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POLLUTION FROM GERGA SUGAR FACTORY MONITORING & ASSESSMENT

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ABSTRACT:

Air quality was studied in Gerga sugar factory to assess and evaluate pollution levels that are generating from sugar manufacturing process. Pollution levels of NO_x, SO_2, CO, CO_2 and THC gasses and particulate matter were detected and determined. Also, associated parameters of meteorological conditions such wind speed, wind direction, temperature and pressure were evaluated. This was done using the mobile monitoring unit. The mobile monitoring unit is a mobile laboratory with rapid response instruments for real-time measurements of gasses and particulate distribution and emission source characteristics.

The results showed that air quality in Gerga sugar factory has been affected from total hydrocarbons and sulfur dioxide gases that exceeded the acceptable levels. As, for particulate matter, it is considered the worst pollution problem in the core of the sugar factory and neighbouring colonies. In general we can say that Gerga Sugar factory affects the air quality with a limit range of pollution.

Aim of the work:

1-To assess the environmental impacts of sugar manufacturing process to evaluate if workers expose to unacceptably high pollutant levels and consequently unacceptable high health risks.

2-To conduct a monitoring program to determine pollutants concentrations and their related meteorological parameters to be compared with allowable levels. Also, to testify the probability of pollutants existence in residential communities that neighbor sugar plants to show if these zones are affected by emission sources.

3-To suggest appropriate measures to be implemented to maximize mechanisms of separation techniques for particulate matter and gaseous pollutant in order to reduce or limit the detected pollution.

INTRODUCTION:

Egypt grows sugarcane commercially for sugar production in its southern part known as Upper-Egypt. This area extends from latitude 28º 30′ to 24º 0′ north. Environmental variation within this region that extends to more than 600 km from north to south is well recognized. The most of sugar factories that exist in Egypt are positioned in this area.

An environmental Impact Assessment was conducted in Gerga sugar factory to evaluate risks and hazards that may do harm to the environment.

A Mobile Monitoring Unit was used to carry out this task, This Mobile Monitoring unit is equipped with advanced analyzers and detection devices which are controlled by a computerized program to give an accurate condition values of pollutants. Also, a related meteorological program was carried out to achieve this task.

This final results showed that the effect of Gerga sugar factory in contaminating the air is confined to the factory core and very close by zones. At the same time, the effect on the town of Gerga and its surrounding communities from the factory is relatively insignificant.

Background:

Many researches were conducted to analyses and evaluate the concentration of pollutants that are present in sugar factories. Some of them are as follows :

Nasieb *et al.*, (1994) investigated the air quality in two sugar factories using an equipped mobile monitoring unit. They found that dominant pollutants were NO_x, SO_x and PM_{10}. The study recommended modification to the used separation technologies if possible and control of air-fuel ratio[1].

Dolignier *et al.*, (1999) Carried out a study to demonstrate that sugar factory carbonation lime which can be used as desulphurization agent. They found that carbonation lime has great efficiency more than that of finally crushed natural lime stone. Also, carbonation lime reduces NO_x in separation techniques[2].

Tombul and koparal (2003), evaluated a mathematical modeling of the total nitrogen contamination in water pollution in Eskisehir region of Turkey. From the study, the potential pollution of ground water was effectively estimated. Prediction of pollution by means of the model contributes to form the future prediction of water resources management[3].

Chen, Y. *et al.*, (2004) investigated particulate matter fractions with aerodynamic diameter nominally less than 2.5 µm ($PM_{2.5}$) in two residual oil fly ash (ROFA) samples. They found that Carbon-rich particles were often observed to be coated with inorganic species, notably transition metals (V, Ni, Fe, Zn) in the form of sulfates, Oxides, vanadates and phosphates[4].

Matushima *et al.*, (2004), developed a dry-desulfurization process using Ca $(OH)_2$/fly ash sorbent in a circulating fluidized bed. They indicated that this process could remove SO_2 in flue gas with a high efficiency under dry conditions[5].

Morgenroth and Batstone (2005), declared that drying of bagasse offered the advantage of an increase in calorific value and an improvement in boiler efficiency. They found that air emissions reduced to a minimum by employing this technology[6].

Ergenc *et al.*, (2006), examined the differences in the properties of gasoline's and how they affected exhaust emissions. They found that the fuels that had high sulfur, low volatility and low Reid vapor pressure exhibit increased emission values[7].

Javed and Irfan (2007), evaluated computational kinetic modeling to remove nitrogen oxides (NO_x) from the flue gases by selective non-catalytic reduction (SNCR). They found that the optimum temperature for peak reduction was around $1075C^0$ with optimum molar ratios of 1.5 Hydrogen was found to be an efficient enhancer. The optimum residence time was found to be about 80 milliseconds[8].

MATERIAL AND METHODS:

Several visits were carried out to execute the proposed monitoring program in the aim of achievement of the environmental assessment in Gerga sugar factory. The industrial processes were identified as well as the basic operation of sugar manufacturing such as, extraction of juice, clarification, evaporation, crystallization and refining. Also, location of power generation unit, tanks of mazout, bagasses stores, bagasses driers and location of lime supply.

The location of measuring sites were in definite positions relative to emission sources. The concentration of gaseous pollutants and particulate matter were determined.

Meteorological conditions related to measurements of pollutant concentration were recorded such as wind speed, wind direction, temperature and pressure. This give means to what extent the environment was affected by such pollutants.

The location of sugar factory with respect to the town of Gerga as well as the approximate location of chosen sites in the factory is presented. Also, a detailed map of sugar factory and its colonies on which the exact location of the first six sites are located.

The monitoring system to record pollutant concentrations and meteorological conditions continued for four months from January to April 2007. Data obtained were presented in charts and discussed below.

EXPERIMENTAL WORK:

Monitoring stations were selected inside the plant and another station in down town of Gerga, Fig. (1) shows the monitoring stations.

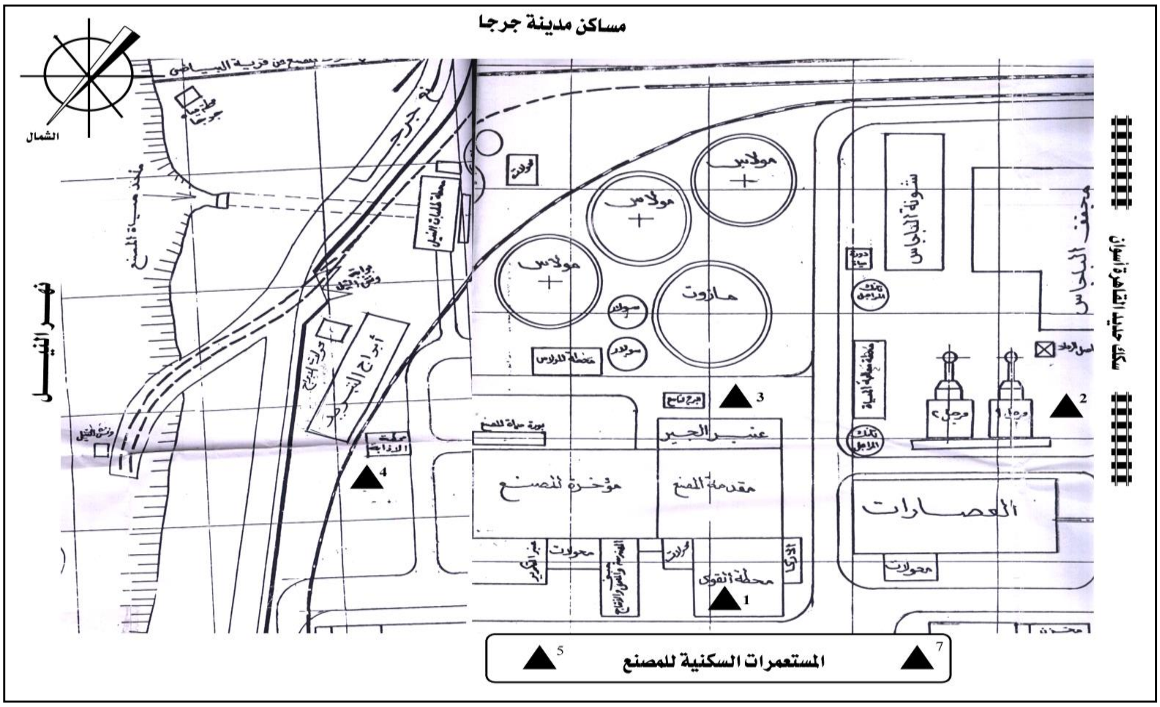

Fig. (1): Location of sugar factory with respect to the town of Gerga showing the monitoring stations in the factory and town

N.B. Site No: 6 is located in down town Gerga city

Monitoring program :

Monitoring program is a sequence of steps and field actions required to accurately determine the air quality at the chosen monitoring sites. It also, sets the proper and essential measures needed to thoroughly investigate the effect of all parameters and conditions on the monitoring process and consequently on the measured quality of the monitored air. Monitoring of air quality was performed at the chosen seven sites in Gerga sugar factory and its surroundings during the months of February to April 2007. The mobile unit was located at each one of the chosen sites for at least three consecutive days during which ambient air samples were drawn, regularly and analyzed in the different analyzers. The three-day period was chosen because of the limited size of the envirologgcr buffer which can accept data from the system instrumentation for a maximum of 72 hours of continuous monitoring. If monitoring continues beyond this three days period without intermediate data-acquisition and or buffer clearing the daily recorded data are overwritten on the stored date. The enviologger was programmed to perform zero and span calibration for all analyzers every day at a specific time. Also, the high volume sampler was programmed according to ref[9]. To start air sampling for particulates matter collection at noon of the second day of monitoring site and continues sampling for 24 hours.

At any site, the monitoring program and its execution procedures can be summarized in the following steps:

1-The mobile unit is oriented in such a way to have the intake of the air sample in an open area not blocked by any close object and not to be in the boundary layer of any existing wall. Power source was connected to the unit which is either electricity mains from the factory or the mobile unit power generator. In case of using the unit power generator for electricity supply it must be located in the downstream of the mobile unit and at about 100 m from it.

2-The tower holding the Meteorological sensor is unfolded and the wind direction sensor is set according to the instructions[9].

3-Power is turned on for all analyzers, calibrators and envirologger following the operation procedure and power on instructions specified for each instrument[10]. Also, the air conditioning units are turned on.

4- At least one hour before the starting and the end of the particulates matter sampling period, the electronics balance is turned on. This period is required for proper stabilization[11] of the balance, before it can be accurately used for weighing the teflon sampling filters fitted in their cassettes before and after sampling in order to determine the quantity of particulates collected during the programmed sampling period.

5- At the end of monitoring period (3 days), data acquisition is performed on the raw data stored in the envirologger buffer. In this process the raw data are checked, formatted and transferred from the envirologger to Hers-II Database files[12]. Then, the, envirologger buffer is cleared for new station data storage.

6-The envirologger station switches are adjusted for new station code. Also, the new station parameters and files in Hers-II are activated for data acquisition[12].

7-Analyzers, calibrators and envirologger turn off procedure are carried out following the instructions specified for each instrument[13-14]. The air conditioning units are turned off and the tower I holding the meteorological sensors is folded down.

8-The above described steps are repeated at each site.

It must be noticed that at each site, instruments surveillance is carried out periodically, during the monitoring period. Moreover, the operating conditions of the pollutants emission sources (e.g. the rate of fuel consumption, rate of material handling and processing.. etc) and any parameters that might cause or might be related to any pollution problem are recorded daily during the monitoring period[15, 16].

Description of the Mobile Monitoring Unit:

Monitoring of air quality in the present project was performed using a mobile monitoring unit in which all instrumentations needed for data sampling, manipulation and acquisition are installed in an air conditioned cabinet (4.3×2.3×2.3 m^3) of a medium size truck, Fig (2). The truck engine is 8.2 liter 8-cylinder, V- shaped, 159 HP diesel engine. The unit cabinet is divided into two compartments; one for instrumentation and a small rear one (0.75 m wide) used as store and as transition zone to the instrumentation compartment as shown in Fig.(2). The instrumentation compartment contains air pollution monitoring instruments, particulate high volume sampler controller, meteorological data recorders and translators, data acquisition and computer systems. The rear compartment contains calibration gas bottles and fire extinguishers. On the roof of the cabinet a telescopic tower is fixed which is used to support the ambient temperature, wind speed and wind direction. The ambient pressure sensor is fixed on the cabinet outside wall near the roof. All instrumentations inside the cabinets can be powered either from electricity mains or from an AC generator integrated with its own diesel engine and which can be trailed by the truck. A 100m power cable is supplied for use with either power sources[17].

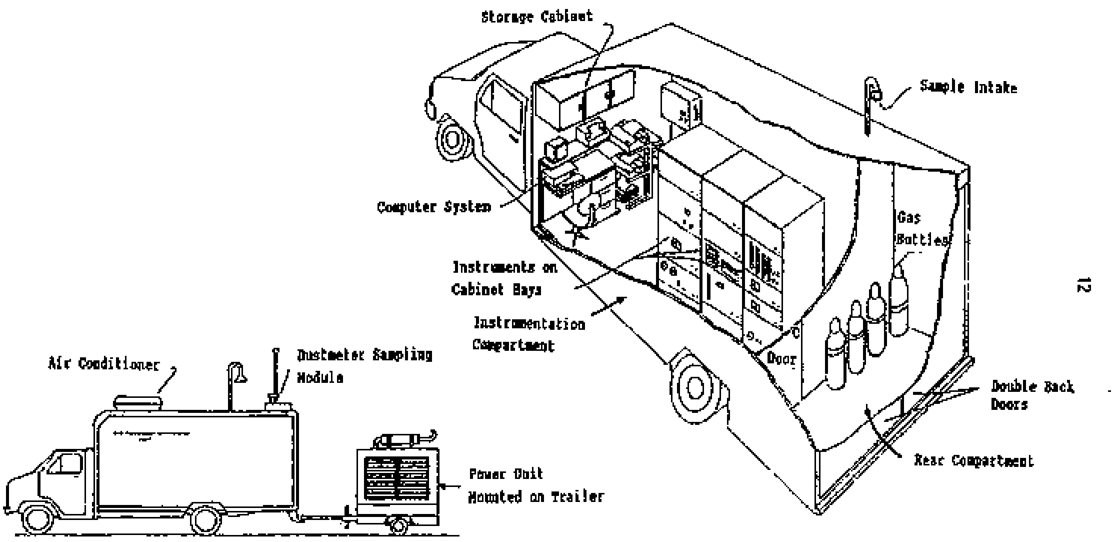

Fig. (2) The mobile monitoring unit and its main components

RESULTS AND DISCUSSION:

All monitored data at the seven chosen sites were analyzed, compared with the standard levels stated by law #4 of 1994. The data were manipulated to be suitable for presentation in the following :

A-Daily statistical of the monitored parameters which are shown in table (1). Which shows the maximum, the minimum and daily average values of all monitored concentrations of pollutants under consideration.

B-Daily statistical of the metrological conditions of wind speed, wind direction and temperature were shown in table (2).

C-Bar charts (Figs. 3-8) represented variation of pollutants average concentration of NO_x, SO_2, CO, CO_2, THC and particulate matter. Also, the air quality standard or assumed level is represented by a dashed line in charts of pollutants whose concentrations exceeded the standard value or assumed level.

D-The concentration of coarse and fine suspended particulates and their exceedance above the air quality standard at the seven monitored sites are represented by a horizontal dashed line on the chart.

The results obtained show several cases of certain pollutants whose concentrations exceeded its air quality standard or assumed level value at specific time for certain duration and under certain operating conditions. Those cases are considered to try to analyze the combined effects of all factors that directly or indirectly influence the pollutants concentrations.

Thus, such exceedances can be related whenever possible to the effects of the location of the monitoring site with respect to the pollutants emission sources, type and daily consumption of fuel as well as the wind speed and direction at the monitoring site. This analyses helps in understanding the cause and effect of pollution problem at the monitoring sites and consequently facilitates its management and control[18].

It is worth mentioning that a pollutant exeedance represents the difference between its maximum concentration and its air quality standard as percentage of the standard level. The hourly average and maximum concentration of different gaseous pollutants that are represented in the figures or used in estimation of exceedance percentage were all zero/span adjusted according to the daily calibration reports performed for the instrumentation during monitoring.

Discussion of exceedance cases for pollutants in all sites:

Nitrogen oxides (NO_x):

The variation of maximum and daily average concentrations of NO_x in sites from 1 to 7 are given in tables (1&2) as well as in Fig. (3). This figure shows that the concentration of this pollutant exceeded the annual air quality standards at all sites except at sites No. 1 & 6. The maximum concentration at the sites above the standard value were in sites No. 2, 3, 5 & 7.

It's worth mentioning that this percentage of exceedance is calculated on the basis of annual air quality not on relative to a daily or hourly values which are expected to be much larger than the annual value. Therefore such exceedance don't trigger any alarm or alert for expected pollution problems. According to the National Air Quality Standard (NAQS-USA), the primary and secondary ambient air quality standards for nitrogen dioxide is 100 $\mu g/m^3$ (0.05 ppm). Hence, it can be considered that the concentration of NO_x emitted from the Gerga sugar factory is insignificant and is considered to be acceptable at all sites[19-20].

Table (1): Measured values of monitored parameters for sites from 1-7 Gerga factory

	SO_2, ppm			NO_x, ppm			CO, ppm			THC, ppm			CO_2, ppm		
	Max. Value	Min. Value	Av. Value	Max. Value	Min. Value	Av. Value	Max. Value	Min. Value	Av. Value	Max. Value	Min. Value	Av. Value	Max. Value	Mini. Value	Aver. Value
Site 1	0.067	0.000	0.007	0.051	0.001	0.012	1.3	0.4	0.7	0.5	0.0	0.1	1144	263	530
Site 2	0.022	0.022	0.012	0.077	0.077	0.032	3.1	3.1	1.7	1.1	1.1	0.4	842	499	633
Site 3	0.448	0.008	0.059	0.051	0.000	0.007	1.0	1.0	0.4	0.3	0.0	0.3	536	305	351
Site 4	0.058	0.002	0.614	0.006	0.013	0.028	1.8	0.0	0.7	0.7	0.0	0.2	496	322	406
Site 5	0.021	0.001	0.006	0.108	0.002	0.032	2.0	0.3	0.9	0.9	0.0	0.1	439	297	364
Site 6	0.006	0.000	0.002	0.009	0.001	0.004	1.4	0.7	1.0	1.0	0.0	0.8	549	258	365
Site 7	0.016	0.001	0.005	0.093	0.002	0.024	2.6	0.7	1.3	1.3	0.0	0.1	412	293	341

Table (2): Measured values of some meteorological parameters in sites from 1 to 7 in Gerga Sugar Factory

	Temperature, DEG			Wind speed, MPH			Wind direction, DEG	
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.
Site 1	20.6	9.6	15.2	15.9	5.8	9.6	350.0	250.0
Site 2	22.9	6.7	14.3	9.5	3.7	5.6	339.0	320.0
Site 3	20.2	10.5	16.1	13.9	3.6	9.3	286.8	295.0
Site 4	22.9	5.5	14.2	15.9	2.8	7.5	355.5	185.50
Site 5	26.8	8.0	17.5	10.8	2.4	4.7	353.5	180.0
Site 6	23.0	13.5	18.5	16.5	6.7	11.9	336.1	295.10
Site 7	22.0	9.9	15.9	6.9	2.5	3.5	355.0	146.50

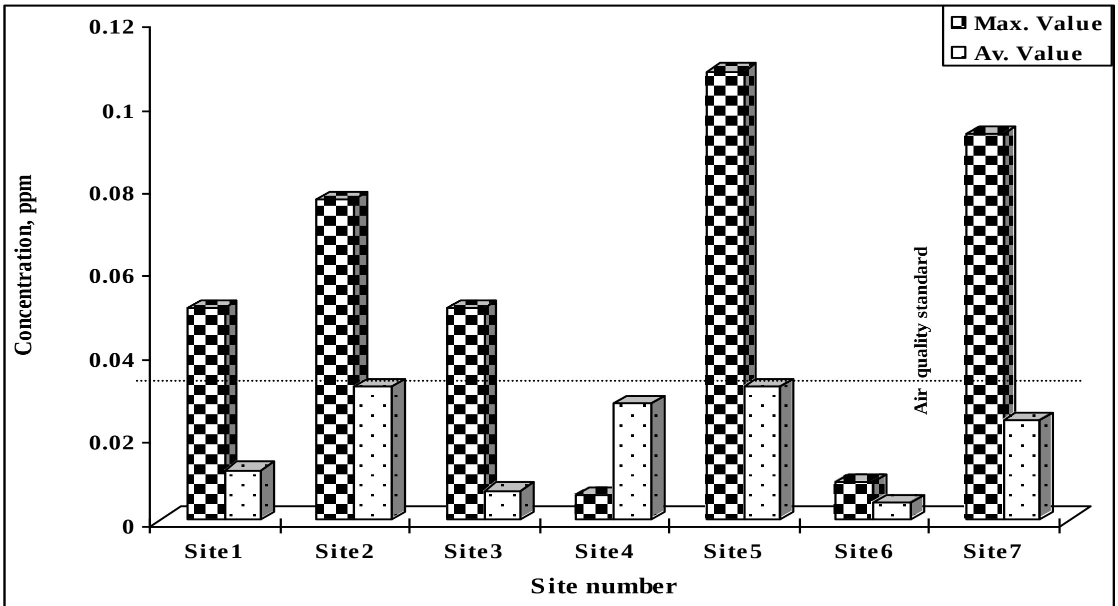

Fig. (3): Variation of Maximum and Average Concentration of NO_x in Gerga Sugar Factory (March 2007)

***Site 6 is Downtown Gerga**

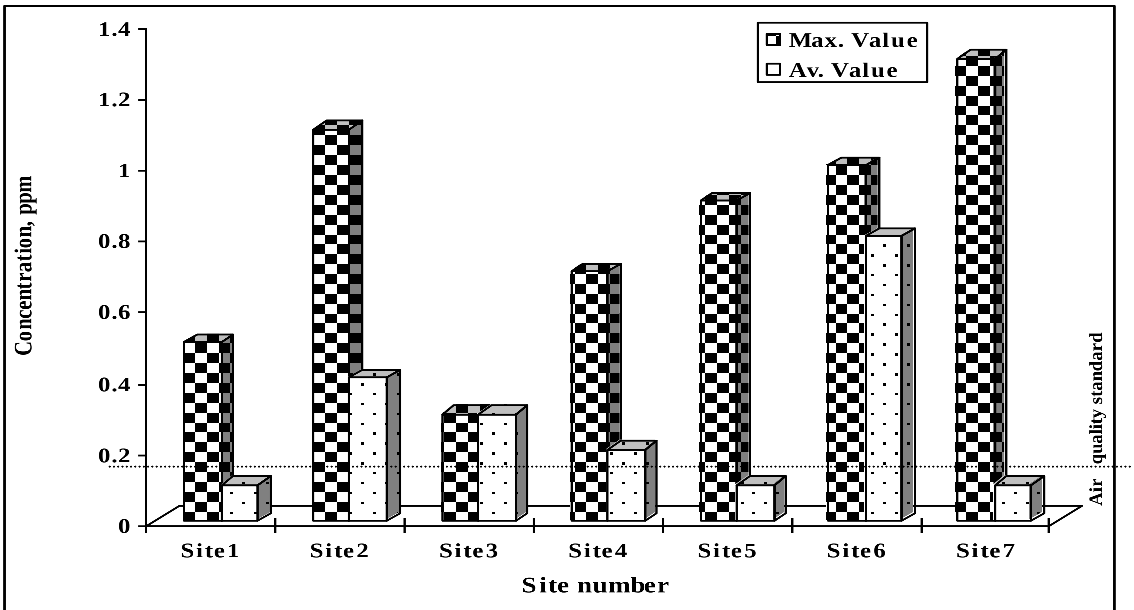

Fig. (4): Variation of Maximum and Average Concentration of THC in Gerga Sugar Factory (March 2007)

***Site 6 is Downtown Gerga**

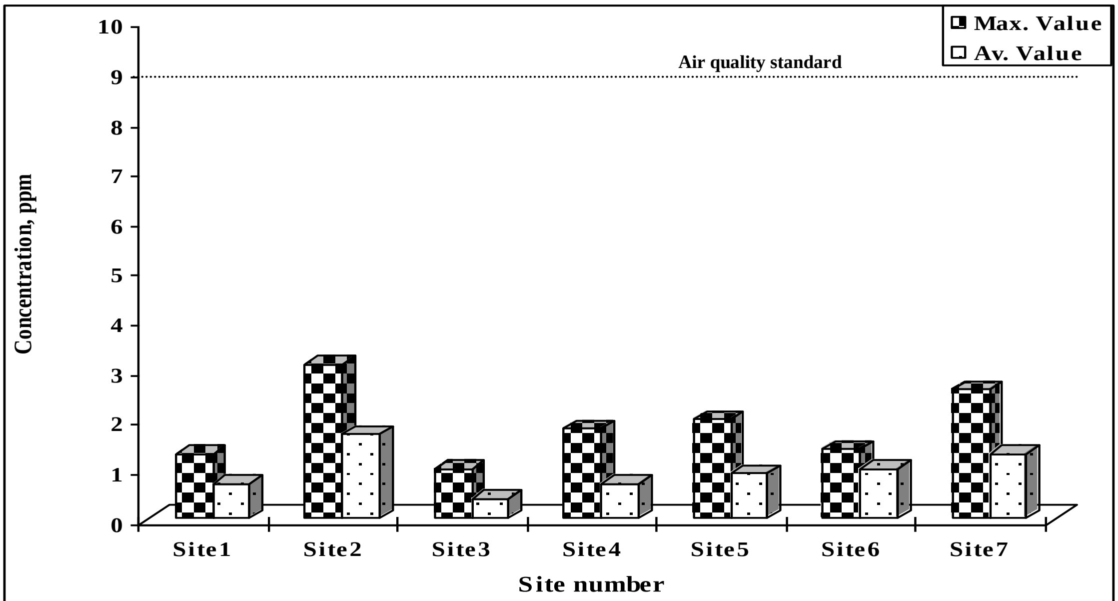

Fig. (5): Variation of Maximum and Average Concentration of CO in Gerga Sugar Factory (March 2007)

***Site 6 is Downtown Gerga**

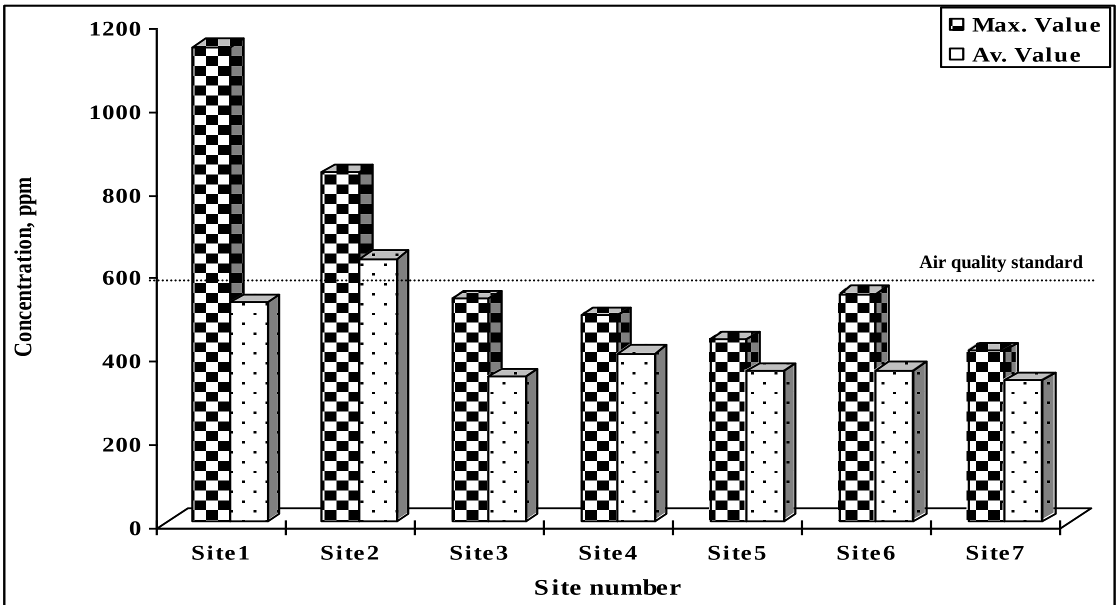

Fig. (6): Variation of Maximum and Average Concentration of CO_2 in Gerga Sugar Factory (March 2007)

*** Site 6 is Downtown Gerga**

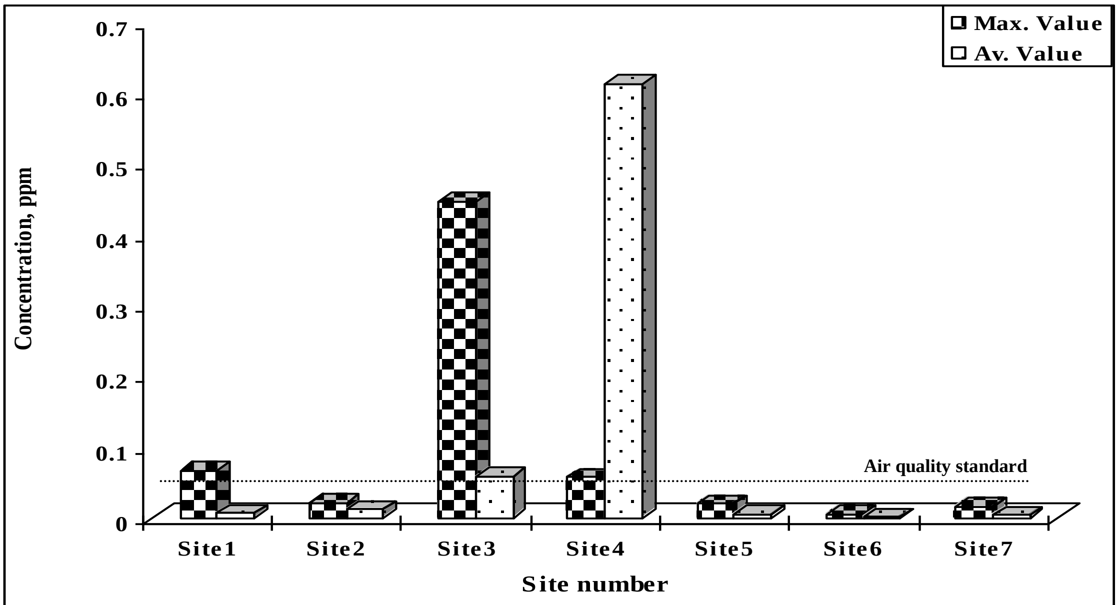

Fig. (7): Variation of Maximum and Average Concentration of SO_2 in Gerga Sugar Factory (March 2007)

*** Site 6 is Downtown Gerga**

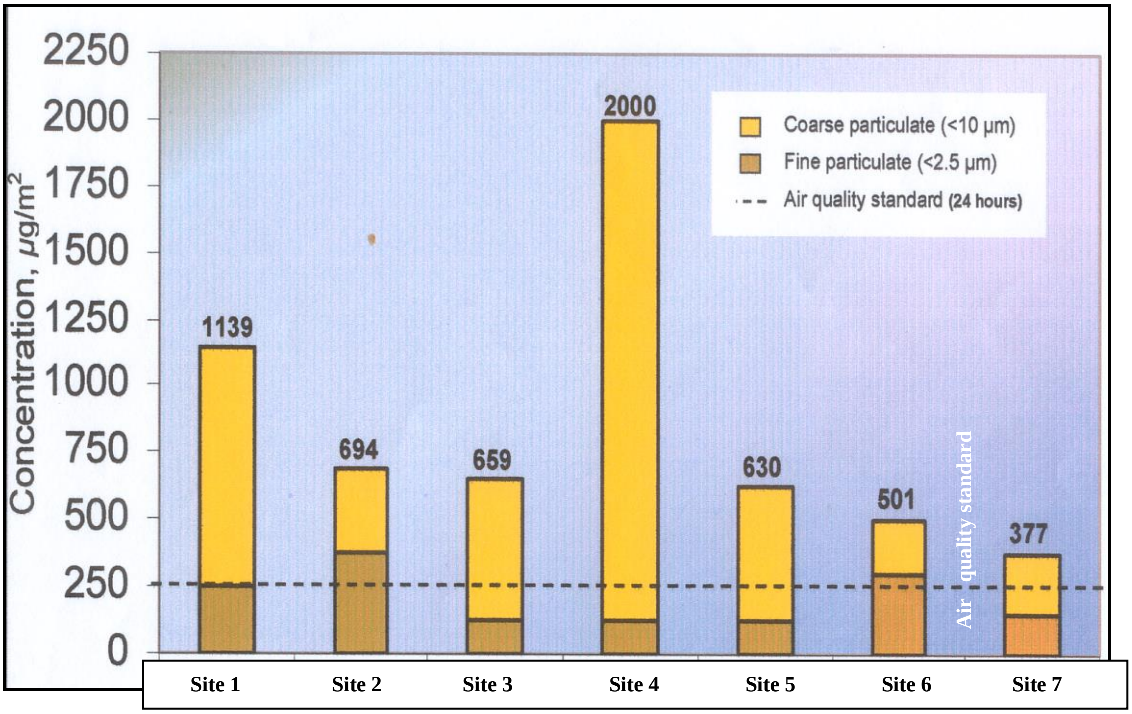

Fig. (8): Variation of concentration of coarse and fine suspended particulates and its exceedance above standard in Gerga Sugar Factory (March 2007)

*** site 6 is Downtown Gerga**

The total Hydrocarbons (THC):

The variation of maximum and daily average concentrations of THC relative to the chosen seven sites are given in tables (1 and 2) as well as in Fig. (4). This figure shows that the concentration of this pollutant exceeded the air quality standards at all sites except in site No. 6. Since the air quality standard of this pollutant (THC) is 0.24 ppm for 3 hours duration time average (which is not to be exceeded more once a year), sites No. 2, 4 and 5 exceeds the allowable level, therefore these sites are considered to be unhealthful concerning of THC. So, to overcome this problem, adjusting of fuel/air ratio is essential[21,22].

The carbon monoxide:

The variation of maximum and daily average concentrations of CO at all sites are given in tables (1 and 2) as well as in Fig. (5). This figure shows that the maximum and daily average concentration of this pollutant were always less than air quality standard respectively at any site. It can be concluded that the concentration of the CO emitted from Gerga Sugar Factory is insignificant and is considered to be acceptable at all sites. The air quality standard for CO where established at 10 mg/m^3 (9 ppm) as the maximum 8-h average and 40 mg/m^3 as the maximum 1-h average[23].

The carbon dioxide (CO_2):

From the above mentioned tables and Fig. (6) below, showed the variation of maximum and daily average concentrations of CO_2 in all sites. This figure shows that the daily average concentration of this pollutant are ranged between 360 to 520 ppm at all sites. The assumed level for CO_2 is 500 ppm. From $C0_2$-graph, it shows that the concentration of CO_2 is insignificant [23,24].

The sulfur dioxide (SO_2):

Form the same tables and Fig.(7) indicated the variation of maximum and daily average concentrations of SO_2 at all sites. This figure shows a significant increase in the maximum concentration of the pollutant at site No. 3 only 9 about (0.45 ppm). Because this site is located very close to the equipment of SO_2 production. The remarkable increase in the maximum concentration of SO_2 detected at its attributed to a leakage in the sulfur furnaces or its piping systems. The exceedance above the air quality standard for this pollutant can be avoided by proper maintenance for the SO_2 furnaces and its pipe fittings. Since the SO_2 gas is very hazard a warning equipment for the detection of small traces of SO_2 leakage is needed at that site[25,26].

The Total Suspended Particulates (TSP):

Now, form tables and Fig. (8) the variation of concentrations of coarse and fine suspended particulates and its exceedance above the air quality standard for all sites. This figure shows that the concentration of TSP at the monitoring sites in Gerga sugar factory ranged between 319 and 2000 µg/m^3. Primary and secondary ambient air quality standards for particulate matter (based on USA National Standards) are shown in table (3).

Table (3): Ambient air quality standard for particulate matter based on national standards (USA)

Pollutant	Maximum 24-h concentration μg/m^3*	Annual (geometric mean)
Primary	260	75
Secondary	150	60

*** Not to be exceeded more than once a year.**

Generally speaking, the TSP exceedance is considered to be the worst air contamination problem in sugar factories Monitoring as well as field investigation indicated that suspended particulates which contaminate the air inside the factory and its colony consists of fly ashes smoke and dust. On the other hand, dust is the main constituent of TSP outside the factory. This problem of increasing of TSP must be solved by using new techniques to reach with concentration of PM_{10} an acceptable limits[26].

Accordingly, it can be stated that the effect of Gerga factory in contaminating the air by suspended particulates mainly (fly ashes and smoke) is limited in the factory core and very close by north and north east zones. At the same time, the effect on the town of Gerga and its surroundings communities concerning total suspended particles emitted from the factory is relatively insignificant. This problem of increasing of total suspended particles concentration in the factory can be treated using more efficient ash collectors or investigating the available collectors to introduce proper modifications (if possible) that improve their efficiency. On the other hand, proper measures and burners modifications must be setup for the use of mazout to inject the correct amount in the boilers which corresponds to the proper fuel air ratio particularly at the beginning of using mazout to supplement the main fuel (bagasse). The correction of fuel-air ratio from the beginning as well as continuous adjustment will result in complete combustion through the whole period of mazout usage. Thus, reduce to a large extent the smoke problem as well as THC concentration in the flue gases. Also, improvement of the bagasse and other material handling and transmission processes (particularly the belt conveyors) are essential to decrease the total suspended particles problems [27,28].

Discussion of meteorological parameters on pollutants dispersion:

In environmental monitoring, pollutants concentration depend chiefly on the associated meteorological parameters such as wind speed, wind direction and temperature in measurement sites. The effects of meteorological conditions on pollutants dispersion are explained as follows[29]:

1-At location 5 and 7, dispersion is unlikely to occur because of the architecture construction and distribution of building surrounding theses sites. These obstacles participate in dissipating the kinetic energy of any wind that might blow.

2-At location 3, the most predominant wind direction was 286.8 as shown from table (2). this site is located in the down stream of the wind coming over the lime and superphosphate stores. This was confirmed by result of the percentage of total occurrence for concentration exeedance of particulate matter[30].

3-At location 2, the most predominant wind direction was 339^0, and the site is located in the down stream of the wind coming over sulfur furnaces, this explains the exceedance cases of pollutant concentrations, especially hydrocarbons and sulfur dioxide.

4-At location 4, monitoring indicated that this site is not affected by any of pollutant emission sources. This due to the large distance between these sources and the site location. The pollution reaches this site from loading and shipping operations due this site is adjacent to port of river Nile.

5-At location 1, the site is exposed to wind for nearly north-west direction which never passes over any of sugar factory main pollutant emission sources. The values of pollutant concentration of at this site results from neighbouring traffic roads.

6-At location 6, this site was located down town and monitoring indicated that the concentration of pollutants is limited and pollution exists in the core of the sugar factory. Hence, the air quality of Gerga city is not impaired.

7-Environmental monitoring was carried out from January to April and the temperatures of this season are mild and have the range from 20.2^0 to 26.8^0 in all measurements sites. This interprets why pollution is localized in the core of the sugar factory and dispersion is limited in the down town of Gerga city[31,32].

CONCLUSION:

The quality of air was examined in Gerga Sugar Factory of Sugar and Integrated Industries Company (SIIC) and in its nearby communities through execution of a comprehensive monitoring measurement program. The concentration, of five types of gases and particulate matter contaminants were recorded. The program also included measurement of all parameters affecting the concentration of these pollutants as well as surveillance of meteorological conditions in the area as well as the operating conditions in the factory.

The results of air quality monitoring indicated that the concentrations of gaseous pollutants emitted from different pollution emission sources in Gerga Sugar Factory are acceptable within the permissible standard levels except those of the total hydrocarbon which were above air quality standards by a very un healthful margin inside the factory while the sulfur dioxide reached a very dangerous unhealthful level in neighborhood of the sulfur furnaces in the factory.

Concerning the total suspended particulate matter, it was found that its lowest concentration at all sites including that in down town Gerga is unhealthful. Therefore, the total suspended particulate matter is considered to be the worst air contamination problem in Gerga Sugar factory and its vicinity. As far as the town of Gerga is concerned, the total suspended particulate matter detected at the site chosen in the down town of Gerga was mainly composed of dust which can be attributed to the existence of external effects of unpaved roads surrounding this site. Therefore, the town of Gerga as represented by this site is in general not affected by the suspended particulates emitted from the pollution emission sources in Gerga Sugar factory[32].

Based on all what is mentioned above, it can be stated that the effect of Gerga Sugar Factory in contaminating the air is confined to the factory core and its vicinity. At the same time, the effect on the town of Gerga and its surrounding communities from the factory is relatively insignificant.

RECOMMENDATIONS:

To minimize the environmental impact, the following measures are to be carried out:

- **The increase of total suspended particulate concentration in Gerga sugar factory and in its area can be treated by using more efficient ash collectors or investigating the available collectors to introduce proper modification (if possible) that improve their collection efficiencies. Also, improvement of the bagasse and other material handling and transmission processes (particularly the belt conveyors) are essential to decrease the total suspended particulate problems.**
- **Proper measures and burners modification must be setup for the use of mazout in the boilers in order to achieve proper fuel-air ratio particularly at the beginning of mazout usage to supplement the main fuel (bagasse). This correction of fuel-air ratio from the beginning as well as continuous adjustment will result in complete combustion through the whole period of mazout usage. This, reduces to a large extent the smoke problem as well as the total hydrocarbon concentration in the flue gases[33].**
- **The exceedance above the air quality standard for sulfur dioxide can be avoided by proper maintenance of the sulfur furnaces and its piping fitting. Moreover, warning equipment for the detection of small traces of sulfur dioxide leakage are recommended to be installed near the furnaces[34].**
- **A full investigation and air quality monitoring nearby the wood factory and its vicinity while it is operating at full load is highly recommended.**
- **Continuous evaluation of production operations to identify modification potentials might reduce the environmental impact.**
- **Control of consumption and pollution control technologies must be carried out periodically.**
- **Working closely with the appropriate regulatory agencies and maintaining open communications to discuss the effects which new regulations may introduce.**
- **Rationalizations of energy use, since its increase may result in more gas emissions and wastes.**
- **Sodium bentonite, a chemical material has special characteristics under high temperature and pressure, can be used as an adsorbent material for particulates. This material can be added to bagasse or in fuel furnaces. This material reduces particulate emissions and raises the calorific value of baggase fuel[34,35].**

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التلوث في مصـــــــانع الســـــــــــــكر بجـرجا

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لقد تم دراسة جودة الهواء في مصانع السكر بجرجا والأماكن المجاورة لها، من خلال تنفيذ برنامج متكامل لقياس تركيزات أكاسيد النتروجين والكبريت والكربون والهيدروكربونات الكلية، وكذلك قياس الأتربة العالقة في جزئيات الهواء وذلك من مصادر الانبعاثات المختلفة بالمصنع، كما تم قياس العوامل الجوية المصاحبة لعمليات القياس والمؤثرة فيها مثل سرعة الرياح، واتجاه الريح، ودرجة الحرارة، والضغط.

وقد استخدم لذلك سيارة القياس المتنقلة وهي مزودة بأجهزة تحليل عالية الدقة وبرامج كومبيوتر متطورة لقياس التغير في تركيز الغازات الملوثة وتوزيع الأتربة والخواص المختلفة للانبعاثات.

وقد أوضحت نتائج الدراسة الخاصة بمراقبة جودة الهواء بمصانع سكر جرجا أن تركيز الغازات الملوثة والمنبعثة من المصنع مقبولة في حدود المستويات المسموح بها ماعدا الغازات الهيدروكربونية وثاني أكسيد الكبريت حيث تعدت تركيزاتها المستوى القياسي بحد غير صحي داخل المصنع ومستعمرته السكنية.

أما بالنسبة للجزيئات الصلبة العالقة في الهواء فقد وجد أن أقل درجة تركيز لها في جميع مواقع القياس تعدى المستوى القياسي المسموح به بحد غير صحي داخل بيئة العمل.

وقد وجد من نتائج القياسات والفحص الميداني أن مشاكل التلوث تنحصر في قلب المصنع والمناطق المجاورة، وعليه يمكن القول أن مصنع السكر بجرجا يؤثر على جودة الهواء داخل المدينة والتجمعات السكنية المحيطة بمقدار غير محسوس.