

Indelible Performance Appraisal of Al-Krama Project Drinking Water Treatment plant: A case Study in Iraq

Ali Ahmed Mohammed, Alaa A. Shakir

Department of Civil and Structural Engineering, Faculty of Engineering,
National University of Malaysia 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia,
Assistant Lecturer in Ministry of Higher Education and Scientific Research, Projects
and Reconstruction Department, Iraq (phone:009647713091730;Fax:00964015237915)

E-mail: aliukm@yahoo.com

Department of Civil Engineering, College of Engineering, University Tenaga Nasional,
KM 7 Jalan Kajang-Puchong, 43009 Kajang, Selangor, Malaysia

E-mail: aliam812004@yahoo.com

Abstract

Al-Krama drinking water treatment plant has been playing a vital role in supplying drinking water to Baghdad city since 1980s. It was designed with a design capacity 22500 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-Krama 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 efficiency 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 24% 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 85% 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 20 NTU. The free chloride (CL₂) was high but it may fall within the parameters, it is interesting to note that it was highly increased at September and December due to the high turbidity discharge.

Keywords: *sustainability water treatment drinking plant, Performance assessment, performance Indicators.*

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 results obtained in this study were taken from Al-Krama water treatment plant on the banks of the Tigris River, Utaifiyya, and Baghdad, Iraq. The project consists of three lines of water filter with design capacity 225000 m³/ day. The first line was established in the early of 1953, the second-line was established in 1962, and the third line was established in 1983. Al- Krama water treatment plant serves vast areas as Utaifiyya, Kadhimiya, Aldjaevr, Haifa Street, a portion of Alhurriay city, Adhamiya and a part of Alshalla. Tests were conducted from the third line which has design capacity around 112 500 m³ / day. Flow diagram of Al-Krama treatment plant is illustrated in Fig.1

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 5 plugs on the pump uploaded the water, four of them working and the fifth-pump is as Standby. The total energy of each pump is 1470.6 m³/ h, the pressure of the head of the water is 20 m, and the type of the pump is (KSP RDL 400-440A). 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 stage is the first treatment step for water after receives it from river. Chemical additive as aluminum is added to the raw water materials in a manner and then distribute the water to the sedimentation basins. Dimensions of the pelvis (6 ×5.6×4) m and the actual capacity of the basin is 118 m³ and the reaction time is 180 seconds.

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 sediments (Sludge), which are collected from the bottom of the basin and are removed by sweeping the tripartite arms (Scraper) continued to rake hole clarifiers in the main station in the middle of the project, where there are 5 pumps are purifying West Water Pumps (WWP) where the rotation of these pumps operate automatically as a way to dispose the waste water when the level rises after the arrival of the sedimentation basins. The total energy of the sedimentation basin is 4687 m³/hour and the energy of each basin is 2343 m³ /hour, a period of slow mixing is 20 minutes.

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Disinfection stage for Water treatment process is done by adding a small amount of chloride is along with some other disinfections method is used to kill any bacteria or microorganisms that may be in the water. Sedimentation is the tendency for particles in suspension to settle out of the fluid in which they are entrained and make it more settled. This is due to their motion through the fluid in response to the forces acting on them: these forces can be due to to gravity, centrifugal acceleration or electromagnetism. In Filtration stage, the water passes through filters which are made from layers of sand, gravel, and charcoal to remove smaller particles. Flocculation removes the dirt and other particles suspended in water. Aluminum and other chemicals are added to the water to form tiny sticky particles called "floc" which attracts the dirt particles. The combined weight of the dirt and the aluminum (floc) become heavy enough to sink to the bottom of basin during sedimentation [24][25].

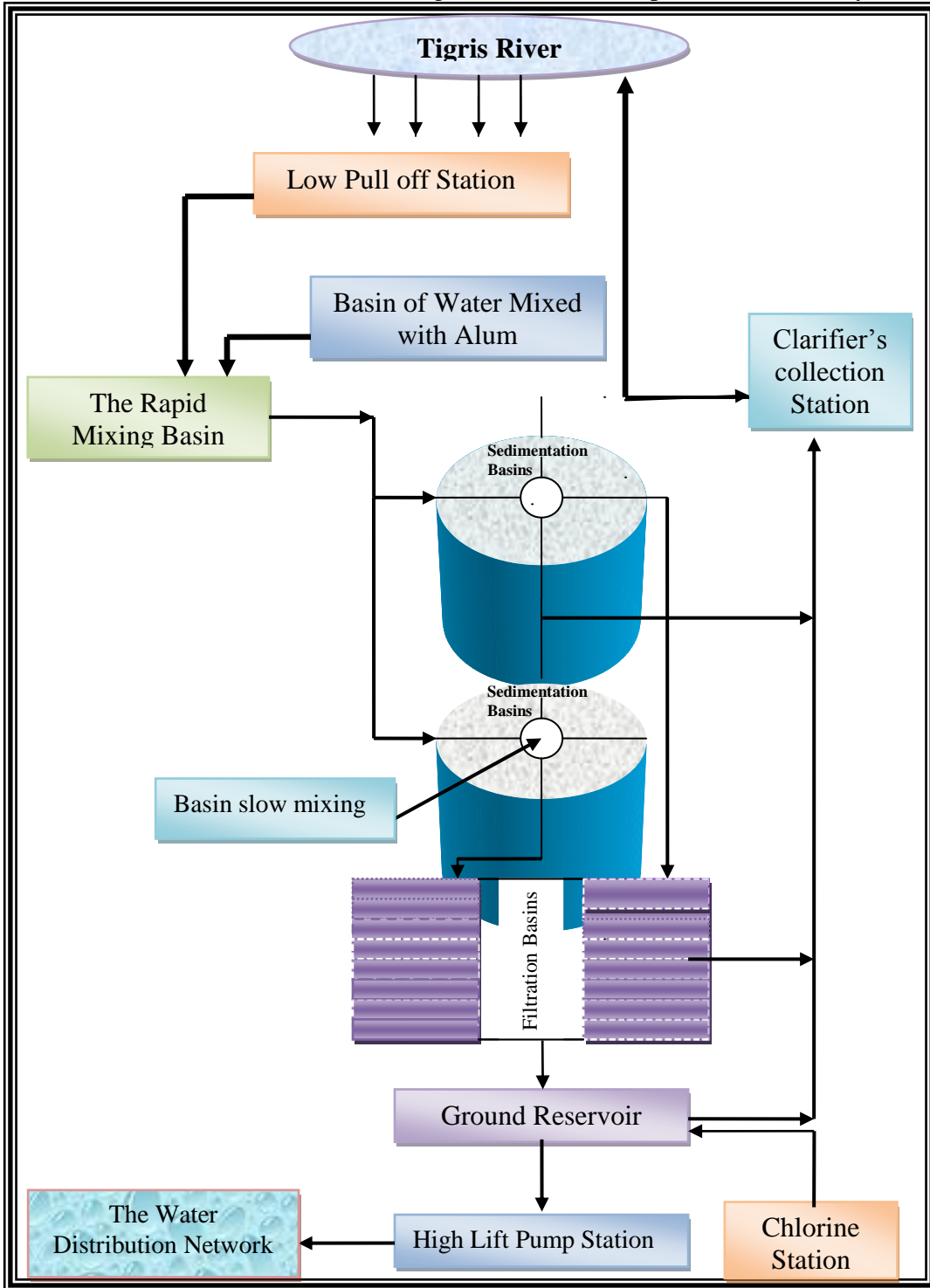


Fig. 1: Sketch the line of drinking water treatment (DWT) plants in the project Al-Krama

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

$$\text{Removal Efficiency} = (\text{Turbidity inside} - \text{Turbidity outside}) / \text{Turbidity inside} \times 100 \quad (1)$$

Table 1: Results from the Sedimentation Basin

<i>Removal efficiency</i> %	After sedimentation			Before sedimentation			date
	pH	Temperature	Turbidity NTU	pH	Temperature	Turbidity NTU	
48.42	7.5	19C ⁰	12.04	7.3	19C ⁰	17.87	3/12/2005
39.59	8.2	18C ⁰	10.81	8.1	18C ⁰	15.09	10/12/2005
23.48	8.3	13C ⁰	16.95	8.1	13C ⁰	20.93	17/12/2005
43.91	8.4	11C ⁰	11.0	8.6	11C ⁰	15.83	24/12/2005
30.11	7.7	10C ⁰	13.32	7.5	10C ⁰	17.33	1/1/2005
24.21	7.8	10C ⁰	13.96	7.7	10C ⁰	17.34	7/1/2006
27.40	7.6	11C ⁰	14.56	8.7	10C ⁰	18.55	14/1/2006
23.89	8.2	13C ⁰	16.49	9.0	13C ⁰	20.43	21/1/2006
35.35	8.0	11C ⁰	14.37	8.6	12C ⁰	19.45	30/1/2006
30.33	8.2	14C ⁰	13.22	8.1	12C ⁰	17.23	4/2/2007
35.32	8.6	11C ⁰	14.44	8.8	11C ⁰	19.54	11/2/2007
38.95	8.2	10C ⁰	12.76	8.4	10C ⁰	17.73	18/2/2007

Table 2: Results from the Filtration Basin

<i>Removal efficiency</i> %	After filtration			Before filtration			Date
	pH	Temperature	Turbidity NTU	pH	Temperature	Turbidity NTU	
75.9	7.4	19c ⁰	2.90	7.5	19c ⁰	12.04	3/12/2005
88.25	8.1	18c ⁰	1.27	8.2	18c ⁰	10.81	10/12/2005
92.40	8.2	18c ⁰	1.15	8.3	13c ⁰	16.95	17/12/2005
70.5	8.3	13c ⁰	3.24	8.4	11c ⁰	11.0	24/12/2005
93.7	7.6	11c ⁰	0.84	7.7	10c ⁰	13.32	1/1/2005
83.3	7.4	10c ⁰	2.33	7.8	10c ⁰	13.96	7/1/2006
82.2	7.7	10c ⁰	2.21	7.9	11c ⁰	12.98	14/1/2006
89.2	8.0	11c ⁰	1.25	8.2	14c ⁰	11.81	21/1/2006
92.0	8.2	13c ⁰	1.35	8.3	13c ⁰	16.93	30/1/2006

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87.9	7.8	13c ⁰	1.21	8.1	14c ⁰	10.0	4/2/2007
91.68	8.1	12c ⁰	1.33	8.2	13c ⁰	16.0	11/2/2007
90.1	7.9	12c ⁰	1.77	7.9	12c ⁰	18	18/2/2007

4. Discussion

It is indicated from Table1. It is obvious to note that the turbidity of the that water entered the sedimentation basin had peaked in 16/12/2005 during the study period on with a total value 20.93NTU and lowered in 9/12/2005 with a total value 15.09 NTU. The overall rate of sedimentation basin turbidity involved 18.11NTU. The turbidity of water before sedimentation has peaked in 9/12/2005 with a value of value of 16.95 NTU and lowered in 9/12/2005 with a value of 10.81 NTU. Whereas the overall rate of turbidity of water after sedimentation was 13.66NTU. The removal efficiency of sedimentation a basin reached its optimum magnitude in 3/12/2005 with about 32%, while it lowed in 9/12/2005 with about 19.0%. The overall proportion of the total basin sedimentation was 33.41 %.

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. The essence reason may be related to the American Army forces which had captured the plant and occupied it for their own martial operations resulted in remarkable downfall of the amount of the resulting in reduction in sedimentation period. Besides, some minor reasons played another role in decreasing the sedimentation period which will be addressed accordingly:

1. Residence time in the sedimentation basin was 3 hours at the early of 2005s, but (GLUMRE) Grease Lakes Upper Mississippi River Board (MRB) recommended that the residence time of the water in the sedimentation basin must be at least 4 hours [5].
2. Aluminum was not added on a regular basis. It was added by hand in some cases.
3. Weirs were not cleaned for long periods of time. Therefore, algae are grouped by layers over there.
4. In the days of official holidays, the workers don't come to the station which had resulted in accumulating the quantities of aluminum as a random experience of workers in the plant.

The removal efficiency of the sedimentation basin was considerably grown after 2006s and peaked in 2007s 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 Al-Krama power plant. Besides, great efforts were given from the ministry of agriculture and irrigation in order to enhance the efficiency of the plant.

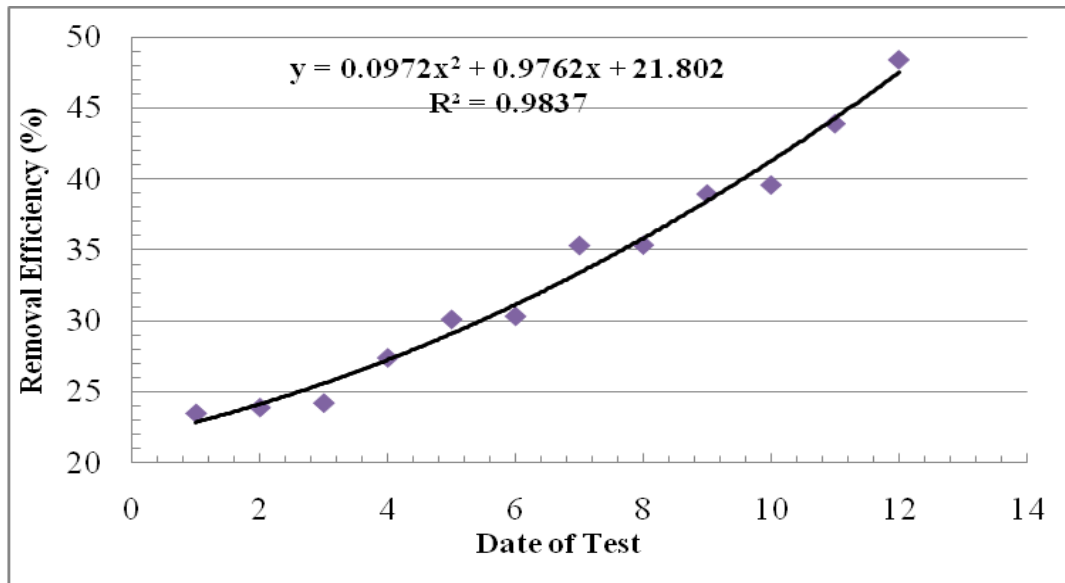


Fig.2: The relationship between removal efficiency of sedimentation and date of test

It is clear to know from Table 2 that the turbidity of water after filtration has peaked in 17/12/2005 with about 16 NTU and the lowered on 10/12/2005 with about 10.81 NTU. Turbidity within the overall rate in filtration basin was 13.65NTU. In the contrary, turbidity of water before filtration had reached its highest value on 24/12/2005 with a total value of 3.24NTU and lowered on 1/1/2005 with a total value of 0.84 NTU. The overall rate of turbidity abroad filtration basin is 1.73 NTU. However, the removal efficiency of filtration basins had peaked in 1/1/2005 with around 93 % and it lowered in 24/12/2005 with about 70.5%. The removal efficiency growth during the period of study is illustrated in Fig.3. It is interesting to note that the removal efficiency of filtration behaved similarly to the removal efficiency of sedimentation as it had been explained before. The removal efficiency lowered at 2005s and then increased after that time. This may be related to the presence of cracks in the walls of basins resulted in exist of huge quantities of water without filtration process. 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 2007s filtration.

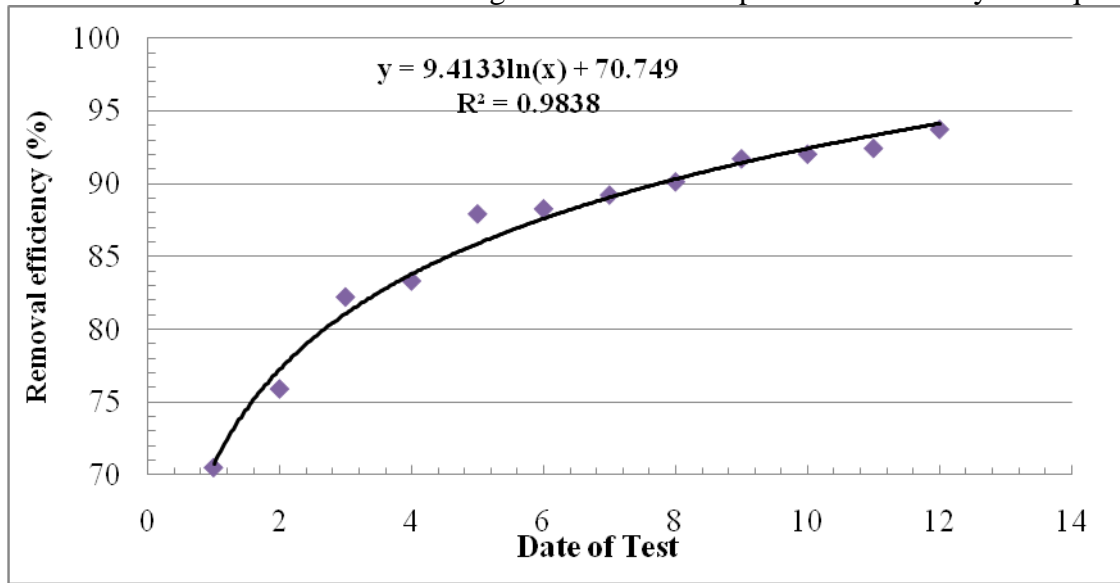


Fig.3: The relationship between removal efficiency of filtration and date of test

Results for PH are illustrated in Fig.4. It is shown the relationship of the values of pH: ranged between (7-8.6), which are among the determinants of global and do not have a significant impact on other water features.

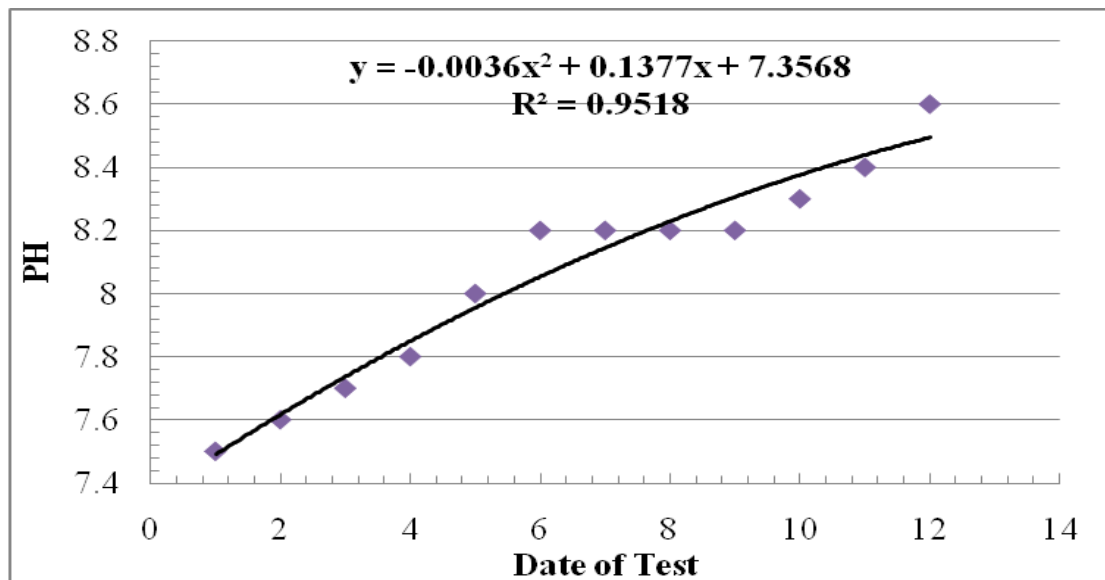


Fig 4: Change of PH within date of test

Relationship between temperature and date of test is recorded in Fig.6. 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 October rather December. Somehow, the increase in temperature doesn't effect the properties of water

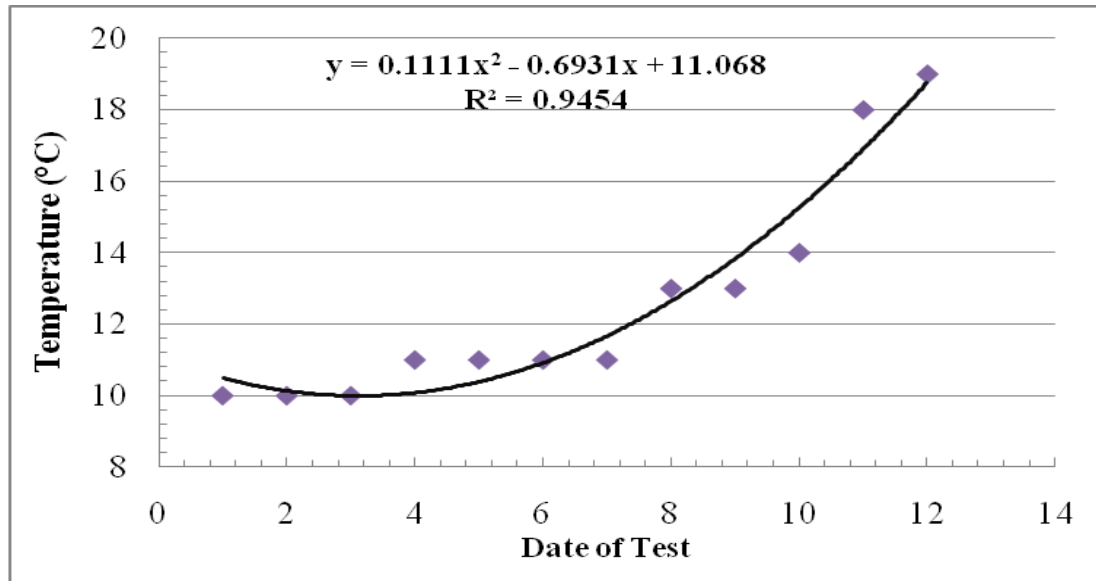


Fig.5: Change temperature with date during the study period

The dose of chloride was within the specifications of Iraqi standards ranging between (1-1.7). It is evidenced that the chlorine dose increased in rainy season as it already illustrated in Fig.6. This is because of the high value of brownish which leads to rise number of contaminants.

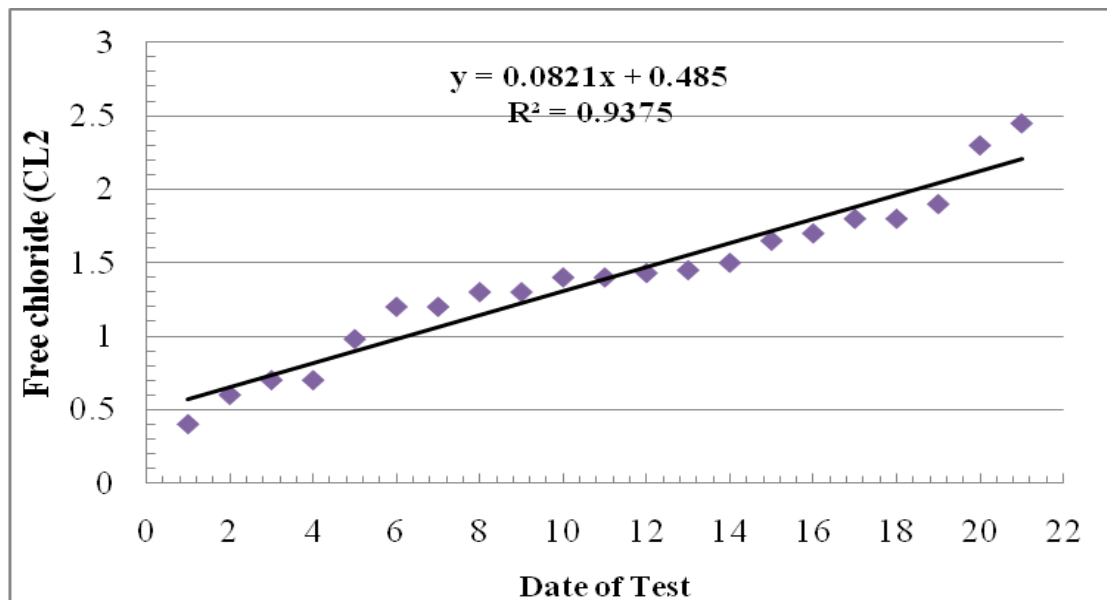


Fig.6: Change Free (CL₂) within date of test

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 significantly enhanced along the years of study. It reported the minimum values at 2005s and then it grew in 2007.
2. The removal efficiency of sedimentation basin has dramatically developed along the years of study. It lowered in 2005s and it was grown in 2007s. It indicates to constitutional awareness from the public and the Iraqi government about the necessity of Al-Krama project water treatment plant.
3. The turbidity of water was increased when the water was filtrated and sediment as well as compared with water before filtration and sedimentation.
4. Water temperature is direct proportion with the temperature of atmosphere.
5. The chlorine dosage increased in rainy season.
6. The general performance of Al-Krama project water treatment plant was significantly enhanced in the recent years as well as compared with 2005 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.

Acknowledgements

Special thank to Al-Krama water treatment staff for their kind cooperation and providing the facilities to accomplish this research.

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