AL-NAJEBIA POWER STATION PLANT EFFLUENTS AND IT'S IMPACT ON PHYSICO-CHEMICAL CHARACTERISTICS OF GARMAT ALI CANAL

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ABSTRACT
The physico-chemical characteristics and water quality near thermal effluents of Al-Najebia electrical power station on Garmat Ali canal have been investigated. Seasonal samples were taken through low tide (from summer, 2007 till winter, 2008). Three stations were chosen, serious one was S2 (located closer to the thermal discharge point), these effects were extended to 625 m east far from S2. The effects were reached the highest through summer season at S2 than S3. The highest water temperature was 42C° and the differences between high water temperature between S2 and S3 was 9C° through summer season, high pH values and salinity were 8.3 and 2.2 (ppt) at S2 respectively. Very sharp decline of dissolved oxygen (3.9 mg/l) was noted at S2 and nitrite values (0.23 as µg- at N/l**)** was noted at S1, and high value of BOD was 4.6 mg/l at S2, the highest value of alkalinity was 135 mg/l at S2 through summer season. Maximum values of hardness (mg/l as $CaCO_3$) calcium and magnesium (mg/l) were 760, 425 and 365 respectively; TDS was 1710 mg/l at S2 through summer season. Maximum values of nitrite and nitrate (as µg- at N/l**)** were 1.30 and 35 at S2 due to many bio-chemical reactions with were happened during high water temperatures.

INTRODUCTION
The broadest definition of thermal pollution is the degradation of water quality by any process that changes ambient water temperature. Thermal pollution is usually associated with increases of water temperatures in a stream, lake, or ocean due to the discharge of heated water from industrial processes (Laws, 1981). Such as the generation of electricity. Increases in

ambient water temperature also occur in streams where shading vegetation along the banks is removed or where sediments have made the water more turbid (Karlsen *et al.,* 2000). Both of these effects allow more energy from the sun to be absorbed by the water and thereby increase its temperature (Hinrichs and Kleinbach, 2001). There are also situations in which the effects of colder-than-normal water temperatures may be observed.

Brown *et al*. (2003) demonstrated that the waste heat from electrical generating stations is transferred to cooling water obtained from local water bodies such as a river, lake, or ocean. Large amounts of water are used to keep the sink temperature as low as possible to maintain a high thermal efficiency. The primary effects of thermal pollution are direct thermal shock, changes in dissolved oxygen, and the redistribution of organisms in the local community. Because water can absorb thermal energy with only small changes in temperature, most aquatic organisms have developed enzyme systems that operate in only narrow ranges of temperature. These stenothermic organisms can be killed by sudden temperature changes that are beyond the tolerance limits of their metabolic systems (Langford, 1999). Therefore, oxygen consumption requirement steadily increase with rise in water temp. (Laws, 81; Slovic, 2000; Hussein *et al*., 2001; Brown *et al*., 2003).

The past half-decade has brought about dramatic changes in the relationship of legal institutions to problems of environmental quality and the recognition of environmental values**.** The impact of big quantities of warm waters from "Electrical Power Stations" may be lead to destroy the ecological balance of aquatic ecosystems.

Castenholtz and Wickstrom (2000) have been reported that hot effluents from industrial processes and power generation can cause temperature increases in the receiving water of 10°C or more, but generally the temperature is of such profound importance in chemical and biological processes that the effects of temperature alterations on aquatic biological communities is potentially large. For these reasons the purpose of this article is to present the problems concerning the location and operation of Al-Najebia electrical power station facilities as a series of points along a unified continuum, in the perspective of the physico-chemical problems caused by thermal pollution and the responses of the environment.

MATERIALS AND METHODS

Air and water temperatures were measured directly by simple thermometer (0-100 C°), hydrogen ion concentrations (pH) and water salinity (as ppt ‰) were measured by using a pH meter. Total alkalinity, total hardness mg/l as $CaCO_3$, calcium and magnesium concentrations (mg/l) were calculated according to Lind (1979).

Dissolved oxygen (as mg/l) was measured by "azide modification of Winkler's method (as recommended by Lind, 1979). Biological oxygen demand (BOD_5 as mg/l) was measured by same DO method, then analysed according to APHA (1985) after the samples were stored in the dark at 20 C° for five days.

Nitrite (NO_2^-) was measured spectrophotometrically following Bendschneider and Robinson (1952) as sited by Parson *et al*. (1984), the results were expressed as µg- at N/l. Nitrate (NO_3^-) were measured according to Parson *et al*. (1984), the results were expressed as µg- at N/l. Total dissolved solids (TDS as mg/l) was measured as recommended by APHA (1985). Water samples were collected seasonally (Twice each season) from Spring 2007 to Winter 2008 during low tide periods and day hours (Data analysis by SPSS computer program).

Study area:

Electrical power stations are definitely constructed near big water bodies for their requirements of very large quantities of raw water for cooling purposes. Sampling area is very close to Al-Najebia electrical power station, this area is situated between latitudes 47°30$^-$ - 47º40$^-$ and 30º52$^-$ - 31º00$^-$. Al-Najebia station was constructed in 1959 by one of Russian companies on the end of Garmat Ali river bank (near Shatt Al-Arab river, Fig., 1), it consists of two units in order to produce about 200 Mega watt/hour (in the beginning) for both units, they were required water quantities is about 36000-37000 m^3/h for cooling. In the same time this station is very important for fisheries and economic purposes. Three stations have been chosen, station 1 (S1) was located very closer to "in let" pipes place. Theses pipes were carried natural water for cooling, station 2 (S2) was located in closer to discharge point or heated waters (about 450 m between S1 and S2) in order to compare some parameters collected from both stations, station 3 (S3) which is far from discharge point about 625 m to the east of power station.

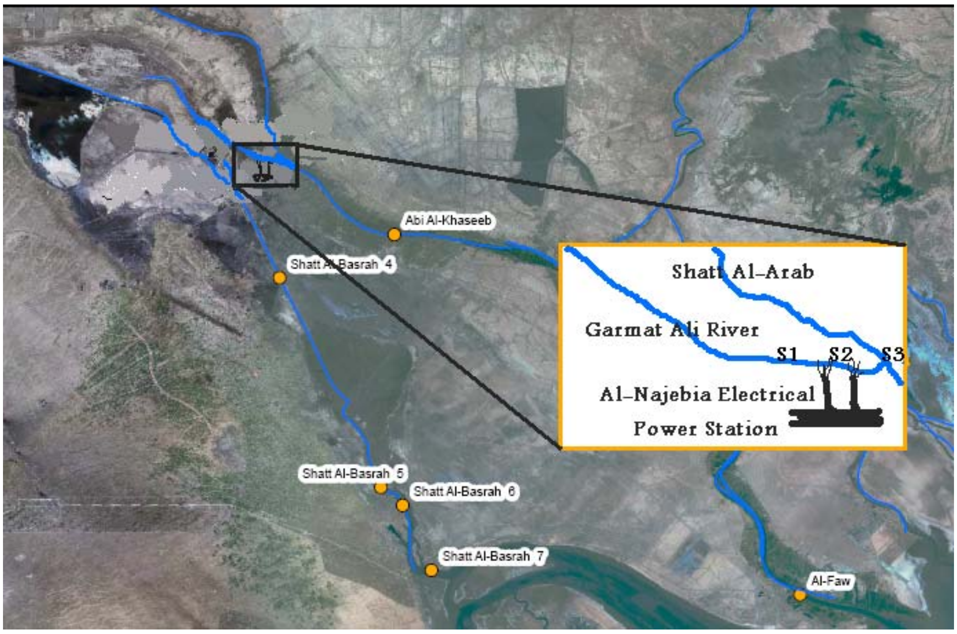

Fig. (1) Al-Najebia Collection Stations (S1, S2, S3)

RESULTS

Seasonal variations of air and water temperatures (C^o) have been noted, range of air temperature was between 8 (at winter) to 39 (at summer) at all studied stations. Maximum water temperatures were 32, 42 and 33 during summer season, and the minimum temperatures were 17.8, 24 and 18 during winter season at S1, S2, and S3 respectively (Fig. 2). Seasonal differences in water temperatures between S1 and S2 (inlet and outlet, discharge points) were 7, 10, 10, 6 and between S2 and S3 were 5, 9, 7, 6 C^o at spring, summer, autumn and winter seasons respectively (Fig. 3).

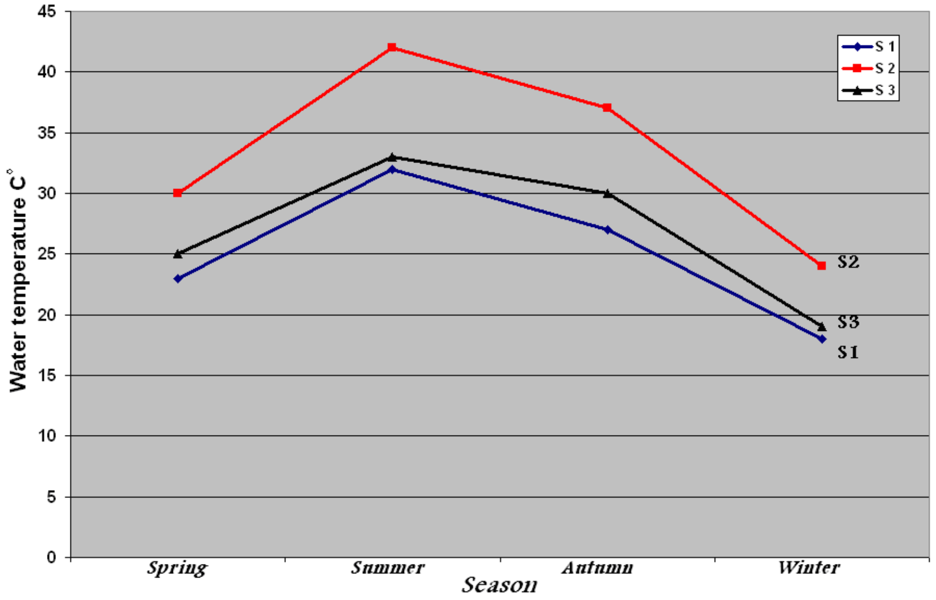

Fig. (2): Seasonal variations in water temperatures at three stations (S1, S2 & S3)

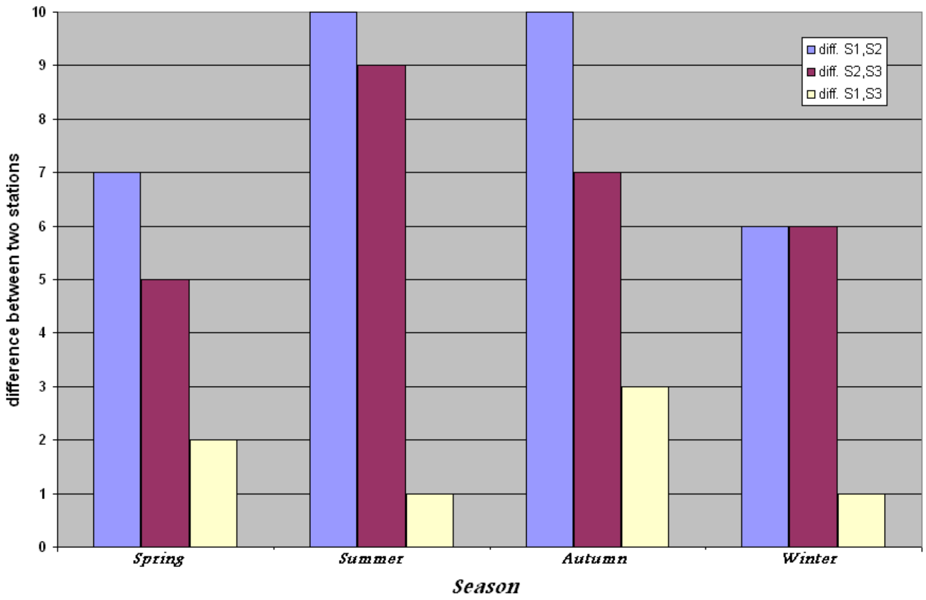

Fig. (3): Seasonal differences in water temperatures at three stations

Maximum concentrations of the pH were pointed to alkalinity, maximum values were 7.9, 8.3 and 7.9, the minimum values were 7.6, 7.9 and 7.7 during summer at S1, S2 and S3 respectively (Fig. 4). Fig. (5) Shows salinity values, maximum values were 1.8, 2.2 and 1.85 during summer , and the minimum values were 1, 1.7 and 1.1 during winter at S1, S2 and S3 respectively.

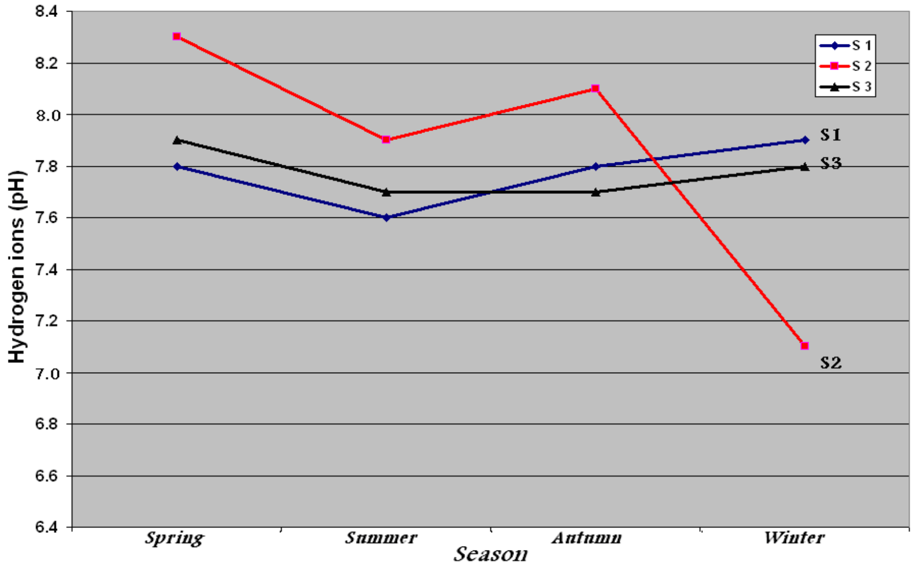

Fig. (4): Concentration of hydrogen ions at three stations

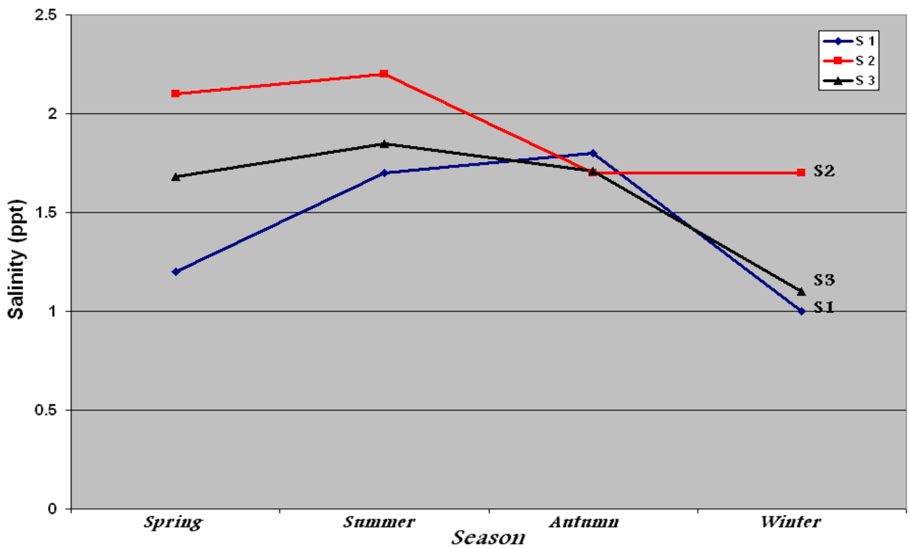

Fig. (5): Salinity seasonal variations at three stations

Maximum values of dissolved oxygen (DO mg/l) were 9, 7.1 and 8 during winter, the minimum values were 5.3, 3.9 and 5.5 during summer at S1, S2 and S3 respectively (Fig. 6). Maximum biological oxygen demand (BOD) values were 2.7 (at summer), 4.6 (at winter) and 2.8 (at spring and summer), the minimum values were 1.1 (at winter), 2.5 (at autumn) and 2.3 (at winter) for S1, S2 and S3 respectively (Fig. 7).

The maximum total alkalinity values (mg/l) were 120 (at spring), 135, 130 (at summer), and the minimum values were 109 (at summer), 128 (at autumn) and 120 (at winter) for S1, S2, S3 respectively (Fig. 8).

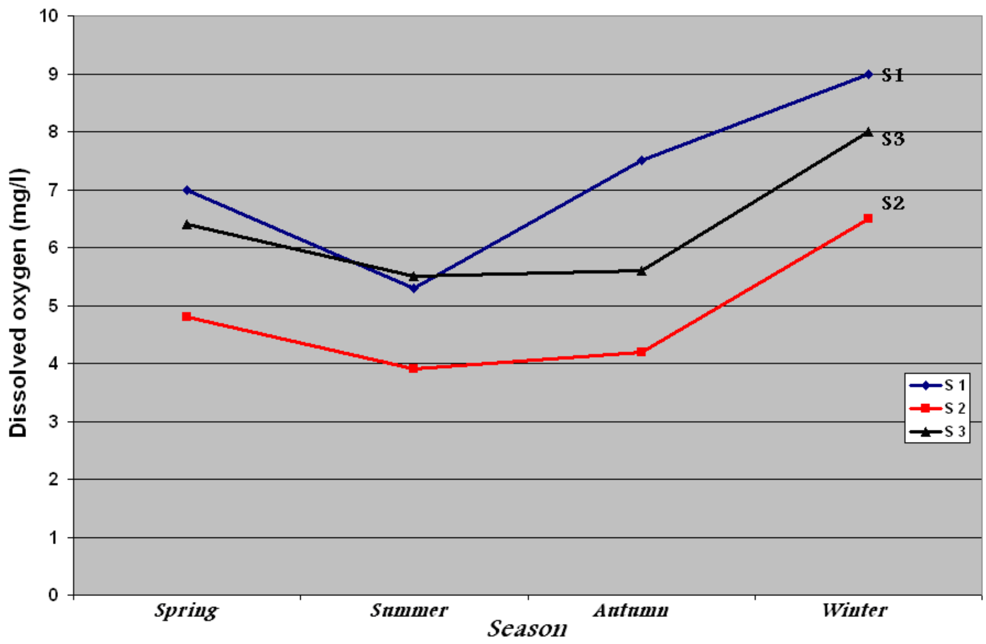

Fig. (6): Dissolved oxygen concentrations in three stations

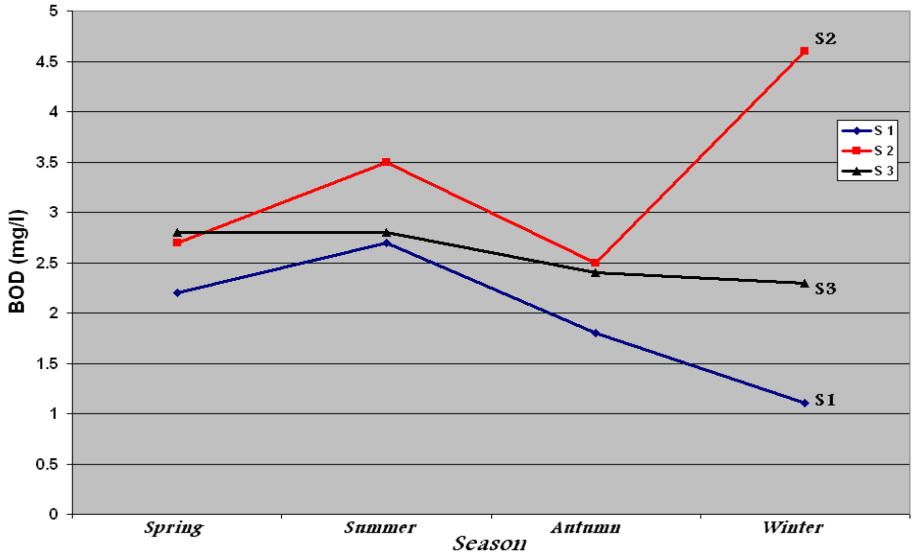

Fig. (7): Biological oxygen demand (BOD) at three stations

Maximum values of hardness (mg/l as $CaCO_3$) were 690, 760, 740 during summer, and minimum values were 500, 580 (at winter), 530 during spring at S1, S2 and S3 respectively (fig. 9). Maximum calcium concentration (mg/l) were 360, 425 and 375 during summer season, the minimum concentration were 270 (at spring), 361 (at autumn) and 311 during spring season at S1, S2, S3 respectively (fig. 10).

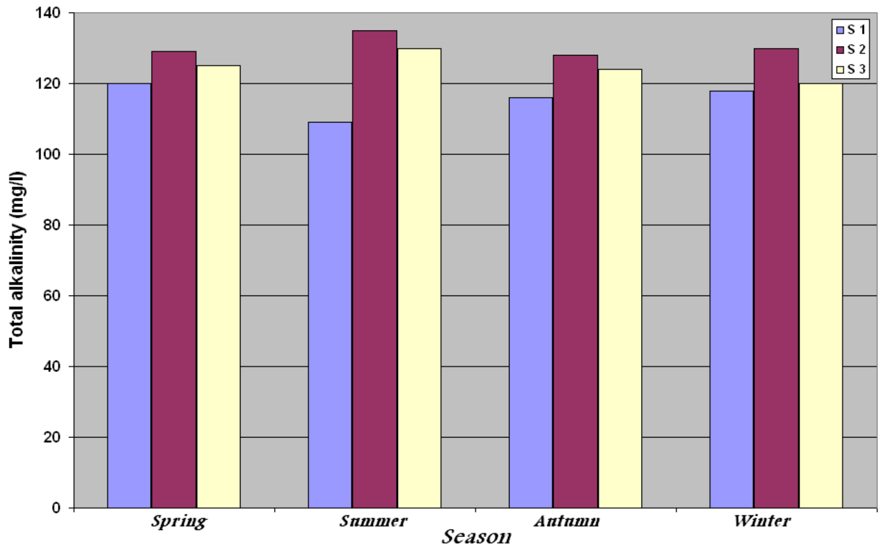

Fig. (8) Total Alkalinity at three stations

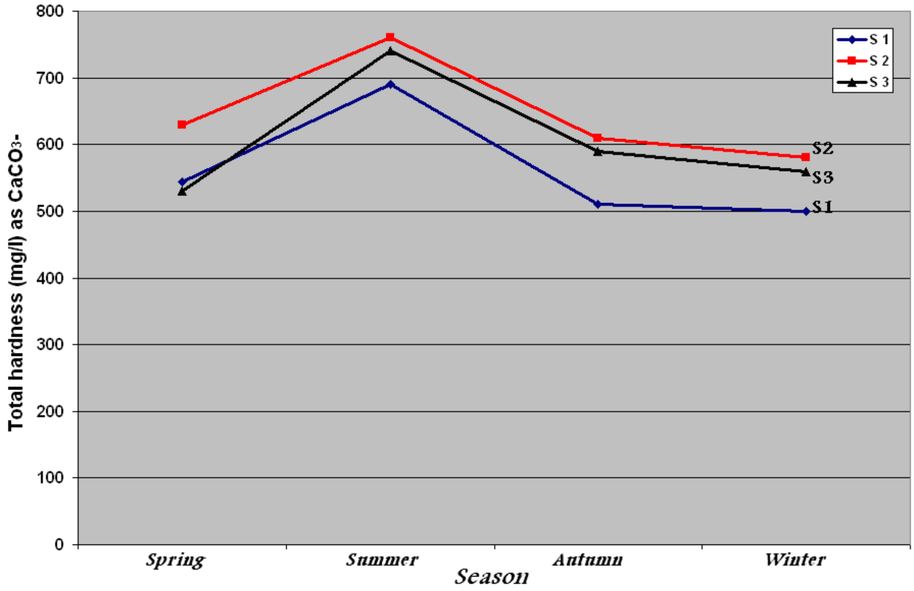

Fig. (9): Total hardness in three stations

Fig. (11) illustrates the maximum concentrations (mg/l) of magnesium were 310, 365 and 335 during summer, and minimum concentrations were 200 (at autumn), 265 (at autumn) and 210 during winter season for S1, S2 and S3 respectively. Maximum TDS (mg/l) values (fig. 12) were 1580,1710 and 1630 during summer season, and minimum values were 1095, 111 and 1055 during winter season at S1, S2 and S3 respectively.

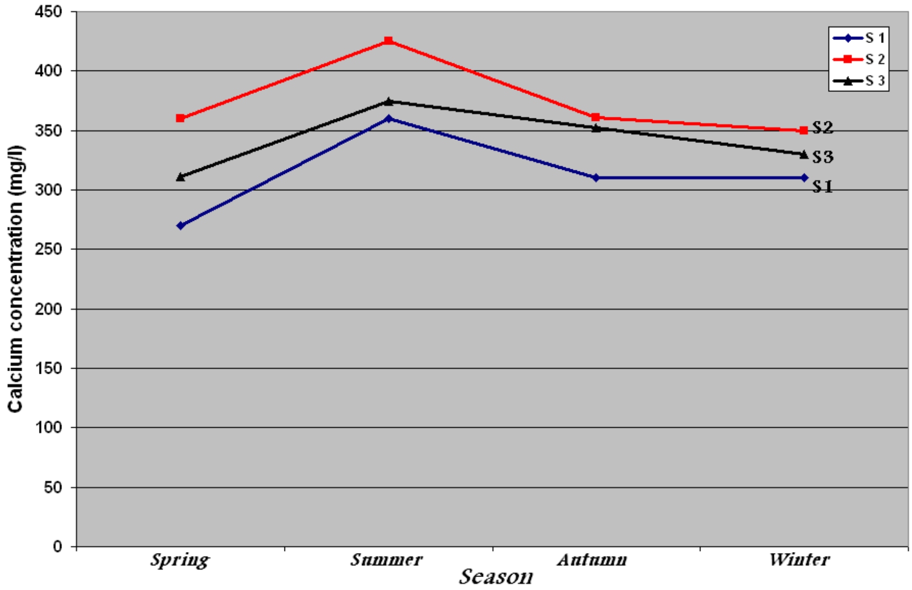

Fig. (10): Calcium concentration in three stations

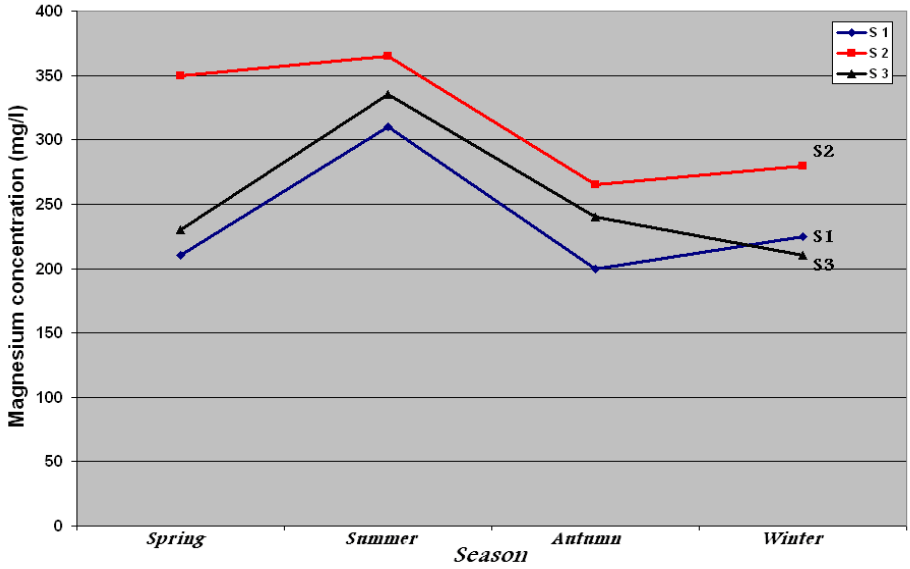

Fig. (11): Magnesium concentration (mg/l) at three stations

Maximum values of nitrite NO2- (µg – at N/l, fig.13) were 0.53 (at summer0, 1.30 and 0.55 during winter season, the minimum values were 0.23, 0.38 and 0.25 during autumn season for S1, S2, S3 respectively. Maximum values of nitrate NO3- (µg – at N/l, fig.14) were 18, 35 and 22.5 during spring season; the minimum values were 9.1 (at winter), 17 (at autumn) and 12 during winter season for S1, S2, S3 respectively.

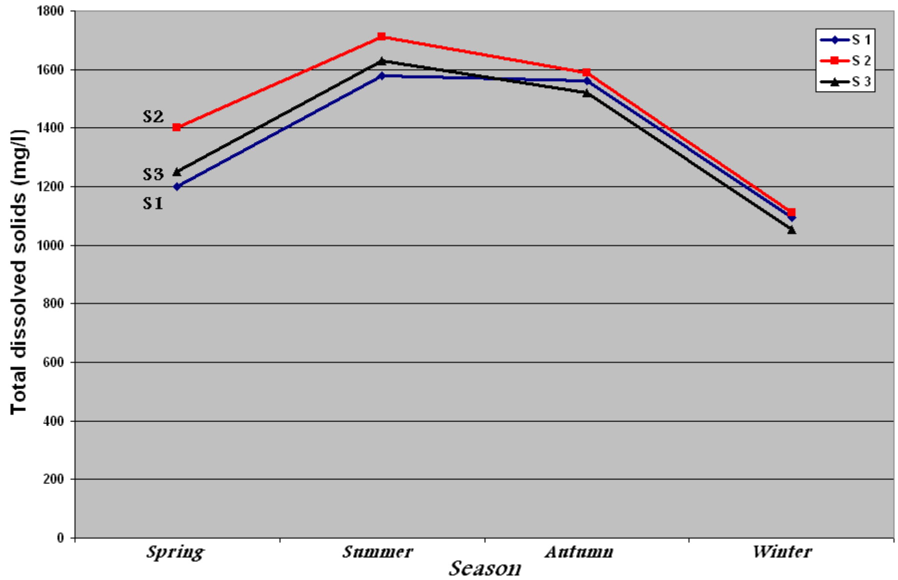

Fig. (12): Total dissolved solids (mg/l) at three stations

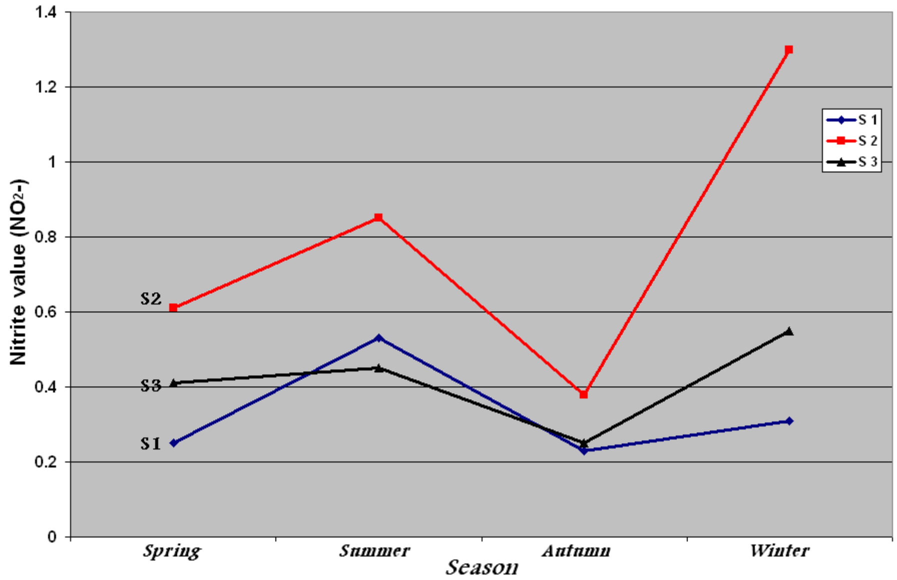

Fig. (13): Nitrite values as µg – at N/l

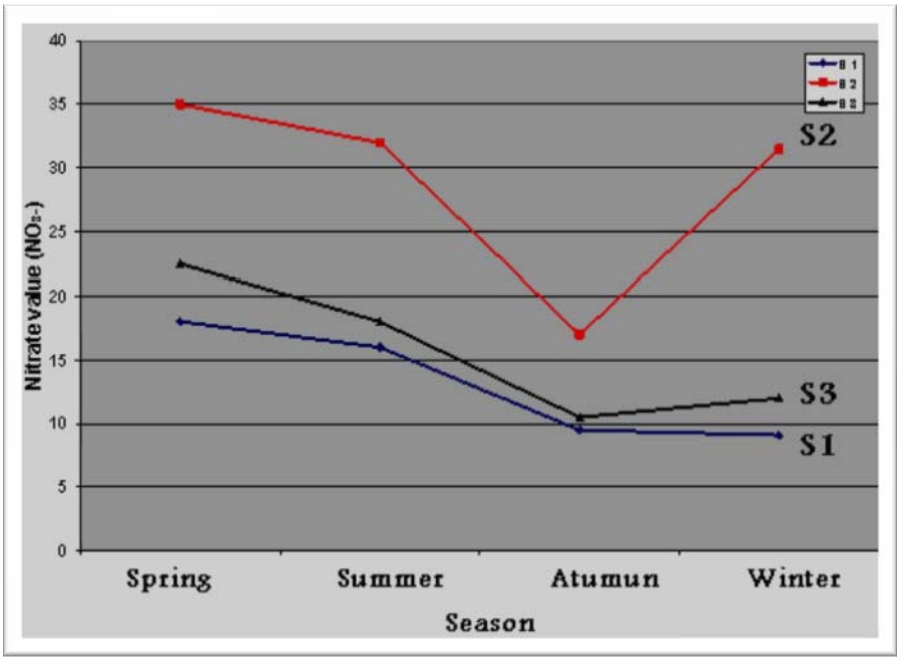

Fig. (14): Nitrate values as µg – at N/l

Discussion:

The problems of dissipating waste heat differ widely from one location to another, so heated effluents from power generation processes can cause temperature increases in the receiving water of 10°C or more. Temperature is very important environmental factor (Power *et al.*, 2000) and play main role in the chemical and physical water characteristics and biota (Kinnesh, 1986). Temperature is of such profound importance in chemical and biological processes that the effects of temperature alterations on aquatic biological communities are potentially large.

Air and water temperatures were noted seasonally varied due to weather changes between month and other. Low air temperature was reached about 8C° through winter periods to 39° through summer periods, but similar degrees in all stations. Water temperatures at three stations were varied, the highest values were during summer season at all studied stations, the lowest values were through winter season (Fig. 2). To compare between S1 (very closer to inlet pipes) and S2 (situated very closer to discharge point of hot water), generally S1 was exhibited the highest value through all studied year. The difference of water temperatures between S1 and S2 was 10 C° during summer season (Fig. 3), this is because there are a lot of water were needed for cooling and condensing purposes inside power station from S1 (Laws, 1981; Henry and Heinke, 2006), statistical analysis was significant difference between S1 and S2 ($p < 0.01$).

Hydrogen ion concentrations (pH) were toward alkalinity in all studied samples, but distinct seasonal variations were observed (Fig. 4). This result was agreed with most of previous studies on Iraqi aquatic environments (Al-Iesa, 1981; Al-Saadi and Antonie, 1981; Al- Sha`eban, 1996; Al-Shawi, 1999; Hussein and Attee, 2000), this means there's effect of impact thermal heated water on hydrogen ions. No correlation factor between S1 and S2 (r=-855).

It seams to be that salinity was much increased in S2 station in general due to heated water discharged and actually increase of evaporation rate (Comine, 1983; Afzal *et al*., 2000) during summer season (Fig. 5). Low salinity was noted during winter season may be due to rainfall (Al-Saadi *et al*., 1981). High significant relation between temperature and water salinity ($p < 0.01$).

Low values of dissolved oxygen (DO, Fig. 6) have been recorded in station 1 (S1) due to increase of water temperatures in (S1), this means that gass solubility was inversely correlated with water temperature (Lind, 1979; Karlsen *et al*., 2000). Different values have been recorded in different sampling stations (Araujo *et al*., 2000). Significant relation between S1 and S2 ($p < 0.01$), this result was agreed with Al-Imarah *et al*. (2006) and Richardson and Hussein (2006).

Biological oxygen demand (BOD_5) values were varied; the highest value was in S1 during winter season (Fig. 7). The heated effluents discharged in this station cause that, this increasing in BOD_5 values were due to increasing of micro-organism activities in high water temperatures, during these activities, they were consumed a lot of dissolved oxygen (Laws, 1981; G.E.M.S, 1997). Correlation factor between BOD and water temperature was $r=0.953$, and significant relation between S1 and S2 ($p < 0.01$).

Small fluctuations were recorded in alkaline values at three stations, but alkalinity at S2 was slightly more than S1 (Fig. 8) because the warm water in discharged point (S2) will do increase in current velocity (in this point) and it will cause the mixing of water with mud and sand of the same area (Al-Shawi, 1999 and Hussein *et al*., 2001), same results have been reported in different areas (Hynes, 1970; Stirling, 1985). Total alkalinity in the samples was attributed to bicarbonate (Hussein *et al*., 2001; Negamesh and Mezel, 2005), correlation factor between alkalinity and water temperature was $r = 0.895$.

Total hardness, calcium, and magnesium ions were higher during warmer periods at all three stations, that were indicated that all factors are correlated with the rise of salinity (Figs. 9, 10, 11). The evident was agreed with the scale proposal by Lind (1979), statistical analysis were shown significant differences $p < 0.01$) between S1 and S2, and sig. correlation between hardness and rise in water temperatures ($r = 0.914$), this result was agreed with Hammer (1971) and Al-Shawi (1999), calcium ions was higher than magnesium ions in all stations due to water temperatures.

Increase in total dissolved solids (TDS) values were noted in S2 through warmer periods (Fig. 12) because the water was in low levels, increased in salinity concentration, nutrients, when evaporation will be increase that leading to increase in salts contents (Hammer, 1971). It might be that TDS will increase in the case of higher productivity in the density of phytoplankton with mixing of water (Hussien, and Al- Mosawi, 1994). Significant relation between water temperature and DTS ($p < 0.01$).

In general, low concentrations of nitrite, high level of nitrite was noted in S1 during warmer periods, this because analysis of organic matters will increase by macro-organisms (Fig. 13). Nitrate will be change to nitrite with the rise of water temperatures and increase in nutrophecation of free ammonia during summer season (Al-Rekabi, 1992; Shrimali and Singh, 2001; Hussein *et al*., 2002; Al-Imarah *et al*., 2006). Correlation factor between S1 and S2 indicated that no sig. in the statistical analysis ($r = -0.765$).

Nitrate values were higher near discharge point (S2) than other two stations (Al-Shawi (1999), same results have been reported in different areas (Reynolds, 1984; Hillbricht and Simn, 1988), one of previous studies (Hussein *et al*.,2001) on the same area during Nov. 1997 until Oct.1998, for comparison between present study and past studied. There is an increase in all parameters values in present study, this means that differences have been happened in ten years. This will be happen in the case of increase of the micro-organism activities in the warm conditions (Fig. 14), during these conditions the organic matters will broken then released nutrients to the aquatic environment (Payne, 1986). Nutrients, some times will release to the aquatic environment due to release of nitrogen fertilization from different agriculture activities (Khalaf *et al*., 1983). Significant differences between nitrate and water temperature ($p < 0.01$).

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المتدفقات الحرارية لمحطة كهرباء النجيبية وتأثيراتها على الصفات الفيزيائية والكيميائية لقناة كرمة علي

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المستخلص:

أهتمت الدراسة الحالية بتأثير المتدفقات الحرارية لمحطة كهرباء النجيبية على الصفات الفيزيائية والكيميائية ونوعية مياه قناة كرمة علي، اخذت عينات موسمية خلال الجزر (من صيف 2007 لغاية شتاء 2008). اختيرت ثلاث محطات للدراسة، والمهمة هي محطة S1 (تقع مجاورة من منطقة الطرح الحراري، هذه التاثيرات امتدت الى مسافة 625 م شرق محطة S2. وصلت التاثيرات لأعلاها خلال موسم الصيف في محطة S2 مقارنة بالمحطة S3، اعلى درجة حرارة للمياه كانت 42 م° والفروقات بين اعلى درجات الحرارة بين المحطتين (S3,S2) كانت تسعة درجات مئوية خلال موسم الصيف، اعلى قيم الحامضية والملوحة كانت 8.3 و 2.2 جزء بالالاف في المحطة S2 على التوالي. انحطاط حاد جدا في تركيز الاوكسجين المذاب (3.9 ملغم/لتر) في المحطة S2 وللنتريت (0.23 مايكروغرام- ذرة نتروجين/لتر) في المحطة S1، واعلى قيمة لمتطلب الاوكسجين الحيوي كانت 4.6 ملغم /لتر في المحطة S2، والقيمة العليا للقاعدية كانت 135 ملغم/لتر في المحطة S2 خلال موسم الصيف. القيم القصوى للعكارة (ملغم/لتر ككاربونات الكالسيوم) والكالسيوم والمغنيسيوم (ملغم/لتر) كانت 365, 425, 760 على التوالي، مجموع المواد الصلبة العالقة كانت 1710 ملغم /لتر في المحطة S2 خلال موسم الصيف. القيمة القصوى للنترات (مايكروغرام- ذرة نتروجين /لتر) كانت 35 في المحطة S2 بسبب العديد من التفاعلات الكيمياحيوية التي تحدث بسبب ارتفاع حرارة المياه.