Proc. Symp. Mar. Chem. in the Arab Region, Suez, April, 1991 : 263 - 278

Impacts of Pollution in Alexandria Harbour

By

S.G. Saad, G. Abouzid and L.MH. Mittwally

High Institute of Public Health (H.I.P.H.)

Abstract

Alexandria Western Harbour is one of the important sea ports in the Mediterranean Sea and the largest in Egypt. More than three quarters of the Egyptian international commercial trade is served at the harbour. It is also the receiving area for the imported petroleum and raw matrials for the heavy industries located at the outer skirts of the Alexandria metropolitian area, resembled in the iron and steel industry, petroleum refining, fertilizer, metal industry, textiles and a large spectrum of chemical and found a large spectrum of chemical and food industries.

The harbour is elliptical in shape with a length of 7.0 Kilometers and a maximum width of 2.0 km. depth of water varies from 5.5 to 16.0 meters. It occupies an area of 1, 962 Acres divided into the inner and the outer part of the harbour with a total length of 9, 875 meters as quays can station a maximum of 62 ships at one time. It also comprises the military harbour, the old dry dook and the the general goods quays, the maritime station and administation buildings.

Mahmoudia canal was discharging its water through a water lock to this part of the harbour. This canal used to be a fresh water canal branching from the Nile. Due to the excessive industrial pollution and land base sources it receives. it is now a heavily polluted water body. Discharging such a heavy load of organics to the dilution and mixing with sea water is rather limited, contributes to the deterioration of the navigation water in this parts of the harbour. Submerged sewage outfalls are another source of pollution. The discharge of sewage, bilge ware and part of the tankers ballast water are all shipsources of oil and organic pollutants. Toxicants as rodenticides, pesticides, chemicals and solid wastes fined their way to the harbour water as result of their mishandling and transport using open systems of cargo transfer.

The outer harbour from the coal quays to the petroleum basin, compries the fertilizer quays, timber quays, the ship yard and grain silos, cement silos and petroleum separation basin, and administration buildings.

Nobaria canal with its laden domestic and effluents poures its water, about 9 million cubic meters west to this sector of the harbour daily.

Activities as handing of goods, construction works, cleaning of quays and oil spillage are all, added sources of pollution. In general marine water receives huge amounts of polluted water exceeding cubic meter daily including industrial and domestic wastes.

Studies concerning the geochemical and the hydrographical nature of the harbour have been carried by steuer (1939), El-Awady (1972), El-Wakeel (1964), El-Wakel and El-Sayed (1978), and Rifaat (1982). Circulation patterns in the western harbour was studied by farag (1982) who indicated that the principle current flow was from inside to outside at the surface and 5.0 meter level. At the 10 meter level the current was reversed. The surface current direction varied between southeast and southwest direction during winter and spring seasons. At 10 m. leve, the current direction varied between the north east during summer.

This research was conducted to evalute the environmental status of the harbour with emphasis on marine pollution, its sources and impacts on the harbour. It also facauses on the possible remedies.

Material and Methods

The harbour was first surveyed to identify the general trade activities and their impacts on the water quality near the quay areas. Eighteen sampling points were selected as shown in Fig. (1), based on the survey, to investigate the distribution of pollutants in the harbour area. The physical and chemical characterizations of water samples were carried according to the standard methods of water and wastewater analysis (1985).

Turbidity was measured by the nephelometeric method. Dissolved oxygen was fixed in the sample bottle and measured in the lab by the modified Azide method. Biochemical oxygen demand was determined using 25% and 50% dilution to avoid magnification of results due to excessive dilutions. Dilution water used contanted 2.0 ml decanted sewage/liter to supply the initial bacteria for the test. Chlorides where measured using Argentometric titration. Phosphates where determined by colour technique using stannous chloride method. Bacterial plate count, coliform and Echirecia coli were both tested for, by the standard techniques and MPN tests documented in the standard methods reference.

Oil and grease were extracted using a solvent extraction technique based on acidifying the sample to pH 3 followed by addition of 10 c.c. of ethyl alchool / 250 c.c. of the sample. Equal volumes of the ether and petroleum ether were used in extracting the oils and grease present in the sample. using technique helps breaking any present emulsions and help extracting to the oil, faster. The solvent after seperation in a separatory funnel were dried at 80 °C in a drying oven with ventilation. The residical oil fraction after solvents evaporation was determined gravimetrically.

The harbour Authority was consulted, to collect the information concerning the maintenance rates and numbers of tugboats which performance was drastically affected by the increased levels of sea water pollution in their dock area where they are stationed for service.

Results

The harbour servey revealed clearly the directs of the different activities taking place their, and the vivid pollutional status of the harbopur. The physical and chemical characterization of the eighteen selected stations are shown in tabel (1a, b and c). Mean, Standard deviation and range of reported values are based on six sets of data collected allover the year 1989.

Starting from the inner harbour, the first zone is used by the military navy academy where their ships dock. Sewage submerged outfals are discharging domestic waste in this area without treatment from the buildings close to the shore line. Oil pollution is observed clearly due to the improper disposal of lubrication oils and petroleum oil from the ships while fueling.

The oil and grease content in station no. 8 which was in a median position of this area showed a value of 29.7 mg/1 and a range of 12-46.4 mg/1. Those value are within the highest value recorded in the harbour area. The biological oxygen demand value (BOD) which is a direct measure of the organic load present in this area showed a mean of 74 mg 02/L and a range of 26-112 mg 02/L. The volatile solid mean value was 70.3×10^3 with a range of 4.9-9. 7×10^3 mg/L.

These values indicate the presence of organic matter whether from sewage or from the biomass present in the water as a result of its content of nitrogen, phosphorus and organic matter as a carbon source for active biological and algaleutrophication. Bacterial total counts showed 40 to 300/m1, the coliform group counts ranged between zero and 23/100 m1. The E. col. Counts recorded a value of zero - 3.6 indecating the presence of human sources of pollution.

Shipyard and workshop zone:

Oil pollution mixed with solid wastes from the adminstration buldings and maintenance of ships is heavily covering the surface of this area. Station number 18 and 17 show the general pollutional status of this area. The BOD mean values were 110 mg 02/L wihtin highest recorded values in the harbour. The dissolved oxygen was mideum giving a values of 4.2 mg 02/L within in both stations. The oil and grease mean value was 24.3 mg/L.

Volatile solids were 7.4×10^3 mg/L, with a range of 5.7 - 9.3×10^3 mg/l for station number 17 and 5.0 to 10.4×10^3 mg/l for station number 18.

Spillage of imported animal feed and solid wastes from ships while docking reduced slightly the level of water quality in this sector.

General cargo Quays:

This area covers the quays number 20 to 38. Sampling stations number 15 and 16 represent the water quality discharge of domestic wastes and leaks from Mahmoudia canal water lock. Mahmoudia canal used to discharge its heavy polluted organic laden for a long time and it was stopped about five years ago yet the self natural cleaning process in the marine water is going very slow as the pollutional loads are exceeding the natural purification rates. High turbidity values with a range of 9.4-35 NTU and a mean of 15.1 NTU limit the light penetration and algal growth supplying the needed oxygen for aerobic marine bacteria to continue their activities as responsible for biological degradation of the accumulated organic residues. This is also supported by the practically absent DO values in the water of the two stations, as well as the high BOD valus as shown in table (1-a).

Mahmoudia Quays:

This sector of the harbour comprises quays number 38 to 54. The container quays extend from number 48 to 54. The goods in this area are handled in a grossly contained form and the spillage is kept to the minimum. Also the types of goods as cotton bales, cement bags, wood logs and the like are not of the easily scattered or spilled type.

Most of the dangerous cargoes are handled in containers and they are handled with utmost care but incidence of spill are encountered from time to time leading to the wash of the spilled chemicals to the sea.

As shown in the map the pollution from the preceeding area is not allowed to reach this area as the design of the quays on the right side act as a physical barrier for polluted water mixing to affect this area.

The turbidity levels are low recording a mean value of 4.5 and 4.3 in stations 12 and 13 respectively.

Station number 13 is affected with the pollution from the previous areas more than station number 12 which is relatively protected. Water is well aerated in this area with a DO value of 6.6 mg/L.

The dissolved air content in station number 13 was in the range of 3.2 - 6.2 mg/L. The BOd mean value was 120 mg 02/L compared to 90 mg 02/L at station number 12.

The data in table (1-b) shows a reduction in the level of phosphates and nitrates than in station 15 & 16.

The total Bacterial counts demonstrated a noticeable reduction in their values in these two stations with further reduction in the E. coli and total coliform count than in both 25 and 16 station table (1-c).

The oil content in station number 13 showed a lower value of 15 mg/L than in station number 12 which recorded 21 mg/L. The reversed trend confirms the effect of ships discharging their engine cooling water contaminated with oil while docking and due to relative water stagnation in this area more than in station number 13, where the oil level was higher.

The Coal, Cement and Fertilizers Quays Area:

This are covers the quays number 55 to 67 where cement silos, coal quays and chemical fertilizers imports are handled. The dust from the coal heaps find its way to

Table (1-a) : Physical and chemical characteristics of marine water in Alexandria harbour

	TURBIDITY NTU			pH	DO mg/1			BOD mgo/1			Oll & grease mg/1			Chlorides mg/1		
	Mean	St.d	Range	Range	Mean	St.d	Range	Mean	St.d	Range	Mean	St.d	Range	Mean X 1000	St.d	Rang X 1000
1	4.8	2.2	2.5-5.8	7.3-8.0	8.2	1.4	6.8-10.1	87.3	19.0	72-120	18.1	13.2	2.4-40	22.5	1673.0	20-25
2	4.7	1.7	2.65-6.8	7.2-8.0	8.1	2.0	6.2-11.2	78.7	8.5	64-88	21.1	7.2	10.8-31.2	21.0	2449.0	16.5-23.5
3	5.0	2.6	3.0-10	7.2-7.8	7.1	2.1	6.2-11.2	83.7	15.8	56-100	25.4	15.1	6-51.2	23.2	1722.0	21-25.5
4	44.3	7.3	37-54	6.7-7.1	2.0	1.6	0-4.8	165.0	47.5	72-200	33.8	14.8	21.2-62.8	22.0	1304.0	20-23.5
5	4.2	1.2	2.9-6.0	7.2-8.0	7.4	2.3	4-10.2	61.3	22.1	56-104	20.8	8.5	9.2-33.6	23.8	817.0	24-25.5
6	4.4	1.1	2.4-5.6	7.3-8.0	7.4	1.4	6-8.8	71.5	9.1	64-88	18.6	7.4	8.0-26	25.1	2354.0	23.5-30
7	4.1	0.5	3.5-4.9	7.3-8.0	7.7	1.1	6.2-9.1	96.5	25.2	76-144	18.2	5.8	8.4-25.6	25.5	2569.0	22.5-30
8	4.0	1.0	2.5-5.6	7.3-7.9	7.3	0.9	6-8.6	73.7	19.9	56-112	29.5	13.5	12-46.4	24.1	2923.0	19.5-24.5
9	4.4	1.7	2.8-7.2	7.2-8.1	8.3	1.5	6.2-10.2	54.0	26.1	24-96	16.1	8.0	3.6-26.4	23.5	2450.0	20-27.5
10	5.8	3.0	2.8-11.0	7.4-7.9	7.6	0.9	6-8.7	78.7	32.2	50-136	20.4	12.8	6.4-37.2	25.2	3044.0	22.5-31
11	6.0	2.9	2.8-11.0	7.4-7.8	8.0	0.7	7-9.1	82.3	27.4	60-136	20.6	8.8	6.4-30.4	23.4	2871.0	19-27.5
12	4.5	1.0	2.9-5.5	7.2-7.5	6.6	1.7	4.4-8.1	89.7	28.5	40-104	14.5	9.2	6.4-30.8	24.1	3353.0	20-30
13	4.3	0.9	2.9-4.9	7.2-7.7	4.8	1.0	3.2-6.2	121.7	12.3	104-140	19.5	5.1	12-24.4	23.6	4018.0	19.5-31
14	4.3	1.3	2.2-5.8	7.2-8.0	7.3	1.4	5.6-9.2	56.8	11.1	40-70	16.6	6.3	7.2-25.6	24.5	4254.0	18.5-30.5
15	15.1	9.9	9.4-35.0	6.8-7.8	0.4	0.6	0-1.2	114.3	32.0	80-160	21.0	10.3	6-35.2	17.4	2290.0	18-21
16	18.5	6.0	9.8-28.0	6.6-7.5	0.2	0.3	0-0.8	105.0	31.3	64-150	19.0	7.3	6.8-28	18.0	3405.0	12-21.5
17	4.4	1.1	2.3-5.4	7.2-7.8	4.2	1.2	2.6-5.8	109.7	30.6	56-144	23.8	8.1	10.8-34.8	24.0	3688.0	20-29.5
18	3.8	0.9	2.3-4.7	7.2-7.6	4.2	0.9	3.4-5.2	104.7	36.3	40-144	24.3	9.5	8.8-37.2	23.6	4140.0	17.5-30

the harbour water causing its blackening. The water discoloration extends to a large area helped with the lower mixing with the open sea water in the outer harbour due to the geometrical shape of the harbour shown in fig (1), and the prevailing inward water movement.

The water is aerated showing a value of 8 mg 02/L in station 11 and 7.6 mg 02/L at station number 10.

The turbidity increased to a value of 6 NTU at station 11 and 5-8 NTU at station number 10.

Both stations showed close values with respect to all parameters as shown in table (1-a, b, c).

Bacterial plate counts showed relatively higher values in station 15 more than 11. The same trend was followed with respect to coliform and E. coli counts recorded in both stations caused by a small submerged sewage outfall discharging its wastewater in this area.

The outer Harbout:

The central part is coverd by stations number 1, 5, 6, 7, 14 and 9. The six selected stations showed the lowest detected pollutional levels in the harbour. Their water is well aerated with mean dissolved values ranging between 7.4 to 8.3 mg 02/L. The chlorides content and total solids illustrate the effect of harbour water mixing with the outer sea water as shown in table (1-a) and (1-b).

The effect of the inner harbour pollution is diminished in those stations as the BOD mean values were the lowest recorded ranging from 54 mg 02/L to 91 mg 02/L.

The oil and grease contents are effected with the oil pollution in the inner harbour and the illegal discharge of engines cooling water of the serviced ships.

Local pollution from docks activities observed at stations 2, 3 and 4 with variable extents.

Station number 4 showed the highest pollutional indices with a low DO value of 2.0 mg/L turbidity value of 44 NTU and BOD value of 165 and the lowest dissolved solid of 32.75 X 103 mg/L indicating a mixing effect with polluted low salinity water. This observation is also supported by the high Bacterial and coliform counts indicating the effect of domestic waste from the present sewage submerged outfall discharging its water to the harbour in this area.

Discussion and Conclusions:

Alexandria harbour Authority has been complaining lately from the increased growth of sea crustacians on the submerged parts of the guiding tugboats. This growth is a limiting factor for those boats to aquire the required speed as a result of increased friction between the submerged rough surfaces and the sea water leeding to more fuel consumtion/mile. This requires the frequent withdrawal of those tugboats from service and scrubbing their bottom metallic surfaces with sand blasting and similar techniques

Table (1-b) : Physical and chemical characteristics of marine water in Alexandria harbour

	Total Solids mg/1			Fixed Solids mg/1			Volatile Solids mg/1			Phosphates mg/1			Nitrates mg/1		
	Mean	St.d	Range X 1000	Mean	St.d	Range X 1000	Mean	St.d	Range X 1000	Mean	St.d	Range X 1000	Mean	St.d	Range X 1000
1	43916	1566	41.2-45.5	35354	1332	33.2-37.0	8558	1409	6.7-10.3	0.19	0.07	0.07-0.25	0.04	0.008	0.04-0.06
2	42446	3008	35.4-43.4	34732	2231	30.6-37.1	6530	1579	4.8-8.8	0.17	0.08	0.10-0.30	0.04	0.008	0.04-0.06
3	36255	3385	31.5-41.0	30771	2676	26.5-33.8	5484	1417	4.4-8.3	0.11	0.01	0.10-0.13	0.05	0.011	0.04-0.06
4	32758	115	37.6-40.7	31715	1543	29.8-34.4	7820	1572	6.0-9.7	0.48	0.05	0.4-0.52	0.07	0.011	0.06-0.08
5	42937	1581	40.2-44.8	35013	1032	33.2-36.2	7924	1170	6.8-9.8	0.1	0.01	0.09-0.11	0.05	0.016	0.04-0.08
6	45164	1030	43.9-46.9	36841	1318	35.4-39.2	836	685	7.7-9.3	0.08	0.02	0.05-0.10	0.04	0.0	_
7	47633	2140	44.9-50.7	37342	1809	35.1-40.3	10439	1307	8.1-11.8	0.09	0.02	0.05-0.10	0.05	0.0	0.04-0.06
8	44071	1173	42.4-45.1	36780	2052	34.8-40.7	7291	1811	4.9-9.1	0.08	0.02	0.05-0.10	0.04	0.0	_
9	42357	3427	35.9-45.9	35362	2251	31.4-37.7	6993	1817	4.5-8.9	0.09	0.02	0.05-0.10	0.43	0.008	0.04-0.06
10	44730	2684	41.0-48.1	35668	1744	33.9-38.8	9061	1932	7.0-12.0	0.09	0.01	0.08-0.10	0.05	0.01	0.04-0.06
11	46698	4617	49.7-50.7	37547	2180	33.9-39.8	7450	2850	5.5-11.9	0.09	0.03	0.05-0.12	0.05	0.01	0.04-0.06
12	45417	1518	43.9-48.2	35182	2321	32.9-39.4	9900	1357	8.1-11.9	0.12	0.03	0.08-0.16	0.04	0.008	0.04-0.06
13	45070	3099	41.6-48.9	37722	3267	35.5-40.6	7430	715	7.4-8.5	0.09	0.02	0.05-0.10	0.04	0.008	0.04-0.06
14	46957	3275	41.3-50.2	36041	1826	33.7-38.3	10916	1999	7.0-11.9	0.09	0.04	0.05-0.11	0.04	0.008	0.04-0.06
15	31417	5760	26.6-42.3	25430	4508	22.8-32.9	5987	1940	4.2-9.3	0.33	0.13	0.15-0.50	0.08	0.023	0.04-0.06
16	29037	7295	14.9-34.8	23631	6198	11.8-28.8	5406	1190	3.1-8.4	0.43	0.08	0.3-0.5	0.07	0.028	0.06-0.12
17	43102	1716	40.9-44.3	35716	1803	33.6-38.6	7386	1640	5.7-9.3	0.08	0.03	0.05-0.12	0.05	0.025	0.04-0.12
18	43442	1664	40.7-45.3	35478	1729	33.3-37.5	7974	2280	5.0-10.4	0.08	0.02	0.05-0.10	0.05	0.016	0.04-0.08

Table (1-c) : Bacterial Counts in marine water at different Station in Alexandria harbour

	Bacterial Plate / ml		Coliform / 100 ml		E.C. Count / 100 ml		N03 P04	Salinity gm / 1000
	Mean	Range	Mean	Range	Mean	Range		
1	98.0	36-120	5.3	36-21	4.7	0-21	0.2	40.6
2	40.0	30-50	16.7	3.6-93	1.5	0-9.1	0.3	37.9
3	2.3X10	1.2X10-6X10	7.4X10	0-2.4X10	4.5X10	0-2.4X10	0.5	41.9
4	1.1X10	3.7X10-1.75X10	7.07X10	2.4X10-1.1X10	5.3X10	1.1X10-1.1X10	0.2	39.7
5	60.0	32-1X10	6.1	0-15	1.8	0-7.3	0.5	43.1
6	73.0	30-1.1X10	0.0	0.0	0.0	0.0	0.5	47.1
7	152.0	40-2.4X10	1.2	0-3.6	0.0	0.0	0.6	46.1
8	270.0	40-3.0X10	6.3	0-23	0.6	0-3.6	0.5	43.5
9	197.0	70-3.2X10	92.2	0-4.6X10	45.9	0-2.4X10	0.5	42.5
10	95.0	54-1.28X10	50.0	0-2.4X10	46.5	0-2.4X10	0.6	45.5
11	72.0	46-1.1X10	7.8	0-14	3.0	0-7.5	0.6	42.3
12	2.75X10	65-3.5X10	5.11X10	0-2.4X10	1.6X10	0-9.3X10	0.4	43.5
13	1.66X10	30-6X10	3.06X10	0-1.1X10	41.6	0-1.5X10	0.5	42.6
14	75.0	50-1.1X10	7.2	0-21	1.2	0-3.6	0.5	44.3
15	1.75X10	1.45X10-4.6X10	2X10	1.6X10-4.6X10	5.5X10	2.3X10-1.1X10	0.2	31.5
16	3.8X10	3.3X10-8X10	2.9X10	0-23	9.95X10	1.5X10-2.1X10	0.2	32.5
17	63.0	30-49	12.7	0-1100	1.8	0-3.6	0.6	43.4
18	83.0	30-1.9X10	11.5		6.5	0-15	0.6	42.6

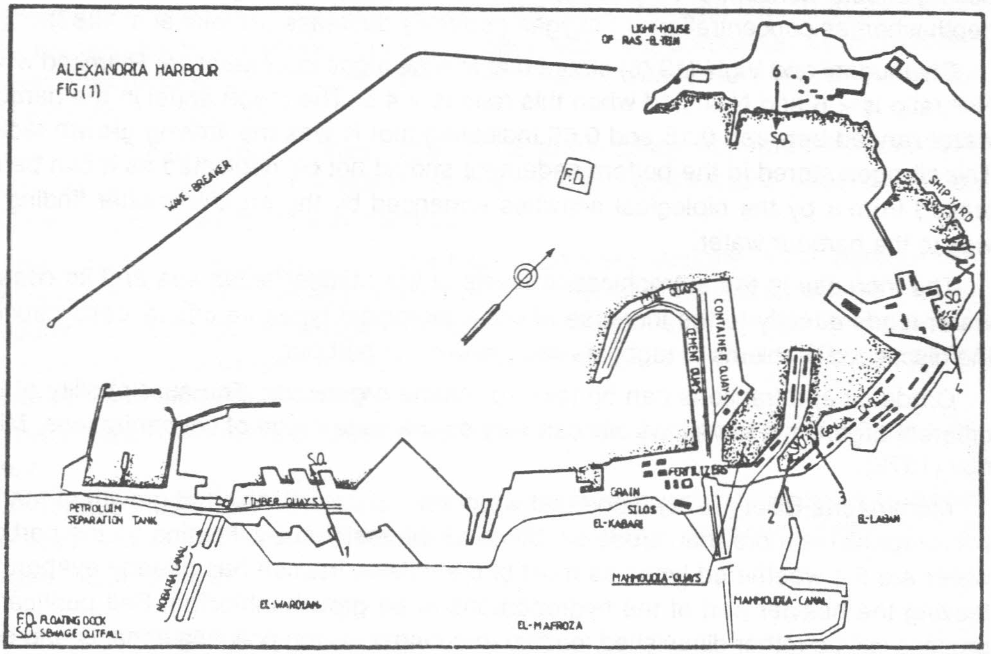

Fig. (1)
Alexandria Harbour

of removing this hard bound scales. The number of out of service boats increased from 26 in 1985 to 89 during 1989.

In certian cases removal of the metallic surface and fixation of new ones is mandatory as crustacians build up result in severe pitting of the metal submerged surfaces and can not be rehabilitated for further use. This also mean an extra loss of income to the harbour authority by lowering the number of service boats.

The effect of pollutional sources on the nutrient chemistry was discussed by Nessim and Tadros (1986). They also indicated that the high phosphorous and organic matter levels in the harbour particularly at El-Mahmoudia area should be considered as indices of sewage pollution. They also indicated that phosphoruos when precipitated was adsorbed and trapped on the bottom sediment. Phosphorous levels increased in the harbour as shown in table (1-b) as compared to Nessim and Tadros data in 1986.

The settling of organic matter and its biodegradation in deeper water produce opposing effects: concentration of metals such as Cu, Cd, and Ni generally increase with depth whereas concentrations of oxygen generally decrease (Brooks et al 1987).

Chianudani and Vighi (1978) stated that marine algae in general are P-limited when N/P ratio is < 6 and N limited when this ratio is < 4.5. The mean anual in the harbour water ranged between 0.15 and 0.65 indicating that N was the limiting growth factor. The nitrogen stored in the bottom sedement should not be neglected as it can be released from it by the biological activities enhanced by the organic matter finding its way to the harbour water.

The increase in the eutrophication levels of the Mediterranian sea and its coastel water leads directly to the increase of other biological types as crustaceans causing the discussed problems of tugboats stationed in the harbour.

Crude oil and fractions can be toxic to marine organisms. The susciptibility of the different organisms to various oils can vary over a wide range of concentrations, Mironov (1972).

Mommaerts-Billet (1973) found that weathered crude oil inhibited growth of marine microorganisms more than crude oil. Since all the residual oils floating on the harbour water are the weathered types as most of the volatile fraction has already evaporated leaving the heavier part of the hydrocarbons to be growth inhibiting. Self purification process will be rather diminished leading to a longer lasting polluting impacts and ecological disturbances in the harbour water for a longer time from the sewage and industrial wastes discharged to the harbour.

This is indicated by the higher BOD and volatile solids in the polluted inner harbour stations.

Certain materials may be preferencially partitioned or extracted into oil or from oil because of solubility properties.

This has been reported for pesticides and more recently, for mercury where concentrations of mercury in benzene extractable materials were 4000 and 300000 times those detected in sediments and water respectively, Seba and Corcoran, (1969) and Walker & Colwell (1974). The water soluble components of petroleum may interfere with chemotaxis of marine bacteria, thereby affecting predator-prey relationships among microoganisms in the marine environment, Boylan and Tripp (1971), Mitchell **et al** (1972), Young and Mitchell (1973).

Effects of petroleum on microorganisms in the marine environment may also be complicated by the use of emulsifiers or dispersants, Boney (1970), indicated that cleaning the oil polluted stations must be caried by mechanical means.

This means a longer needed time for the heavily poluted stations in the inner sector of the harbour to self clean it self specially with the continous rate of pollutants addition.

Bacterial die away is clear in the harbour's different stations. Those stations very close to the sewage outfalls have persistently showed a larger number of total bacterial counts, total coliform and E-coli counts while the outer and middle stations recorded lower numbers due to the direction of currents specially at the surface layer.

Aubert et al (1975) determined the main bacterial groups responsible for producing antagonistic substances to Escherichia coli in the Mediterranean sea. They found that those bacteria belong to several genera, in particular **Pseudomonas, Achromobacter, Flavobacterium, Chromobacterium,** and **Vibrio,** which make up the bulk of the marine bacterial population.

The studies carried out on these species led to the conclusion that they are widely distributed geographically, but likly to be limited to the well-areated water of the euphotic level since they are strictly aerobes.

This lead to the conclusion that the heavily polluted stations in the harbour with high, coliform and E-coli bacterial counts will not suffer from rapid die away as they accompany the discharge of sewage ladened with organic matter quickly biodegradable with lowering of the oxygen tension in those stations. This in turn will supress the growth of the antagonistic bacteria.

This situation will rednder those sites hazardous to the divers of the harbour Authority.

Anaerobic conditions will support the generation of corrosive gases as hydrogen sulphides and ammonia which solutions in marine water enhances pitting of submerged metal surfaces.

Recommendations

Sewage outfalls shoud be diverted to the sewerage system. Ships whould be fined severelly for disposing their domestic water, engine cooling water or garbage in the harbour water while docking. Facility areas for sewage treatment and oil seperation can help docking ships to discharge their wastewater in an environmentally sound system with the least impact on the marine environment of the harbour.

Proper handling of solid wastes generated by the serviced ships and their proper final disposal in the city dump can stop those wastes from being dumped in the harbour.

Those services can be supervised by the harbour authority for levied fees to be utilized in upgrading harbour services and pollution control measures.

Military naval ships should observe strict measures controlling their discharge of oil contaminated water.

Ship yards and workshops should manage to privent lubricants spillage as well as solid wastes from reaching the harbour water.

Mechanization of the cargo handling using continuous belts and closed conduits will reduce drastically the losses of imported and exported cargoes, and will reduce tremendously the marine water pollution in the general cargo area.

Condemned food supplies should not be disposed to the sea as they will be a good source of polluting organic load with the subsequent marine water deterioration.

The harbour heavily oil polluted areas Fig. (2) where water stagnation will help mixing the oil with garbage, wood and debris should be cleared out using floating boam system to be further disposed of in the sanitary landfill of the metropolitan area.

Emulsification of oils with chemical imulsifiers should be avoided as it will finally settle to the bottom causing future deterioration of the benthic environment.

Spills of hazardous chemicals should be contained properly and not washed to the harbour water in order not to disturb the self cleaning activities of the marine water by inhibition of biological life in the contaminated water area.

Hazardous cargoes international handling regulations should be strictly adhered to, in order to limit their spill and dangerous health and environmental impacts on the harbour and its task working force.

The harbour authority should strengthen the patroling marine service in order to control properly the discharge of pollutants to the harbour. Meanwhile utilites for handling liquid and solid wastes should be promptly acquired and utilized to help the serviced ships to dispose their waste with minimal impacts on the receiving harbour environment.

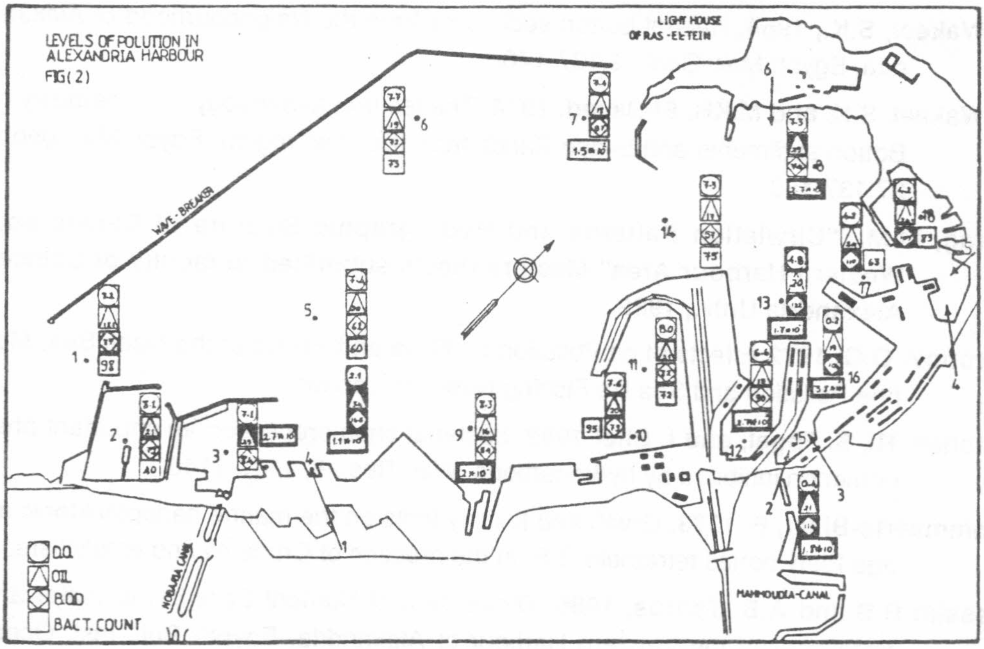

Fig. (2)

Levels of polution in Alexandria harbour

References

Aubert, M.A., D. pesando and M.J. Gauthelr (1975) "Effects of Antibiosis in a Environment". Paper no. 20, supplement to progres in water technology, discharge of sewage from sewage outfalls, pergamon press, oxford, New York.

Brooks, N.N., R.G. Aronld and R.C.Y. Koh. 1987, "A Research plan for deep-Ocean disposal of Sewage Sludge off Orange, Country, Colfrina". Oceanic Processes in Marine Pollution Volume 2, chapter 10. pp. 100-107.

Boney, A.D. toxicity studies with an oil-spill emulsifier and the green alga prasinocladus marinus. J. mar. biol. Ass. U.K., 1970, 50, 461-4730.

Boylan, D.B., and B.W. tripp 1971, determination of hydrocarbons in sea-water extracts of crude oil and cryde oil fractions. Nature, lond., 230. 44-47.

Chet, 1., fogel, S., and R. Michell 1971, Chemical detection of microbial pery bacterial predators. J. bact., 106, 863-867.

El-Awady, M.M., 1972. thepfysical and chemical Properties of Alexandria harbour Waters relevant to Fouling paints. M.Sc. thesis, cairo Univ.

El-Wakeel, S.K., 1964. Recent botton sediments from the Neighbourhood of Alexandria, Egypt. Mar. Geol., 2:137-146.

El-Wakeel, S.K. and M.KH. El-Sayed, 1974. The texture, mineralogy and chemistry of Botton sediments and beach Sands from the alex. region, Egypt. Mar. geol., 27:137-160.

Farag, M.M., "Cirwlation Patterns and Hydrographic Struture of El-Mex and Western Harbour Area" Masters thesis submilted to faculty of Scince, Alexandria Univ., 1982.

Mironov. O.G. 1972 Effects of oil Pollution on Flora and Fauna of the black Sea, Marine Pollution and Sea life Fishing New Ltd. London.

Mitchell, R., S. Fogel, and I. Chet 1982, bacterial chemoreception an important phenomenon inhibited by hydrocarbons. Wat. Res., 6, 1137-1140.

Mommaerts-Billet, F. 1973, Grwth and toxicity tests on the marine nanoplanktonic alage Platymonas tetrathele G.S. in the presece of Crude oil and emulsifiers.

Nessim R.B and A.B. Tadros, 1986 "Distribution of Nutrient Salts in the Water and Porewater of the Western Harbour of Alexandria, Egypt". Bull. Inst. Oceanogn & Fish. ARE., 12, 165-174.

Rifaat, A.S.M., 1982. bottom Sediments of the western harbour of Alexandria and its Neighbour. M.Sc. thesis, Alex, Univ., 115 p.

Standards Methods of Water and Wastewater Analysis, Published by Awwa, WPCF, 1985.

Seba, D.B., and E.F. Corcoran, 1969 surface slicks as concentrators of pesticides in the marine environment. Pestic. Monit. J., 3, 190-193.

Steuer, A., 1939 "Notes and Memoires", Alex. Inst. Hydrobiol. Fish., N. 33 (1).

Walker, J.D., and R.R. Colwell, 1974, Mercury-resistant bacteria and petroleum degradation. APPL. Microbiol., 27, 285-287.

Young, L.Y., and R. Michell, 1973, Negative chemotaxis of marine bacteria to toxic chemicals. APPL. Microbiol., 25, 972-975.