession to standards to shield the land and water resources along with the public health protection Required category of treatment determent through the development of treatment objectives of the approach and check all applicable laws and regulations and finally compared the characteristics of the wastewater with the constraints of the laws. And thereby determine and consider possible options, disposal and re-use. Next decide the most acceptable option is to get rid of pollutants in the wastewater in ways that are either chemical or physical or biological individually or grouped. This study evaluates and analyzes the performance and the efficiency of Shoubra Al Khaima (Balqus) wastewater treatment plant (WWTP). Based on the results, it shows that Balqus WWTP operates with removal efficiencies higher than 90% for biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS) and oil & grease (O&G) were established. This analysis applied to define a performance measuring plan based on the most important parameters that can be reliable and applicable for any WWTP.

Keywords**:** Wastewater, biological treatment, Performance, Removal efficiency

1. Introduction

Nowadays, wastewater treatment plants are facing new challenges to comply with tighter wastewater discharge limits [1]. The scarcity of freshwater resources is not a problem in Egypt only, but has become a global problem which impose itself in the twenty-first century. It will be a witness on the emergence of water problem in the whole Middle East.

Wastewater are commonly categorized as domestic wastewater or industrial wastewater. Domestic wastewater refers to wastewater generated from "non-manufacturing activities" occurring in residential homes which includes sewage (from toilets) and grey water (from bathrooms and kitchens) [2]. There are many types of industrial wastewater based on the different industries and contaminants; each sector produces its own particular combination of pollutants. Wastewaters are typically contaminated with physical, chemical and biological composition which has tremendous negative impact on environment, where it has the ability to destroy many animal habitats, and cause irreparable damage to many ecosystems [3].

Secondary treatment process is applied to get rid of the colloidal and dissolved solids from the effluent resulted from the primary treatment. The wastewater is further treated using biomass as an agent that why the Secondary treatment is always termed by biological treatment.

Removal of colloidal suspensions is achieved by the principal of physiochemical adsorption and by enmeshment of suspended solids or particulate matter on the biological floc, while reduction of soluble organic solids (BOD or COD) is achieved by microbial biosorption and their further degradation and stabilization by microbes [4].

The efficient performance of a biological treatment units depends on developing a suitable mixed culture of microorganisms in the treatment unit (bioreactor), maintaining appropriate environmental conditions for the system and removing the excess sludge produced [5]. If excess sludge, which itself is organic in nature, is not removed from wastewater, it will be measured as increased BOD or COD in final effluent and ultimately when disposed into a stream, will deplete the dissolved oxygen DO of the receiving stream [6].

Performance evaluation of existing treatment plant is required to assess the existing effluent quality and/or to meet higher treatment requirements, and to know about the treatment plant whether it is possible to handle higher hydraulic and

organic loadings [7]. Performance appraisal practice of existing treatment plant units is effective in generation of additional data which also can be used in the improvement in the design procedures to be followed for design of these units [8].

2. Case Study

Balqus wastewater treatment plant built in 1995. The total area of the treatment plant is up to 83 Acres, and it serves more than 3 million people in one of the biggest governorate. The output capacity of the treatment plant is 400000 cubic meters per day and may reach 600000 cubic meters per day at the peak time. Balqus treatment plant consists of three phases in terms of each stage is considered as an independent unit this beside the Preliminary treatment facility involving the three phases together, it is divided into: Pretreatment, Primary treatment, Secondary (biological) treatment and Disinfection (chlorination).

3. Data and Methods

In this study the performance of Balqus wastewater treatment plant was evaluated. This done based on the analysis of mainly four parameters BOD, COD, TSS and O&G. the sampling campaigns were carried out through a period of six months. We were identified four sampling points: (1) the wastewater treatment plant influent; (2) the outlet of the primary sedimentation tanks; (3) the outlet of the secondary treatment process; (4) the outlet of the disinfection stage. All the laboratory analysis for the samples were done according to Standard Methods for examination of water and wastewater [9]. Based on the results we can determine the removal efficiencies of the different parameters for each stage in the wastewater treatment plant.

The collected samples from Balqus treatment plant may have three sources of error; human error, devices accuracy and sampling procedure. The reliability of data resulting from the experimental analysis of samples was examined and the sources of error were highlighted. In the following points, the main sources of error are discussed briefly. Using a manual sampling method is more practical in forming sample with a variable volume technique.

4. Results and Discussions

The pH value of the wastewaters were ranged between 7.83 to 9.1with mean value of 8.02. The pH value were measured because it is a very effective parameter on the removal efficiencies of the different contaminants. The concentrations of different contaminants taken from the four assigned sampling outlets along the study period are shown in Fig.1. The removal efficiencies of different contaminants for all the WWTP process are shown in Fig.2.

Some of the data is subject to the errors which discussed before such as the values of the BOD which indicates a grip sample or some error in taking sample by the technician. The dilution of storm water combined to the sewerage system which runs to Balqus treatment plant rises some error in the values of contaminants of an influent sample. Data filtration were applied on the values which considered to be lower than the minimum average expected values of different measuring parameters. A strong reliability of the measuring analysis were indicated through a comparison between the average concentrations of COD, BOD and TSS with the theoretical relations between these parameters which indicate a strong reliability of the GWWTP lab analysis.

4.1. Primary treatment

The COD removal efficiency were ranged from 44% to 55 % with mean value of 51% regarding to an average concentration of 213 mg/l. The BOD removal efficiency were ranged from 45% to 53 % with mean value of 49% regarding to an average concentration of 140 mg/l. The TSS removal efficiency were ranged from 46% to 57 % with mean value of 52% regarding to an average concentration of 235 mg/l. The O&G removal efficiency were ranged from 52% to 54 % with mean value of 53% regarding to an average concentration of 135 mg/l.

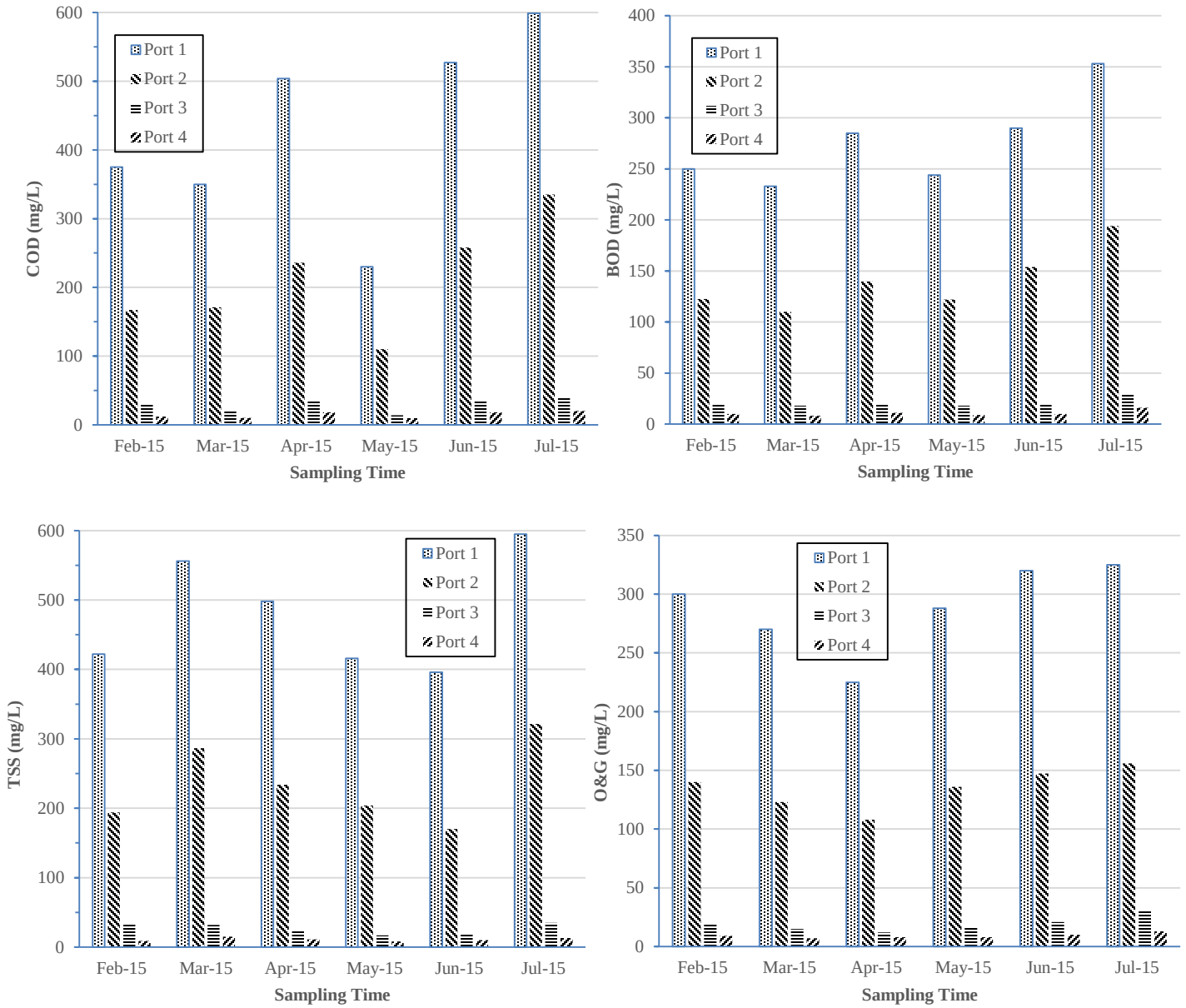

Fig. 1: the concentration of different contaminants taken from the four sampling ports during the study period.

4.2. Secondary treatment

The Secondary treatment in Balqus WWTP is a biological treatment (Activated Sludge System) composed of 3 Aeration tanks and 18 secondary sedimentation tanks. The COD removal efficiency were ranged from 92% to 94 % with mean value of 93% regarding to an average concentration of 29 mg/l. The BOD removal efficiency were ranged from 92% to 93 % with mean value of 92% regarding to an average concentration of 21 mg/l. The TSS removal efficiency were ranged from 92% to 96 % with mean value of 94% regarding to an average concentration of 27 mg/l. The O&G removal efficiency were ranged from 91% to 95 % with mean value of 93% regarding to an average concentration of 19 mg/l.

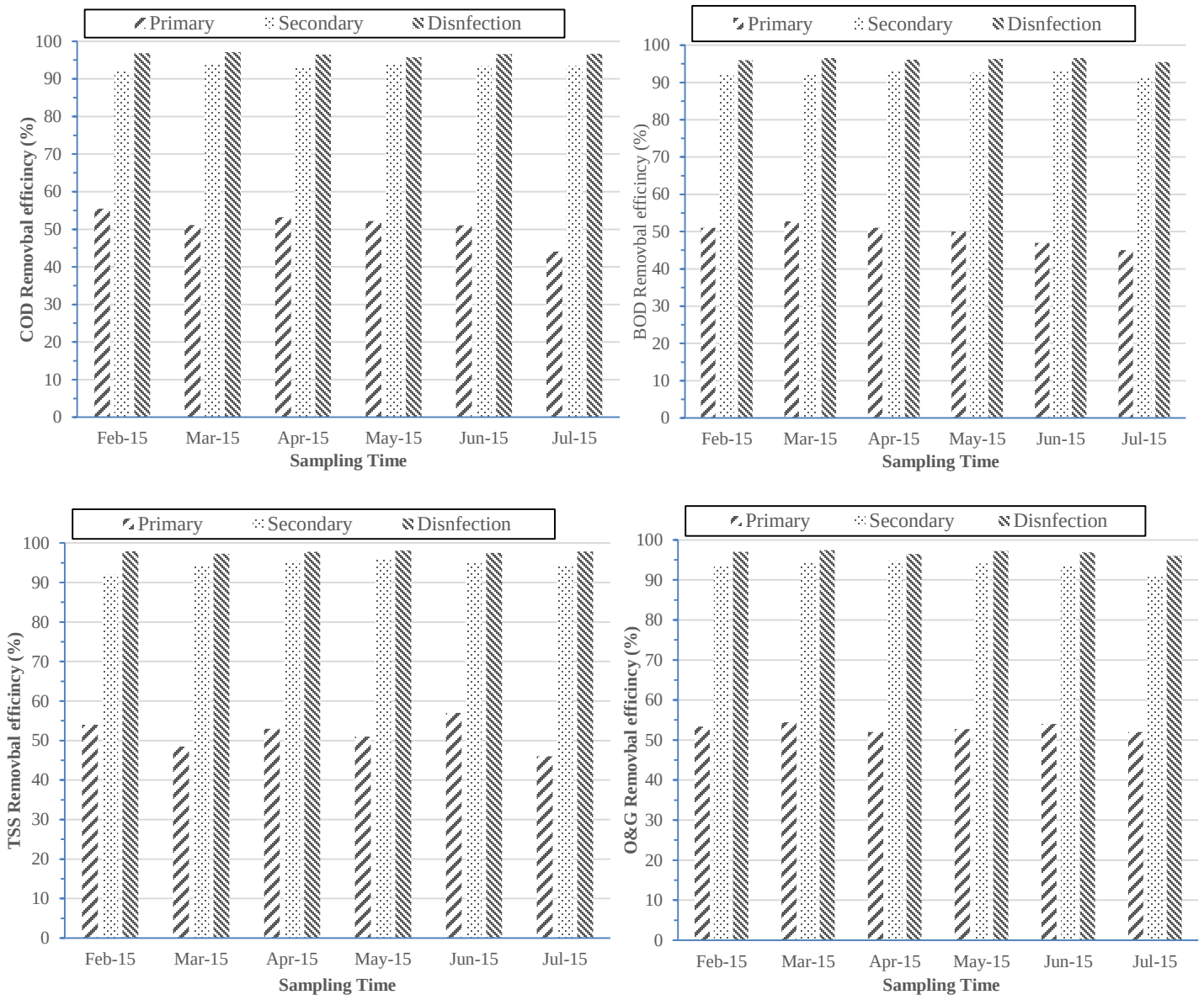

Fig. 2: the removal efficiencies of different contaminants for all the WWTP process.

4.3. Disinfection

The COD removal efficiency were ranged from 96% to 97 % with mean value of 97% regarding to an average concentration of 15 mg/l. The BOD removal efficiency were ranged from 95% to 97 % with mean value of 96% regarding to an average concentration of 11 mg/l. The TSS removal efficiency were ranged from 97% to 98 % with mean value of 98% regarding to an average concentration of 11 mg/l. The O&G removal efficiency were ranged from 96% to 97 % with mean value of 97% regarding to an average concentration of 9 mg/l.

5. Conclusion

The objective of this study is to make an evaluation of the performance of WWTP. Conclusions are depending on the results from the experimental works and its analysis. The main conclusions points of the study can be interpreted into the following points (1) the removal efficiencies of COD, BOD, TSS and O&G were acceptable according to the process guide lines; (2) All the effluents from every sampling ports of the WWTP are agreed with the Egyptian law No. 93/62 and its modifications at Decree No. 44/2000, especially the samples taken from the WWTP output (from port 4) which is less than 20 mg/l for all the measured contaminants.

The operation of the Secondary (Biological) treatment need a fully control of the factors which affect the system efficiency such as temperature, organic loading rates, up flow velocity and the hydraulic retention time.

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