Evaluation the Performance of Al-wahdaa Project Drinking Water Treatment Plant: A Case Study in Iraq

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Article Info

ABSTRACT

Al-wahdaa project drinking water treatment plant has been playing a vital role in supplying drinking water to Baghdad city since 1942s. It was designed with a design capacity 68000 m3/d So that it can cover the needs of the public properly. However, the fatal circumstances which have recently hit Baghdad city represented by wars and terrorist operations have considerably resulted in a significant deterioration in the quality of Al-wahdaa project water treatment plant in the early of 2005s and 2006s. Furthermore, the failure of the equipments and the deficiency of the crew of the power plant have dramatically caused a shortage in the efficiency of the plant. Therefore, this work is the earliest attempt in addressing the problem of this plant. In this study, the removal efficient of the filtration, sedimentation will be addressed as well as the turbidity during three years of investigation. It was found that the average value of the removal of the sedimentation basin was about (46%) and the (R^2 0.902) which is obviously low due to the absence of the permanent maintenance and the continuous clean out for the sedimentation basin. The removal efficiency of filtration basin was as high as (75%) and the (R^2 0.445) comparatively with the removal efficiency of the sedimentation basin .The turbidity magnitudes were slightly oscillated along the study period since there has been shortage in the efficiency of sedimentation basin, it is then peaked at rainy season with about (18 NTU). The Total Dissolved Solids (often abbreviated TDS) was high but it may fall within the Limitations, it is interesting to note that it was highly increased at January due to the high turbidity discharge.

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1.   INTRODUCTION

Drinking water is the most vital infrastructure since it serves industrial, domestically and agricultural sectors. The water resources since has been an enthusiastic field since ages. Various researches were held on analyzing the water webs [1] [2]. In many cases drinking water was incorrectly treated resulted in the trail of epidemics diseases which threaten the health of human potential [4-5]. The main objective of water treatment is to purify the polluted water and make it fit for the human consumption, through the removal and killing of organism's sickness (pathogenic organisms) and remove the taste, smell, unpalatable brownish discharge, some of the excess of dissolved metals and a range of items. However, the desired chemical and harmful [6][7][8]. The validity of the water for human consumption is a measure of the purity

of water as well as compared with the water consumption for industrial and agricultural sectors[3]. However, some industries require high purity water like pharmacological industry and paper industry [10]

Potable water for human consumption contains permitted concentration of impurities, particulates, chemical compounds and minerals dissolved water treatment [11]. Moreover, it contains the number of bacteria in source water and like colon bacteria (E-coli), also included the parameters of the highest amounts of radiation in the presence of water [12-14]. Some developed countries identified the concentration of water allowed by the World Health Organization standards (WHOS), which is more complicated than conventional treatment, leads to an increase in cost [15]. However, costs do not represent an impediment to these countries especially for developed countries as Japan which has made strict methods in water treatment plant [16].

The World Health Organization had done some arrangements to enhance the capacity of water treatments plant as establishing the stations in the form of story in order to exploit the area, establishing the internal walls of the basins of the treatment where algae can't growth [17]. Pan-American Health Organization has identified the highest concentration of turbidity permitted by (1NTU) in 2003 of water turbidity actual centers in American cities of Amount (0.1NTU) [18-20]. Keep in mind that the seasonal events such a spring runoff, summer and fall algae blooms, and soil erosion affect final effluent quality. It was indicated that influent turbidity to the water plant is high during rainy periods [19-20]. Moreover, rivers are more susceptible to pathogen contamination than lakes and reservoirs, besides higher particulate concentrations. It was found that the water color highly affects the sizing of the particles and Giardia cysts as measured by the particle counter. The level of pathogens, such as Giardia and Cryptosporidium, in the filtered water is related to their respective levels in raw water [21-22].

2.   DESCRIPTION OF THE PROJECT

The location of Alwahdaa Station project in the neighborhood for the General Company for Vegetable Oils at the entrance of Street almusbah , and contain the station on two projects for water treatment first (completed in 1942) feeds the Arsat alhndiaa and parts of the Karrada district and industrial district located between the intersection of Al-Rasheed Camp and the area of Uqba bin nafeaa and regions surroundings, while the second project (completed in 1959) feeds the neighborhood of Riyadh (known as Camp Sara area) and the Street and Industry Street, University of Technology and 52 street and adjacent areas. Flow diagram of Alwahdaa treatment plant is illustrated in Fig.1

The advantage of these areas, high water consumption, especially in periods of the day because of high population density of this region during the day, showing a large deficit and significant inquires about the possibility of feeding these areas are of sufficient drinking water, because the station is one of the oldest water purification plants in Iraq, where completed in the monarchy has not seen any attempts to develop to keep pace with industrial development, commercial and residential area experienced significant since the establishment of the station and to this day.

2.1. Intake

It is located on the Tigris River in depth of 9 meters, a rubber protector to prevent the entry of floating material and algae. The pump contains 3 plugs on the pump uploaded the water, two of them working and the one-pump is as Standby. The total energy of each pump is 680 m^3/ h, the pressure of the head of the water is 40 m, and The maximum capacity of the pumps working during the summer hours in the high consumption during the day for that is running standby pumps in addition to the main pumps for the purpose of bridging the growing consumption during that period. These pumps are meant to raise the water from the river to the Rapid mixing basin. There is an organized system near the lift station in order organize the amount of water drawn from river

2.2. The Purification Process

The rapid mixing basins is the first treatment step for water after receives it from river. Added alum of the highest basins mixing speed (by means of center minutes in advance), and is mixing by hydraulic power to the flow of water so there is no blenders in these basins, and furthermore it does not exist in the water plant process blending slow at this station.

Sedimentations Basins Sedimentation basins: The entry of water from basins mixing speed directly to the clarifier the first of which is dimensions (22 m × 23 m) and has a sweeping clays at the bottom and the installation from the top makes it work sweeping clays floating and make up on this machine in practice (rotor) moves water then to the basin sedimentation II, who has the same dimensions of the basin the first but does not contain sweeping clays and both basins of the depth of each and every one of them from the sides (3 m) and middle (5 m) are grouped clays in the medium and is pulled by gates located in the center for this purpose .

Filtration Basins Water is pumped from the basin of sedimentation basins to the second filter presses that are working on the project, as there are eight filters, and water out of these filters have a Turbid relatively high due to the fact that filters are old and poor as well as from within the nomination and not subject to required specifications

Disinfection stage After the withdrawal of water from the filters passes to the sterilization room located behind filters where added chlorine and other disinfectants before the passage of water into a reservoir of pure water.
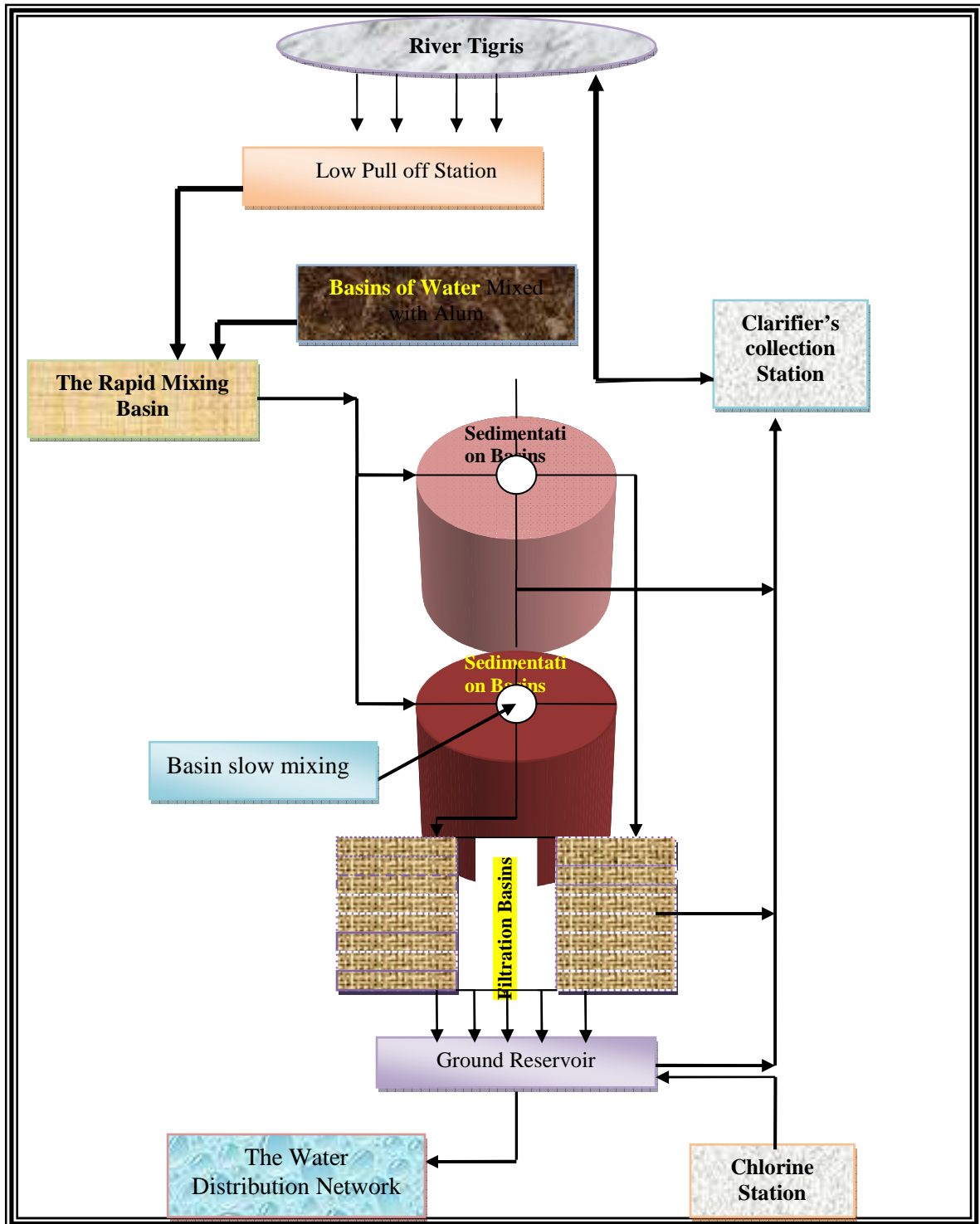

Fig. 1: Sketch the line of drinking water treatment (DWT) plants in the project Alwahdaa

The flocculation stage is the second step in purifying the river water which is held in the basin is of flocculation which is round basin contains inanimate to increase the surface area of the basin. It is of reinforced concrete column which is medley to bearing the Drawbridge Special with sweeping. Turbid water is mixed with aluminum at the bottom of the basin, then the water goes into the sintering after a period of time estimated by (20-30) minutes and then to the sedimentation basins with the period between (2-3) hours. The time duration that the water remains in sedimentation basin is 3 hours.

The mechanical Flocculation in the equation of the shipment of materials suspended by adding chemicals with charge opposite, leading to the attraction of plankton to the additive (alum) accumulate and are conglomerates relatively large size (felts), the goal of blending slowly and care is to prevent the break Felts formed during the process, and designed docks the survival time ranges between (20-30) minutes, preferably 30 minutes to complete the mixing process fully, and the value of the velocity gradient (G) between (25-65) sec $^{-1}$ and rapidly mixing between (0.15 -0.45 m / s)

3. EXPERIMENTAL ANALYTICAL

Results for sedimentation basin and filtration basin are indicated in Table1. Removal efficiency between the efficiency of sedimentation and efficiency filtration basins of the plant through the calculation of the percentage removal was evaluated by the following equation

$$\text{Removal Efficiency} = \frac{\text{Turbidity inside} - \text{Turbidity outside}}{\text{Turbidity inside}} * 100 \qquad (1)$$

Table 1: Results from the Sedimentation Basin

	After sedimentation			Before sedimentation			
Removal efficiency%	pH	Temperature	Turbidity NTU	pH	Temperature	Turbidity NTU	date
31.61	7.5	19C^0	11.16	7.3	19C^0	16.32	5/12/2005
48.67	8.2	18C^0	9.09	8.1	18C^0	17.71	12/12/2005
33.22	8.3	13C^0	9.83	8.1	13C^0	14.72	19/12/2005
32.52	8.4	11C^0	12.78	8.6	11C^0	18.89	26/12/2005
12.54	7.7	10C^0	13.6	7.5	10C^0	15.55	2/1/2006
34	7.8	10C^0	9.96	7.7	10C^0	15.1	9/1/2006
89.19	7.6	11C^0	17.07	8.7	10C^0	158	16/1/2006
87.12	8.2	13C^0	18.54	9.0	13C^0	144	23/1/2006

Table 2: Results from the Filtration Basin

	After filtration			Before filtration			
Removal efficiency%	pH	Temperature	Turbidity NTU	pH	Temperature	Turbidity NTU	Date
80.2	8.4	19c^0	2.21	8.4	19c^0	11.16	5/12/2005
77.66	8.1	18c^0	2.03	8.3	18c^0	9.09	12/12/2005
80	8.2	18c^0	1.97	8.2	13c^0	9.83	19/12/2005
86.7	8	13c^0	1.7	8	11c^0	12.78	26/12/2005
67.94	8.2	11c^0	4.36	8.3	10c^0	13.6	2/1/2006
83.6	8.0	10c^0	1.63	8.2	10c^0	9.96	9/1/2006
58.23	7.7	10c^0	7.13	7.8	11c^0	17.07	16/1/2006
66.61	7.4	11c^0	6.19	7.7	14c^0	18.54	23/1/2006

4.   DISCUSSION

It is indicated from **Table1.** It is obvious to note that the turbidity of that water entered the sedimentation basin had peaked in16/1/2006 during the study period on with a total value 158 NTU and lowered in 19/12/2005 with a total value 14.72NTU. The overall rate of sedimentation basin turbidity involved 50.03 NTU. The turbidity of water before sedimentation has peaked in 23/1/2006 with a value of value of 18.54NTU and lowered in 12/12/2005 with a value of 9.09NTU. Whereas the overall rate of turbidity of water after sedimentation was 12.7 NTU. The removal efficiency of sedimentation a basin reached its optimum magnitude in 23/1/2006 with about 87.12%, while it lowed in 2/1/2006 with about 12.54%. The overall proportion of the total basin sedimentation was 46 %.

The relationship between removal efficiency and the date of test is reported in Fig.2. It is obvious to observe that efficiency removal of the sedimentation was developed during the period of study as it was obviously low at the early of 2005s. It is indications from the results that the rates of removal of the ponds deposition is relatively low due to the absence of basins blending slow it consists felts properly, hampering the process of sedimentation, and the exception to some of the results of the limit familiar with note down the phase-in the week, the fifth due to the disruption of machine add alum at the time In the seventh and eighth weeks, note the high rate of removal significantly because of the high turbidity water coming from the river in the rainy season.

It can be concluded from that that the removal capability increases at higher turbidity removal where increases plankton density and high concentrations and large sizes, while less than removal at concentrations decrease and plankton volumes involved.

The removal efficiency of the sedimentation basin was considerably grown after 2005s and peaked in 2006s as it is indicated in Fig.2 since the Iraqi situation had been generally settled and there was a grown awareness about the validity of Alwahdaa power plant. Besides, great efforts were given from the ministry of agriculture and irrigation in order to enhance the efficiency of the plant.

$$y = -0.717x^4 + 13.514x^3 - 82.923x^2 + 187.91x - 87.97$$
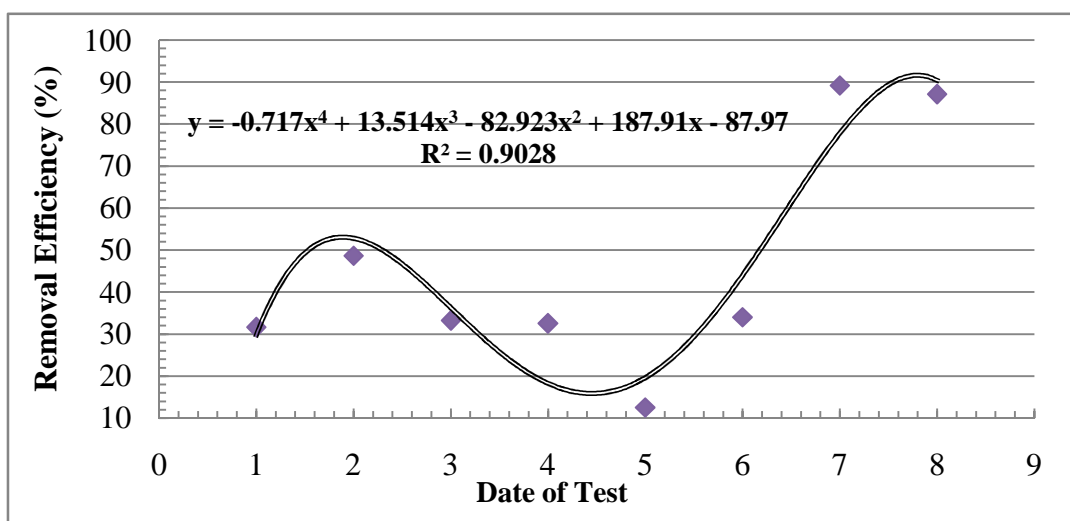$$R^2 = 0.9028$$

Fig.2: The relationship between removal efficiency of sedimentation and date of test

It is clear to know from Table 2 that the turbidity of water after filtration has peaked in 23/1/2006 with about 18.54 NTU and the lowered on 12/12/2005 with about 9.09NTU. Turbidity within the overall rate in filtration basin was 12.7 NTU. In the contrary,   turbidity of water before filtration had reached its highest value on 16/1/2006 with a total value of 7.13NTU and lowered on 9/1/2006 with a total value of 1.63NTU. The overall rate of turbidity abroad filtration basin is 3.4 NTU. However, the removal efficiency of filtration basins had peaked in 26/12/2005 with around 86.7 % and it lowered in 16/1/2006 with about 58.23%. The removal efficiency growth during the period of study is illustrated in Fig.3. it observe that the rates of removal of the basins filtration is relatively good, indicating the efficiency of filters, but show some problems when the turbidity entering the filter with water precipitated a high and this is what observe in the week, the fifth and two weeks, the seventh and eighth, with low rates of removal with the increase in brownish within which indicates that this turbidity consisting of grains with diameters soft so small that could not each of the basins of sedimentation and filtration was stopped and disposal. Consequently, ministry of water resources

had taken serious steps in applying substantial renovations in the filtration basins. Therefore, the removal efficiency was drastically grown in 2006s filtration.
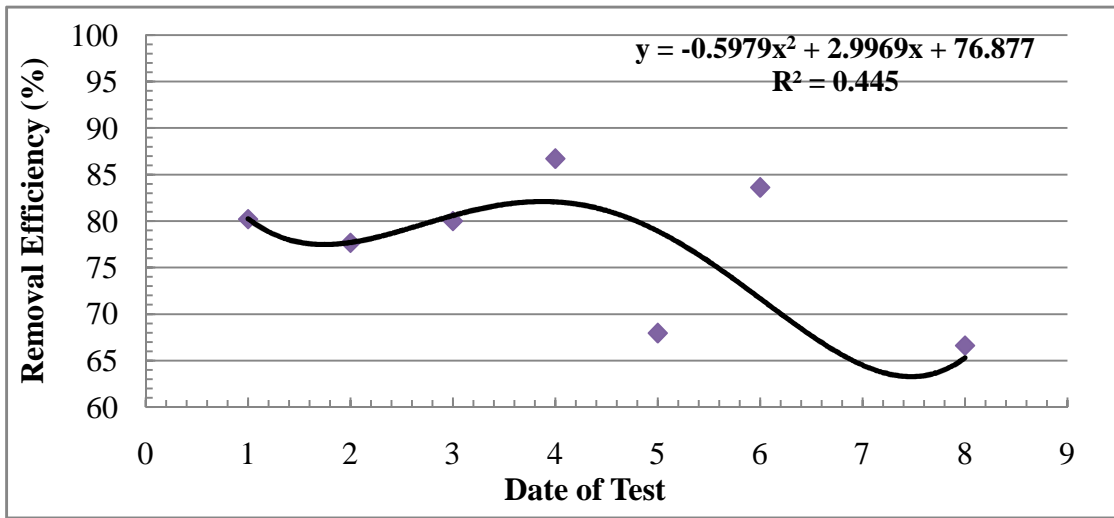

Fig.3: The relationship between removal efficiency of filtration and date of test

Results for PH are illustrated in Fig.4. It is shown the relationship of the values of pH: ranged between (7-8.), which are among the determinants of global and do not have a significant impact on other water features.
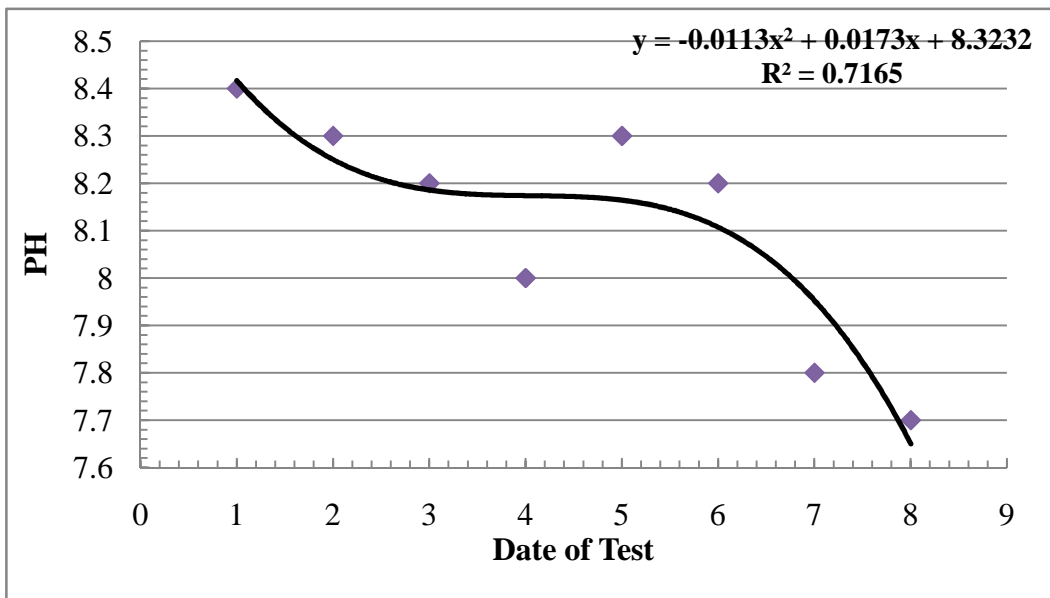

Fig 4: Change of PH within date of test

Relationship between temperature and date of test is recorded in Fig.5. It is indicated that the temperature increased within date of test. This is because the temperature of change is direct proportion with the temperature of the atmosphere. Therefore, the temperature of water was increased at January. Somehow, the increase in temperature doesn't effect the properties of water
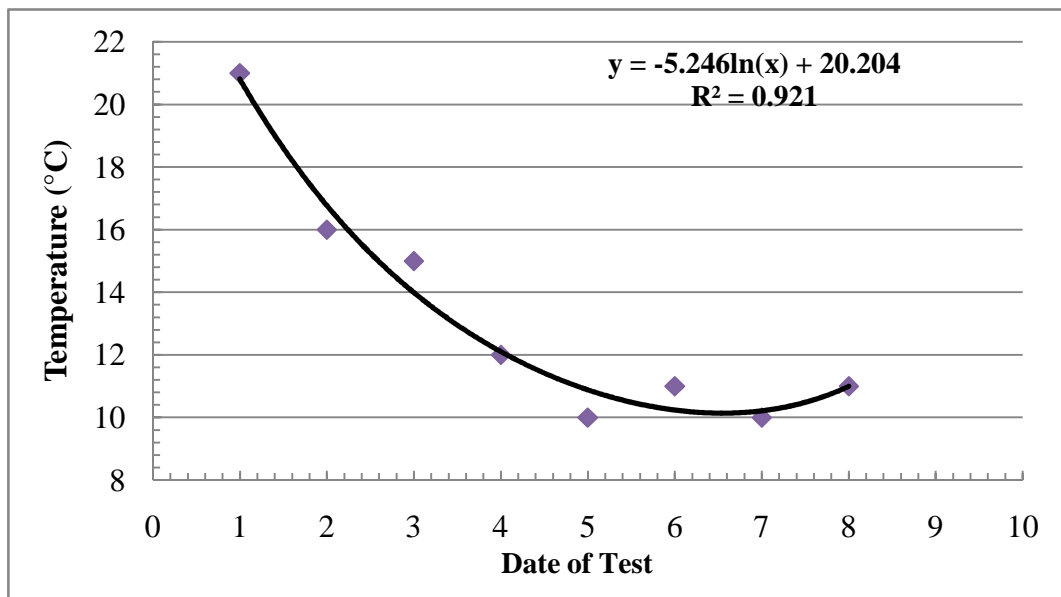
Fig.5: Change temperature with date during the study period

The (TDS) in water with acceptable levels according to the specifications of the Iraqi drinking water (less than 500 mg / l), but appeared in the last two weeks, the high values (TDS) to numbers higher than permitted levels, which requires treatment and reduce the concentrations. As shown figure 6
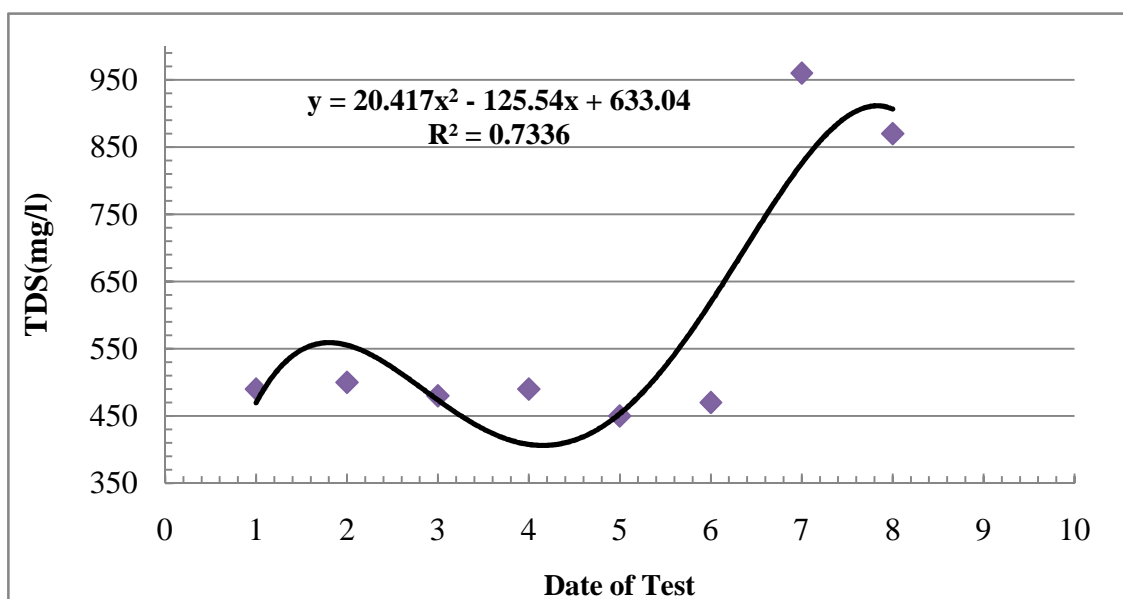

Fig.6: Change in concentrations of total dissolved salts within date of test

5.   CONCLUSION

Based on extensive investigations and monitoring the performance of Al-Krama project power plant for around three years the following conclusions can be drawn:

1. The removal efficiency of filtration basin had a filtration with high efficiency but low removal rates in periods of high turbidity due to the reason for this is that most of the suspended particles flocculation

large scale has not been removed by sedimentation minutes remaining, but the small size that are difficult to remove.

2. The removal efficiency of sedimentation basin has rates of removal in weeks the first did not exceed (40%), namely that the rates of removal is not good and attributed the reasons for this to the lack of basins mixing slow at the station, appeared in the last two weeks, the high rate of removal significantly, largely due to the high amounts of turbidity from the river are reducing the speed of output and increase the amount of alum added. Moreover, it can be concluded that the increase in the amount of turbidity in the water leads to an increase in sedimentation rate of removal so that still turbidity high-density and large sizes, weights and easily, while difficult to sintering and deposition of particulates from turbidity water of low-lying due to the small size of the plankton and light weight .

3. It indicates to The values of (TDS) is high, but some things fall within the parameters, and appeared to rise in the past two weeks almost doubled due to high turbidity, which requires careful of these cases and to develop useful solutions to control these cases.

4. Water temperature is direct proportion with the temperature of atmosphere.

5. The general performance of Alwahdaa project water treatment plant was significantly enhanced in the recent years as well as compared with 2006 when the American army had occupied the Iraqi infrastructures.

6. FUTURE WORK AND RECOMMENDATIONS

The governmental supports to the water treatments plants are insufficient to maintain their performance since there is still lack of public awareness about the importance and the sensitivity of the water plants. This can be done by educating the local with visual and auditorium programs. Moreover, there must be some newness in designation method of the basins, new approaches should be adopted to reduce the cost of water treatment and plant raise the quality of the plant, whereby achieving sustainability.

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