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Pollution Monitoring Program and the Treatment of the Wastewater Producing From Petrochemical Industries

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ABSTRACT:

The main purpose of this study is the contribution in the protection of the environment, and gives the opportunity to the factories to be environmental friendly industries.

The general outlines of this study are: 1) Preparing a monitoring program for petrochemical industries, 2) Making auditing study 3) Making sampling campaigns 4) Proposing some in-plant control concepts or pretreatment processes.

Auditing study or in depth investigation has been performed by using standard forms for data collection and in cooperation with the engineers and chemists working in the factory. Several points have been examined as the water uses in the various processes, the raw materials, the effluent analysis, the major pollution sources, the industrial processes, and the wastewater management.

The results of this study include in particular :1) A description of the sites, 2) Sketches showing the industrial processes and, 3) Proposal of internal measures for pollution reduction and the required pretreatment plant.

I- MONITORING PROGRAM

The objective of the industrial wastewater monitoring program is to monitor in an effective manner the industrial pollution producing from the industries. This monitoring program contains:

- The study of the actual site conditions at the factory to propose the least convenient sampling points.
- The study of the parameters to be analyzed according to the activity.
- The frequency and the duration of the sampling campaign, depending on the probable pollution loads.

  The results presented in this program could be used as a model for the other plants.

Some problems have appeared during the monitoring program as: 1) the amount of the water consumption of the different processes, 2) the products used in the fabrication and 3) the absence of general process diagrams and the layout including their sewage networks.

The results are presented in standard form, including : 1) A brief general description, 2) Activity, 3) The water balance, 4) The description of the wastewater management, 5) The recommendations proposed for the monitoring program.

General manager for Central Lab
General Organization for Sanitary Drainage

I-1 Monitoring Results

I-1.1 Production

This factory produces, processing, operating, treatment, export and import the petrochemical substances.

I-1.2 Activity and Water Utilization

The production processes and water utilization in the factory are:

I-1.2.1 Mono-vinyl chloride production unit (VCM)

Figure no. (1) shows the steps of the VCM production.

I-1.2.2 Poly vinyl chloride production unit (PVC)

It includes:

- Polymerization.
- Pasting production (with steam).
- Drying by central centrifugation.
- Recovery of the free VCM and return back to the condensers.

Figure no. (2) shows the industrial process for the PVC production.

I-1.2.3 Electrical production unit

It produces almost 105 Mega Watt / Hour.

I-1.2.4 Chlorine and sodium hydroxide production unit

It produces the chlorine gas (necessary for VCM production) from the sodium chloride through ion exchange membrane.

Fig. no. (3) shows the industrial processes for chlorine production.

I-1.2.5 Treatment unit

The raw water which is taken from Noubaria canal is treated before using in the processes as follow:

1) disinfection, 2) sedimentation with alum, 3) sand filtration, 4) reverse osmosis and ion exchange.

This treated water is used in boiler, air production, and in PVC unit.

I-1.3 Water Balance

There are 2 sources for water consumption in the factory as shown in the following figure.

Source supply	Mean daily consumption (m^3/day)	Uses
- Public network	6000 – 7000	Used in dilution
- Noubaria canal	1250	Used in industrial processes after the treatment

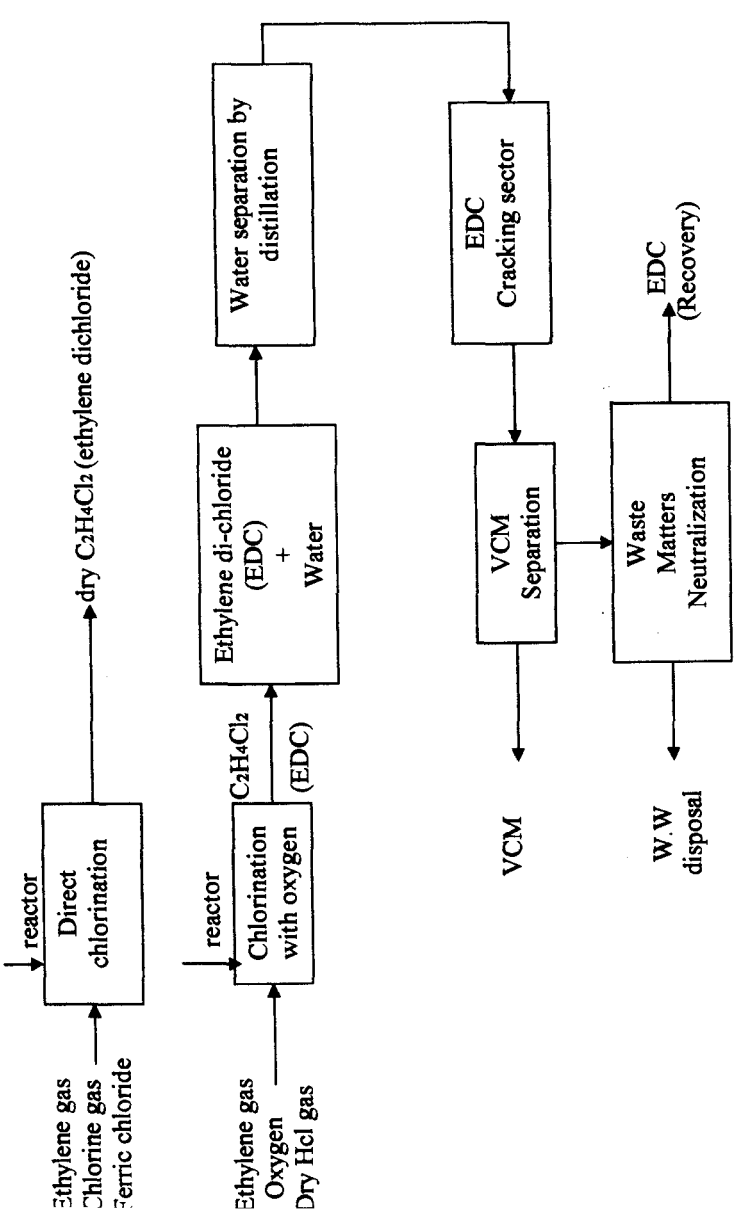

FIG. (1): Industrial processes for vinyl chloride monomer (VCM) production

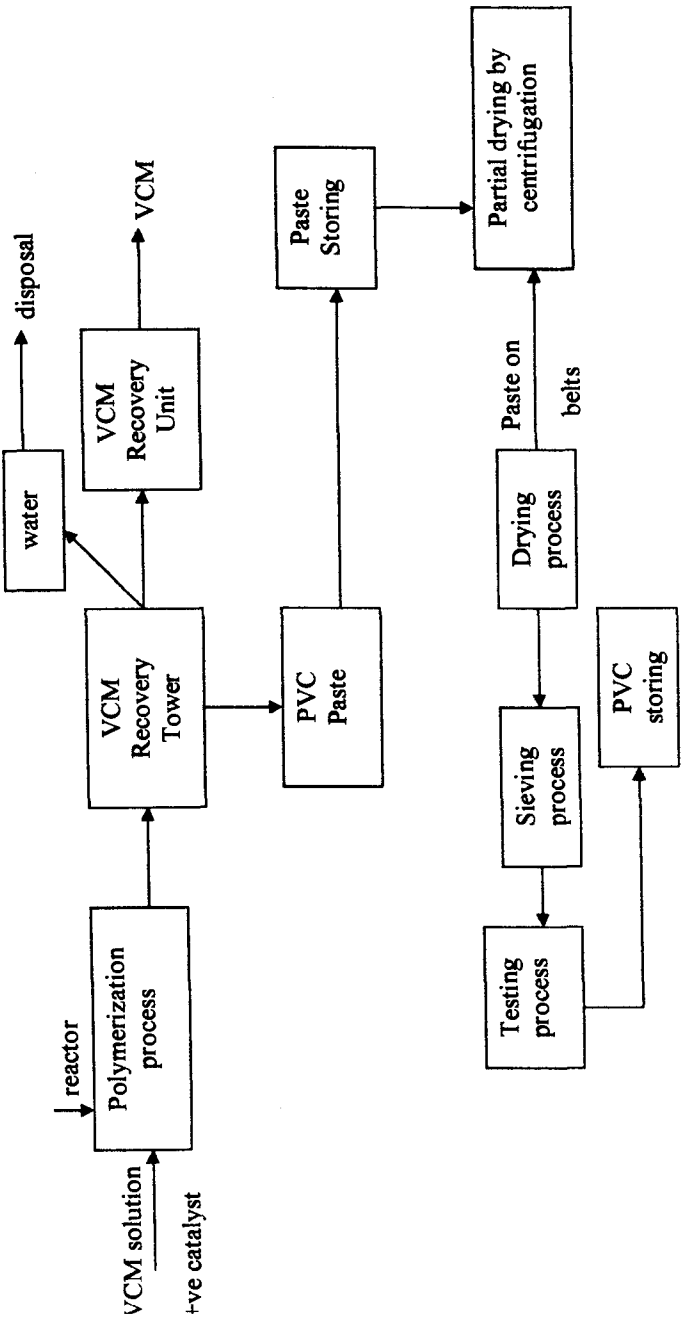

Fig. (2): Industrial processes for poly vinyl chloride (PVC) production

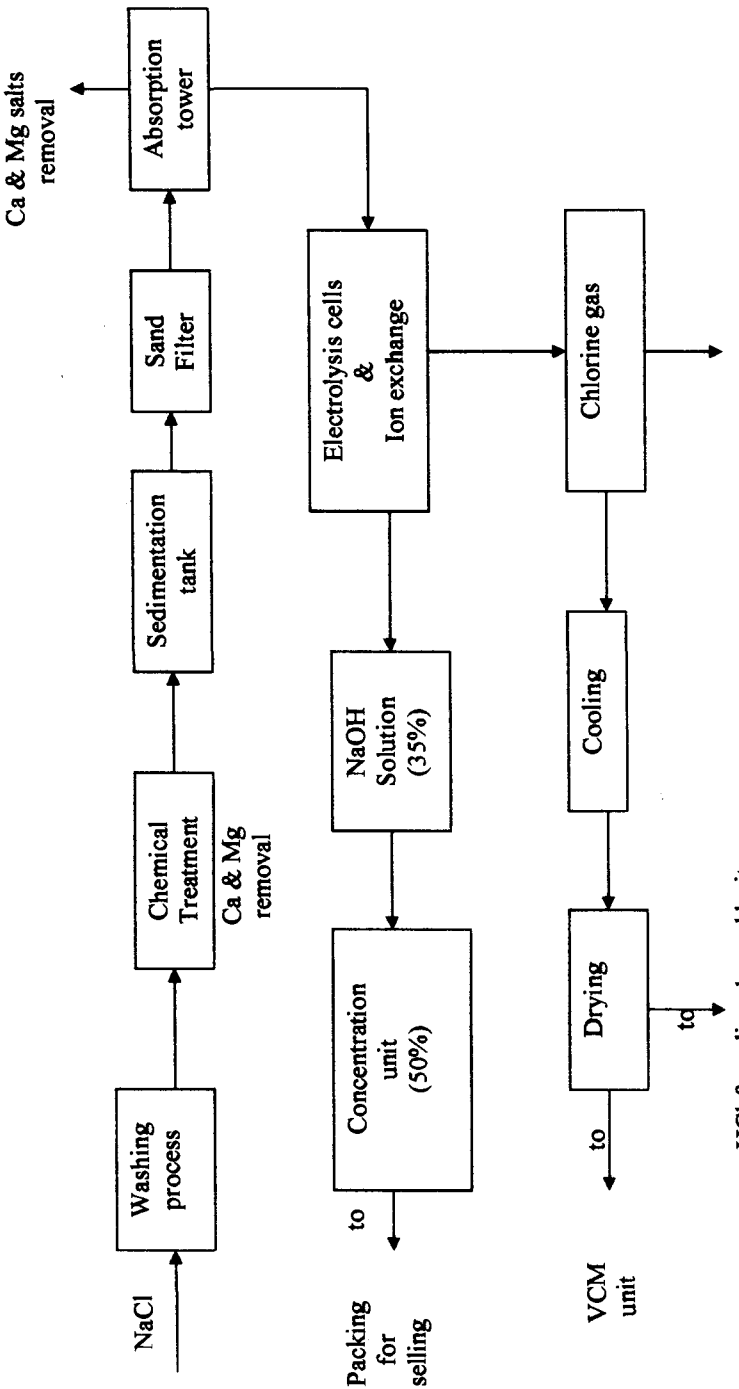

Fig. (3): Industrial processes for the chlorine and caustic soda production

I-1.4 Wastewater Network

This company is served by two collection networks, one for domestic wastewater which is discharged into some caissons inside the factory and the other for disposal of the industrial wastewater to EL - Tahrir drain.

I-1.5 Wastewater Management

- The factory is equipped with clean water pretreatment processes to be suitable for the industrial processes where the suspended and dissolved solids are removed.
- But the factory is not equipped with any industrial wastewater pretreatment processes.
- Domestic sewage is discharged into caissons inside the factory.
- Industrial wastewater is discharged through sewerage system to EL – Tahrir drain.
- Both wastes must be complying with law of the disposal on the water bodies.

I-1.6 Hazardous Products

The raw material and chemicals are stored in a protected closed room.

I-1.7 Parameters

The parameters which should be measured in the wastewater of this factory are : daily volume (m^3/day), hourly peak flow rate (m^3/hour), and the parameters of the analysis (mg/l) as : biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solid (S.S), grease and oil, total phosphorous, nitrogen, sulphides, pH and temperature.

I-2 Monitoring Recommendation

I-2.1 Site Conditions

- The assessment of industrial wastewater volumes could be done regularly by fixing inlet flow meter.
- Sampling could be easy to organize.
- Sampling collection is possible within and outside the factory.
- Industrial wastewater is discharged into internal sewerage system and collects into a collection sump then discharge to EL – Tahrir drain.

I-2.2 Sampling Recommendation

- Industrial wastewater results from successive various processes induces important changes of the flows and the pollution loads during a day.
- The recommended type of sample is one average daily composite sample, proportionally to the flow over 8 hours.

- The regular production rhythm of this factory enable however to carry out the measuring campaign at any time in the year.

- The most suitable period cannot be determined in advance because production peaks are not regular across the year.

I-2.3 General Comments

- Few wastewater analysis has been done in this factory.
- There is available space in the factory to install an industrial wastewater pretreatment plant.

II- IN DEPTH INVESTIGATION

II-1 General Information

The general information includes the firm name, address, phone number and the name and the title of the respondent.

II-2 Production Information

II-2.1 Activity

Production of vinyl chloride monomer, poly vinyl chloride, chlorine gas and sodium hydroxide.

II-2.2 Raw Materials

Tables no. (1) (2) represents the chemicals which are used in the production processes.

II-2.3 Final Products

a- adhesive strips, pipes, plastic bottles, sports shoes, electrical cables & windows and doors.
b- chlorine (liquid).
c- caustic soda.
d- sodium hypochlorite.
e- cross linkable polyethylene.

II-2.4 Storage Condition of Hazardous Materials

Chemicals are stored in a storage room.

II-3 Plant Operational Characteristics

The processes are not subjected to seasonal variation, but according to the requirement of the market so, the peak production time is variable.

There are 3200 employees in the company where they are working all the day through 3 shifts and 7 days / week.

Department	Chemical Name	Department	Chemical Name
- Intake	Chlorine	- Air unit	Activated Carbon Activated Alumina
- Clarifier	Sodium Hypochlorite Alum Liquid + powder Cationic fluculant		Molecular Sieves Hopkalite.
		- Chilled unit	Nitrite Borate
- Cooling Towers	Sulphuric acid Different types of Nalco.	- Nitrogen unit	Molecular Sieves
- Reverse Osmosis	Sand and Gravel Anthracite Sod.Mexa meta phosphate Sodium Tripoly phosphate Sodium Meta Bisulphite. EDTA. Formaldehyde. Citric Acid. Enzyme cleaner.	- Maintenance for Heat exchangers.	Sulphamic Acid Thio Urea Sodium Dichromate
- Demi – units	Strong Acid Cation Exchange (Resin). Strong Base Anion Exchange (Resin). Activated Carbon. Hydrochloric Acid 30%. Sodium Hydroxide 50%.		
- Boilers	Trisodium phosphate. Sodium Sulphite Analysis. Liquid Ammonia. Hydrazine Hydrate.		

Table (1) Different chemicals which are used in the different departments.

Production Unit	Chemical Name
VCM Production Unit	Ammonia Tri-sodium phosphate (29%) D.C. Catalyst O.C. Catalyst Molecular Sieves Sodium Sulphite Blast furnace coke
PVC Production Unit	Sulpamic acid Paro Nonyl Phenol Iso octane Alcotex Methocel Methanol Nitric Oxide (cylinder) Rodine Sodium Dodecyl Benzene
Chlorine Production Unit	Sodium Carbonate Barium Chloride Sodium Sulphite Sugar Sulphuric Acid (98.5 %) Molten Salt Chelat Resin Anthracit Activated Carbon

Table (2) Chemicals which are used in the different production units

II-3.1 Water Recycling

There is no water recycling in the factory, but there are several processes for matters and compounds recovery.

II-3.2 Water Sources, Consumption, and Uses

The sources of the used water are:

- 6000 – 7000 m^3 / day are taken from the municipal network used in dilution processes.
- 1250 m^3 / hour are taken from Noubaria Canal used in the industrial processes after the treatment as follow:
  70% for utility unit
  10% for PVC production unit.
  10% for VCM production unit.
  5% for power unit.
  5% for chlorine and caustic soda production unit.

II-3.3 The Future Expansion

There are planning for new projects in the factory.

II-3.4 Description of Wastewater Treatment

There is no pretreatment unit in the factory for treating the wastewater. But there is a large treatment plant for treating the fresh water coming from Noubaria Canal before using in the industrial processes. The treatment plant consists of:

1- Chlorination process (for disinfection).
2- Sedimentation with alum (used in power plant).
3- Sand filtration (used in reversing osmosis unit).
4- Desatination unit:
   a- Osmotic pressure unit (removes 90% of T.D.S.).
   b- Ion exchange.
5- Cooling unit (to the PVC production unit).

The desalinated water is used in the boiler and the other industrial processes.
Figure no. (4) represents the treatment processes for the fresh water.

II-5 Sewerage System

- There are two outlets in the factory:

One for the disposal of the sanitary wastewater which is discharged into some caissons to the underground water.

The other one for the disposal of the industrial wastewater which is discharged to the EL – Tahrir drain.

III- WASTEWATER CHARACTERISTICS:

Three samples were taken from the wastewater of the following disposal points:

- Utility unit.
- Power unit.
- Chlorine and caustic soda production unit.
- VCM production unit.

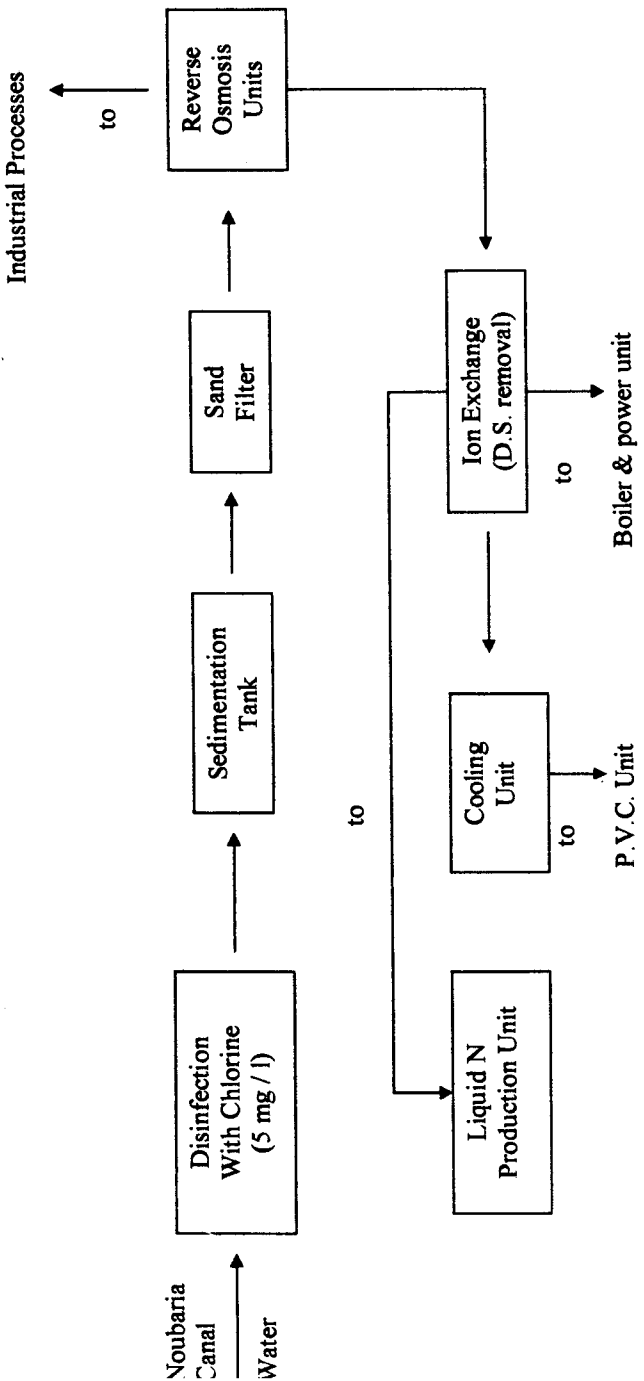

Fig. (4): Noubaria Canal Water Treatment Plant

- PVC production unit.
- Final industrial wastewater of the factory.

III-1 Characteristics of the Wastewater of the Utility Unit

This unit is treating the canal water before using in the industrial processes. Three samples were taken from the producing wastewater of this unit where, the third sample is not complying with the limits of the law no. 48 for 1982 for the disposal on the water bodies (drains) in S.S. and C.O.D.

Table no. (3) represents the characteristics of this wastewater.

III-2 Characteristics of the Wastewater of the VCM Unit

- This unit is producing VCM which is used in the polymerization process to produce PVC.
- Three samples were taken from the final wastewater of this unit where all of them are complying with the mentioned law.
- The presence of free VCM was not performed.

Table no. (4) represents the characteristics of this wastewater.

III-3 Characteristics of the Wastewater of the PVC Unit

- In this unit the VCM is polymerized to PVC.
- The samples are not complying with the limits of the mentioned law in BOD & COD & SS & pH and the total phosphorous.

Table no. (5) represents the characteristics of this wastewater.

III-4 Characteristics of the Wastewater of the Chlorine & Caustic Soda Unit

- In this unit the liquid chlorine and caustic soda are produced (from NaCl) where they are used in the production of VCM & PVC.
- The samples which were taken from the wastewater of this unit were not complying with the mentioned law in pH & D.S &S.S & BOD and sulfides.

Table no. (6) represents the characteristics of this wastewater.

III-5 Characteristics of the Wastewater of the Power Unit

The results of the samples which were taken from this wastewater were complying with the limits of the mentioned law except in sulfides.

Table no. (7) represents the characteristics of this wastewater.

III-6 Characteristics of the Final Wastewater

The results of the analysis of the samples which were taken from the final wastewater were not complying with the limits of the law no. 48 for 1982 for the disposal on the drains in D.S, S.S, BOD, COD, pH, sulfides.

Table no. (8) represents the characteristics of the final wastewater.

III-7 Comments on the Results

1- The specifications of the wastewater producing from the utility and the power units are complying with the limits of the law.

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 48 for 1982
Temperature °C	27	25	27	35
pH	7	6.8	6.9	6 – 9
T.D.S	532	418	433	2000
S.S.	17	46	87	60
C.O.D.	20	56	110	100
B.O.D.	12	20	48	60
G. & O.	Nil	Nil	Nil	10
Sulphide	1.2	2.8	0.4	1
T.N	0.09	1.88	4.48	30
T.P	1.06	1.02	0.73	1

Table (3) Characteristics of the wastewater produced from the utility unit

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 48 for 1982
Temperature °C	27	25	27	35
pH	8.2	7.8	9.9	6 – 9
T.D.S	203	325	995	2000
S.S.	40	79	195	60
C.O.D.	70	141	500	100
B.O.D.	25	36	150	60
G. & O.	Nil	Nil	3	10
Sulphide	2.8	1.6	13.2	1
T.N	1.4	1.19	1.44	30
T.P	1.43	1.14	0.48	1

Table (4) Characteristics of the wastewater produced from the VCM production unit

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 48 for 1982
Temperature °C	27	25	27	35
pH	10.8	10.5	7.5	6 – 9
T.D.S	1328	1418	6.9	2000
S.S.	115	141	220	60
C.O.D.	295	295	228	100
B.O.D.	95	72	60	60
G. & O.	Nil	2	3	10
Sulphide	18.4	16.8	2	1
T.N	0.56	5.48	1.16	30
T.P	5.72	1.34	1.11	1

Table (5) Characteristics of the wastewater produced from the PVC unit

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 48 for 1982
Temperature °C	27	25	27	35
pH	12.1	10.9	11.1	6 – 9
T.D.S	981	52388	2995	2000
S.S.	723	467	219	60
C.O.D.	840	2250	262	100
B.O.D.	160	280	80	60
G. & O.	Nil	Nil	Nil	10
Sulphide	13.2	15.2	13.6	1
T.N	3.08	6.15	5.81	30
T.P	3.98	1.34	1.66	1

Table (6) Characteristics of the wastewater produced from the chlorine unit

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 48 for 1982
Temperature °C	27	25	27	35
pH	7.7	7.6	8	6 – 9
T.D.S	521	486	539	2000
S.S.	29	14	55	60
C.O.D.	32	25	62	100
B.O.D.	16	12	21	60
G. & O.	Nil	Nil	Nil	10
Sulphide	1.2	2.4	2	1
T.N	0.56	2.86	5.56	30
T.P	1.7	0.49	0.94	1

Table (7) Characteristics of the wastewater produced from the power plant

Parameters In (mg / l)	1st sample	2nd sample	3rd sample	Limits of the law No. 93 for 1962	Limits of the law No. 48 for 1982
Temperature °C	28	25	27	43	35
pH	10.1	10.7	10.2	6 – 9.5	6 – 9
T.D.S	280	8363	1211	—	2000
S.S.	235	245	342	800	60
C.O.D.	275	287	375	1100	100
B.O.D.	90	70	110	600	60
G. & O.	4	4	5	100	10
Sulphide	12	16.4	12.2	10	1
T.N	0.29	2.39	0.78	100	30
T.P	0.46	0.78	0.22	25	1

Table (8) Characteristics of the final wastewater produced from the factory

2- The specifications of the wastewater producing from the VCM & PVC & chlorine and caustic soda units are higher than the limits in the law.
3- The specifications of the final wastewater of the factory are not lying within the limits of the law.

III-8 Conclusion

The pollutants producing from the wastewater of the PVC & chlorine & caustic soda units are the reason of why the final wastewater does not comply with the limits of the law.

III-9 The Pretreatment Facilities

There are no any pretreatment units in the factory for the treatment of the domestic or industrial wastewater. So the following facilities were proposed to reduce the pollutional parameters to the law no. 48 for 1982 for the disposal on the underground water or drains.

III-9.1 Treatment of the Industrial Wastewater

III-9.1.1 Changing the final disposal point to the net work after the adjustment of the pH value in the final wastewater by adding 0.6 ml of the commercial sulphuric acid for each liter of the wastewater to reduce the pH from 10.1 to 7.1 consequently the value of the sulfides were reduced from 12 to 8 mg / l and hence the final wastewater reduced to the limits of the law no. 93 for 1962 for the disposal on the sewerage system.

III-9.1.2 The Proposed Pretreatment Plant

The suitable methods that could be used for the pretreatment of the wastewater of this factory are:

1- Flow Equalization Process
2- Neutralization to reduce pH & sulfides.
3- Primary sedimentation tank to reduce the suspended solids.
4- Biological secondary treatment to reduce the organic load (BOD & COD).
5- Final sedimentation tank.

The first alternative is cheaper and simpler than the second one if the capacity of the sewerage system of the region is suitable for these extra wastes.

III-9.2 Treatment of the Domestic Wastewater

There are three alternatives for the treatment of these wastes:

III-9.2.1 Changing the final disposal point of the domestic wastewater from the underground water through the present caissons to septic tanks.

III-9.2.2 Or changing the final disposal point to the sewerage system if its capacity is allowed.

III-9.2.3 Connecting the domestic wastewater on the industrial wastewater sewerage system in the factory. The produced wastewater is treated in the treatment plant proposed in III-9.1.2 before the disposal to the drain.

The last alternative is the most expensive one but it has to be used if the other alternatives are not available.