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PHARMACEUTICALS AND DRUGS INDUSTRIAL WASTE TREATMENT IN IRAN

SI/IRA/88/801

ISLAMIC REPUBLIC OF IRAN

Technical Report: Pharmaceutical Industrial Waste Treatment*

Prepared for the Government of the Islamic Republic of Iran
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. B.C. Gautam
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United Nations Industrial Development Organization
Vienna

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INTRODUCTION

This report is based on a four week stay in Tehran, Iran under UNIDO Assignment ref SI/IRA/88/802/11-51. The purpose of the project was to advise the Ministry of Health through Darou Pakhsh Co. on the ways of treatment in the existing pharmaceutical plant and to evaluate the solutions for the multipurpose chemical pharmaceutical plant actually under the construction.

I was expected to carry out the following jobs :

1. To visit the actual pharmaceutical production area as well as the area where the multipurpose plant is under construction.

2. On site study of the existing effluent treatment plant as well as the design and conceptions for treatment in the multipurpose plant.

3. To know the future production programme of the plant, the possible combinations of products and make recommendations about their treatment.

4. To advise in the preparations of workers for the running of the treatment system.

I have collected the information from the site visits to the pharmaceutical plant, multi purpose chemical pharmaceutical plant through discussions with those who are responsible for the management of the above two plants, and from study of drawings and various report available at sites and in the office of Darou Pakhsh Co. in the Tehran and as well as published documents in the field of latest advances for industrial waste treatment.

The conclusions are discussed in chapters I, II and III and the recommendations have been given in each chapter. All the recommendations have also been listed under summary and recommendations.

SUMMARY AND RECOMMENDATIONS

These recommendations have been discussed in individual chapters, and are listed herewith in order to put all of them together.

1. General recommendation

It is recommended that the solution for the treatment of industrial waste from pharmaceutical chemical multi purpose plant as proposed by contractor M/S Cheokomplex may be as such installed and commissioned to give a fair trial.

2. Incineration

2.1 During incineration of chemical waste, the vent gases may be completely analysed for completion of combustion and for presence of any toxic gases, if any. If the system is found deficient in these two respect it may have to be modified suitably as discussed in chapter no I

2.2 The recoveries of solvents and chemicals may be improved by improving technology. This may result in saving of raw materials and will also reduce the load on incinerator.

2.3 It is recommended that paper bags and polythene bags may not be incinerated and are collected to be disposed off to the outside parties to be used for hard board making or recycling respectively.

3. Evaporation

3.1 It is recommended that the vent gases may be analyzed for the presence of solvents; gases and their concentration may be monitored and recorded. If there is any odor that also may be evaluated.

If the concentrations and odor are beyond the limits, evaporation system may have to be re-examined.

3.2 Production programme may be planned in such a manner that the load on evaporation system is minimum during winter months.

3.3 If the system does not come upto the expectations, it is recommended as a first step to provide all the accessory equipment similar to vegytek plant i.e. arrangement for skimming oil primary settler, before the neutralization, secondary settler after neutralization followed by sand filtration unit.

4. Biological treatment

4.1 If insipite of providing equipments under first step the problem of affluent treatment is not solved, it is recommended to make use of biological treatment process after combining biological waste (munical waste) with industrial waste as proposed by consultant in lay out (enclosed for ready reference). The detailed designing and sizing of equipment will be done by consultant whenever it is desired.

4.2 For the existing production capacity only one series of equalization and surface aerated lagoon will be required. The second series may be installed as and when it is required. When the capacity of existing products is increased or more products are added up.

4.3 The treated mater may be further filtered, charcoaled and deionised. The deionised water may be used for steam generation, cooling the heat exchangers or may be used for flushing the bath rooms.

5. Dumping of solid wastes

5.1.1 It is recommended that the proposed dumping site near Mardabad may be suitably prepared by making bunds on all sides for exclusive dumping of non incinerable waste from multi purpose plant as a temporary measure.

5.2 It is recommended that another alternate dumping site may be identified on priority and may be suitably protected against seepage/leakage through rain water, to be used when the present site may have to be abandoned.

6. Organisation of laboratory for biological waste treatment plant. There is no provision to control the treatment process as no laboratory facilities are existing for analytical work.

It is therefore recommended that a process control laboratory may be established to cater the needs of biological treatment plant. It may also be helpful to control environmental pollution.

All the relevant details for its organisation are given in chapter II.

7. Industrial safety and protection of environment

It is recommended to organize a nucleus for maintaining industrial safety and prevention of pollution.

This section may prepare emergency handling plan firestanding order, safety manual, detailed safe practice procedures for handling each and every chemicals, designing and implementing permit systems, to organize safety and fires fighting training, to supervisions, workers and also the check to check the presence of contamination in the environment.

The same section may be able to organize first aid to all injured employees if any.

8. Municipal waste treatment for industrial areas of Tehran

8.1 It is recommended that where ever possible in industrial areas the system to collect municipal waste may be taken up. To which pretreated industrial waste may be mixed up. The mixed up waste may be treated in biological treatment plant. The treated effluent may be further used for land application method for further purification by using for landscape and wood land farming. By this method the recharging of water in the ground structure will take place.

8.2 It is also recommended to take steps to prepare chemical energy handling plans and to monitor the environment by state agencies.

CHAPTER I

Treatment of Industrial Waste in Pharmaceutical Chemical Multipurpose Plant

1. Introduction

I have held discussions with Dr. A. Zomorodian, Project Manager and his colleagues working for establishing pharmaceutical chemical multipurpose plant which is under ultimate supervision of M/S Darou Pakhsh Co. I have also visited the site several times to carry out on the spot study. In addition to this all the reports layout, other document have also been studied.

1.1 The following type of wastes are expected to be generated and are to be handled satisfactorily.

1. Industrial waste water from production unit (this includes all types of waste waters including from gas scrubbles and demineralisation unit).

2. Waste water from bathrooms toilets

3. Rain water

1.2 As per the original contract, the contractor was under obligation to prepare and submit a proposal for the treatment of industrial waste water. The treatment of waste water from toilet (municipal waste water) was not given any consideration as its volume could be ascertained only after the plant is started. It was assumed that the rain water, being irregular would either be absorbed in the ground where it falls or if it is in excess, through the open drains, it will be collected and let outside the factory.

In India also it is a practice that rain water is collected in open drains and is let out into surface drains under permission of State Pollution Control Board only during rainy season.

1.3 As the basic concept was that the total industrial waste water should be treated chemically or biologically the contractor made his proposal for the chemical and biological treatment of industrial waste water in the first edition of basic engineering. According to that this combined treatment facility was supposed to use an area equal to 100M X 50M = 500M2.

1.4 During the first discussion of the basic engineering in Tehran (20 to 23rd November, 1986) it was made clear to understand that chemical and biological treatment facility occupies a large area out of limited area available for main activity. There is no provision for disposing off the treated effluent to a natural water source. Therefore, the proposal of biological waste treatment did not find acceptance.

New proposal

2. Keeping in view the local site conditions of Darou Pakhsh Co., the contractor prepared another possible solution and submitted a new proposal for the flow diagram of industrial waste water and process waste stream. The drawings showed the average hourly and daily flow rates according to the planned annual production programme.

In the proposed solution the following aspects were considered.

- To put all efforts to reduce the absolute quantity of waste water.

- To reduce significantly the quantity of waste water containing toxic material.

- To conserve power and thus to reduce energy consumption.

The following points were also considered.

- To keep the waste water and waste materials of different nature segregated.

- To recycle the water as far as possible

- To evaporate certain solvents into atmosphere from their dilute aquecus solutions.

- To incinerate the combustible waste which produces only non toxic flue gases

- To treat the non combustible wastes, separately

Evaluation of contractors proposal

2.1 Incineration :

Thus contractor prepared a proposal for incineration of various type of waste arising in the pharmaceutical chemical multipurpose plant e.g. - solids (packing materials, filtration residues), liquids (unrecoverable solvent mixtures, distill tion residues and polluted mother liquors etc)

2.1.1 According to this proposal the solids are to be collected into drums and are placed on the incineration furnace grid where they can be burnt by means of fuel oil. The liquids are to be collected into drums and a uniform mixture is prepared in a heated, agitated vessel of 10M3 capacity. The homogeneous mixture is to be pumped into the supply tank of incinerator for incineration. In case the calorific value of waste mixture is too low, fuel oil is to be fed into furnace to maintain the optimum temperature in the furnace.

2.1.2 This proposal is based on thermal reduction process. The other incineration processes are (1), (2).

Flash combustion : This process involves the incineration of municipal solid wasted with other industrial solid, liquid waste.

Copyrolysis : In the destructive distillation and decomposition of organic solids at temperature ranging from 370 degree C to 870 degree C in the absence of air and other gases which support combustion.

Wet air oxidation : The zimmerman involves met air oxidation at elevated temperatures and pressures to oxidize volatile solids more completely.

Fluidised bed incineration : In this the most of the ash residue is swept out of the combustion area with the flue gases which are passed through a met rescrubber where ash is removed and the gases are exhausted through the stack. Dorr oliver Has developed a fuel fired horizontal spiral flow incinerator especially adopted to the needs of small waste water treatment plants.

Multiple hearth incineration :

In 1970 about 120 units were being used for waste water sludge incinertions. The sludge is fed into the top hearth. From the centre it drops to second hearth where rakes move it to the periphery. Here it drops to third hearth and is raked to the centre. In the hottest portion of hearth (middle one) where the sludge burns and is converted into inert ash. This process is used normally in larger plants.

2.1.3 Therefore it maybe inferred that during recent past years a great progress has been made in incineration design to break down a range of toxic materials which are not suitable for disposal by other means. These include oils and solids, liquid organics such as polystyrene polythene, organic solvents and pesticides. The combustion gases are normally reburnt to ensure complete combustion and the residual gases are passed through a wet scrubber to minimize the risk of atmospheric pollution.

2.1.4 Therefore, it may be concluded that the proposal to incinerate the combustible waste which does not produce toxic gas is in tune with the latest technology of treatment of industrial waste.

Accordingly the incinerator was ordered. The working of a similar incinerator of same capacity was observed by two engineers from Darou Pakhsh Co. In Sweden before the incinerator was to be dispatched to Darou Pakhsh Co. Shri Chari UNDO expert has also observed the working of similar incinerator in Hungary.

2.15 Limitation of present incinerator

1. The working of incinerator in Sweden was shown to engineers from Darou Pakhsh Co. using furnace oil only. No combustible waste was incinerated. Therefore, it can not be said definitely whether the vent gases will be completely burnt and will be harmless.

2. There is no mention about the ashes formed during the incineration and the method for its disposal.

2.1.6 Recommendations

1. It is therefore recommended that the incinerator may be installed and commissioned. During the incineration of the waste from multi purpose thevent gases may be analysed fully for the presence of toxic gases, their concentration (to ensure whether within prescribed limits)

In case the gases are found not burnt fully it may be examined how to improve incineration efficiency or detoxification of vent gases if they are found to be toxic or acidic.

2. It is recommended that the ash from the incinerator may be disposed off along with other concentrated waste to the chosen dumping site.

3. It is recommended to improve the recoveries of solvents/chemicals by suitable upgradation of technology. This will additionally result in decreasing load on incinerator.

4. It is recommended that paper bags and polythene bags may not be incinerated. They may be collected and sold to agents for recycling (there is already a world wide shortage of paper).

3. EVAPORATOR

Regarding the waste water from the production hall the contractor submitted proposal. According to which the waste water is first neutralized, evaporated in the evaporator and then led into the evaporating basin of 50M X 30M X 2

dimensions. The concentrated highly contaminated non combustible materials will be disposed off at a suitable site.

3.1 A similar evaporating system for the treatment of industrial waste water, working in Vegytek, Hungary was studied by Mr. C. Chary UNIDO expert during January 26-28th, 1988. The evaporator at Vegytek plant is of 3M3 capacity per day. The system is said to be in operation for the last tow years at the time of study.

The evaporating system at multi purpose plant is supposed to handle 6.5M3 waste water/day. The report and the lay out of evaporating system were studied with a view to compare it with the scheme proposed by the contractor.

3.1.2 The process followed at Vegytek is as given below :

The waste water is settled in the settling tank and the solvent layer is skimmed and incinerated. The settled solids are sent to solid waste deposit basin. The waste water is further neutralized to pH 7.0 with lime or acetic acid. The ingredients are further mixed using compressed air and settled in settling basin. the settled solid is sent to solid waste deposit basin. The resultant liquid is filtered on sand filtered. The filtered liquid containing 1-2% dissolved solid is evaporated

3.1.3 Limitations of evaporating system proposed for multi purpose plant

1. No facility is provided to skim out the oily layer or organic solvents immiscible with water it will result in spoiling the anticorosive lining of neutralization tank.

2. No facility is provided to settle the solid waste either before or after the neutralization.

3. No sand filter is provided to filter the neutralized waste water before evaporation.

4. There is no mention in the reports about the quantity of solvent to be evaporated, their concentration in the stack gases and the odor nuisance from the vent gases.

Therefore, the functioning of evaporator tower is to be studied in these respects only after it is commissioned.

3.1.4 Recommendations

1. It is therefore, recommended that the scheme for evaporating waste water may be erected taking care that the distance between fire hydrant basin (20M X 30M) and the evaporating basin (50 X 30 X M) may be kept at 20 to 25 M. to facilitate any modification of system in future.

2. The evaporating tower may be commissioned as planned and the vent gases may be sampled and estimated for their concentrations present, toxicity, odor etc in all the three shifts.

3. The production programme may be made in such a way that during the winter months the following products may be produced in order of the priority given before metronidazole, chlordrazepoxide, clotrimazole, indomethacin followed by trimethoprim.

3.1.5 Remedial measures to be taken if the proposed evaporation system fails. If the system is found unsatisfactory the first step may be to provide the arrangements existing in the vegytek plant i.e.

1. Arrangement for skimming oils and immiscible solvents.

2. Providing primary settling tank before the neutralization tank and secondary settling tank after.

3. The arrangement for compressed air in the neutralization tank.

4. The water from secondary tank may be filtered on sand filter before the evaporating tower.

Municipal waste : The solution proposed by the contractor does not take the municipal waste from bath rooms and toilets into account therefore, no provision has been made by the contractor. As there is no municipal waste collection system nearly in operation this problem still remains to be resolved. One method may be to lead this water to the pharmaceutical plant of Darou Pakhsh to be treated in their biological treatment plant. After ascertaining it has spare capacity final recommendation may be made only after the capacity of existing plant has been carried out. The municipal waste generated at the multi purpose plant will be order of 14M3/day to bring about 200L of municipal waste per working person per day.

4.1 If after making the above mentioned provision for improving evaporator system the evaporator system does not perform as expected or the multi purpose plant is expanded and evaporating system is found not capable to take extra load in the opinion of consultant the only solution will be the combination of chemical and biological treatment as the final answer. The consultant is very confident that the plant proposed by him will be able not only to treat the combined municipal, industrial waste satisfactorily but will also reclaim the waste water. For this purpose the existing fire water basin may be converted as equalization tank and evaporating basin by suitable partitioning, raising its height, followed by providing aerators will be able to treat the water satisfactorily. This may be followed by the carbon treatment, disinfection and deconisation. The reclaimed water will be useful as cooling purposes, gardening and may be used for flushing toilets by making a separation of pipe lines.

4.2 A layout, utilizing the existing fire water basin and evaporation basin has been proposed for biological treatment of industrial waste (a copy of layout enclosed herewith) consisting of two series of treatment equipments.

In actual practice only one series may be sufficient as one of the equalization tank will have retention time of 3.48 days and the aeration lagoon will have retention time of 17.4 days taking into consideration 0.9.M free board and 2.1M depth of water in the equalization tank and aeration

lagoon and total volume of waste water as 90.5M3/day [in organic contaminated water 16.5M3/day, industrial waste water from production hall 12M3/day (maximum for any of the product) and municipal waste water 14M3/day]

Therefore, only one series of proposed biological treatment plant will be required in immediate future. In addition to strengthening. The walls, partitioning the fire water basin and evaporation basin, a few more equipments such as pumps for recirculation of liquid and slurry and 2 to 4 surface aerators will be required. When the pharmaceutical multi purpose plant is expanded the second series may be installed and commissioned. Both the facilities may be run in parallel during summer and in series in winter when the ambient temperature fells down.

The exact sizing of the biological treatment plant will be carried out if this proposal is accepted and the consultant is entrusted the responsibility to design, supervise the construction, commission the plant and train the operations and analysts of which he is confident.

5. Disposal of solid waste

The following type of solid wastes are expected to be generated during the operation of pharmaceutical chemicals multipurpose plant.

1. Concentrated non combustible waste from evaporating basin.

2. Ash from the incinerator.

Contractor has suggested in his proposal to dispose off the waste described at item No 1. The waste at item No 2 also can be disposed off by dumping in a for off place with suitable safe guards.

One such are is existing near the city of Mardabad. This site was visited along with Dr. A. Zomorodian, project manager. The water table of this are has been surveyed carefully. there is no water in under ground as the geostructure reveals. Two wells have been bored at a distance of 3 to 4 km away from this area proposed as

dumping which were found as 1500, 1900 milimetres site. the water was analysed for conductivity and hardness as 400 and 500 mg respectively indicating that this water can not be used for potable or industrial purposes.

During the visit of site it is observed that the dumping of various other wastes along with some industrial wastes, is already going on under the supervision of local municipality. Some tarry material was observed stagnating in two or three places giving off obnoxious smell. The oozing material and its odor nuisance may not take a very long time to reach the residents of a locality situated down the slopes at a distance of 5-6 km.

Therefore, the dumping of concentrated waste from evaporating basin at the proposed site may be accepted only after the dumping is started at the proposed site after providing suitable bunds for surrounding the dumping sites as exclusive to multi purpose plant only.

In the meantime another suitable site may be identified and used as dumping site for industrial waste.

It is therefore recommended that the present dumping site may prepared by suitable partitioning exclusive to multi purpose plant only.

Alternate site may be searched, identified and prepared to receive the solid waste form chemical multipurpose plant.

6. Industrial safety and protection of environment

The plant will be handling a large number of chemicals and solvents. These have to be stored, transport and used in such a way that the plant and the operating staff is always protected against any hazard arising out of any one of these chemicals. It is therefore, recommended that a nucleus of one officer and one supervisor may be created to supervise industrial safety and control of environmental pollution. The first aid centre may also be attached with this unit for better co-ordination.

It is therefore, recommended :

1. An emergency plan may be prepared identifying the hazardous chemicals, hazardous areas, team of experts, list of fire fighting units, dispenseries hospitals civil authorities to be contacted along with latest telephone number, procedures to handle all the chemical emergencies etc.

2. Detailed instructions for safe practices may be prepared for every chemical to be handled in the plant keeping into consideration the hazardous properties.

3. Fire standing order and safety manuals may be prepared with command procedure to minimize confusion during any emergency.

4. All the hazardous jobs such as hot works like gas cutting, weedding, entry into confined spaces or vessels, working on heights and on lines used to carry solvents/corrosive liquids may be controlled through permit system.

5. Operating staff and the supervisors may have to be trained thoroughly in fighting any eventualities which may arise including fires.

6. A mutual fire assistance scheme may be made to pool the mobile fire fighting equipments.

7. To protect the environment the prevention of pollution may be given top priority, by regularly monitoring the presence of solvents chemicals in the atmosphere and their concentrations may be kept below the permissible limits.

8. The proposed laboratory for biological treatment plant may be utilized for these analyses. In all the above areas the consultant may be able to assist if it is so desired.

CHAPTER II

Pharmaceutical industrial waste biological treatment plant

The pharmaceutical industrial waste biological treatment plant was visited. During site inspection the treatment plant was found working. The color of areation pond was golden brown indicating the good functioning of the treatment facility. The reason for its not working properly, was expressed that there were leakages from the septhic tank, therefore the treatment plant did not work properly. Since the leaks are rectified, the plant is working satisfactorily.

On further inquiry it was made known that analytical records for the performance in past years were not available as the samples of influent and effluent after treatment were not analyzed regularly. Only some times the samples were taken and sent to outside laboratory for complete analysis.

Therefore it is felt that topmost priority may be given to organize and set up an analytical laboratory attached to biological treatment plant to cater its needs, which may be able to help controlling the treatment process as well as to generate the data. The data in turn may be helpful in monitoring the performance efficiency of biological treatment plant in general and to evaluate the spare capacity of biological plant in particular to take further load.

The location of laboratory is preferred in the vicinity of the biological treatment plant. It may be possible to do so as some new construction is going to be completed in the vicinity of the biological treatment plant. If at present it is not possible to provide the location of laboratory near the biological plant, the same may be provided at other suitable place for the time being and maybe shifted near the biological treatment plant at a later date when the nearby location is ready.

A layout for the laboratory is proposed (3), (4), (5), (6). (a copy enclosed herewith for ready reference). All the

requirements of chemicals, glassware and equipments are listed in details. The procedures for the preparation of various standard solutions are described in details. Elaborate analytical procedures eq B.O.D,C.O.D, D.O along with calculations are also given for ready use. In case any other procedure for analysis are required, consultant will be able to send from India.

Since M/S Darou Pakhsh Co. is having quality control laboratory for its pharmaceutical preparation plant and also has its R&D centre in the vicinity, most of the chemicals, glassware and equipments may be available and may be spared to organize biological treatment laboratory in near future.

ORGANIZATION OF LABORATORY ANALYSES

The following are the standard methods for the examinations of quality of waste water :

1. pH Value.
2. Alkalinity.
3. Total Solids.
4. KMnO4 Value 3 Hrs. at 37 degree C or 4 Hrs. at Room temp.
5. Chemical Oxygen Demand (C.O.D.)
6. Bio-Chemical Oxygen demand (B.O.D.)
7. Dissolved Oxygen (D.O.)
8. Determination of Chlorides.
9. Microscopic examination of the Bio-filter film.
10. Preparation of Reagents.

Collection of samples

(a) Water

The sample collected must be representative of water to be examined otherwise the results will not be reliable. Care has to be exercised during collection of sample to avoid accidental contamination. Whenever samples for different examination are collected from the same sampling point, the sample intended for bacteriological examination should be collected first. All the samples should be properly labeled indicating the source of the sample, the time and date of collection, including the name and designation of the person collecting the same.

The samples must be examined immediately after collection, if this can not be done, they shall be packed in ice and sent to laboratory or kept in refrigerator. Such samples must be examined as early as possible and within 48 hours of collection. In case of analysis for dissolved gases like dissolved oxygen or carbon dioxide this analysis should be done immediately.

Sample bottle :

Well cleaned wide mouthed, 250 ml or 6 ounce glass stoppered bottles of pyrex or similar brand glass should be used as ordinary glass can not stand repeated heating needed for sterilization and may import sufficient alkali to a sample to be bactericidal. To protect the stopper neck and mouth of bottle against, contamination, cover with metal foil or heavy paper before sterilizing the bottle at 170 degree C for one hour. The bottle should not be opened until every thing is ready for sample collection. The sterilized bottles must be handled with care to avoid contamination.

(b)Waste water

IN case of waste water, sampling point must chosen where there is a good mixing of materials to be sampled. Samples for physical and chemical examination must be collected in clean, glass stoppered bottles. About 2 to 3 liters of samples are necessary for all the determination. The samples must be analysed as early as possible or must be stored at 3 to 4 degree centigrade in a refrigerator. Special sampling apparatus is used for obtaining samples for dissolved oxygen and B.O.D.

pH Value

pH Value is important for analyzing any sample in water analysis. pH meter should be standardized before taking the value. This can be done with a standard Buffor solution with pH 4.0 or pH 9.18. BDH buffor tablet can be used for this purpose. Both Electrodes should be always kept in distilled water.

After standardizing place the electrodes in the beaker containing sample and start stirring slowly. Note the pH value after the needle in the pH meter comes to steady. Wash the electrodes with sufficient quantity of distilled water. Put off the pH meter after keeping both the electrodes in distilled water.

Alkalinity

If the sample is turbid filter it and take 25 ml. of sample by means of pipette into a cleaned conical flask add 2 or 3 drops of phenolphthalene indicator. Now titrate with 1/50 or 0.02H H2SO4. End Point should be colorless. NOte the reading on the burette.

Take another 25 ml. of sample in a conical flask and add methyl orange indicator, Rundown the acid until it just changes to red color. Note the reading. Total Alkalinity is then obtained by taking the volume of Acid rundown upto the methyl orange end point. Similarly phenolphthalene Alkalinity is obtained by taking the volume up to the phenolphthalene end point. Phenolphathalene Alkalinity as milligrams of Calcium Carbonate/liter. = $\frac{A \times B \times 1000 \times c}{D}$

A= ml titrations for sample to reach the ph. end point.
B= Normality of acid.
c_ Equivalent weight of CaCO3 (50)
D= ml of sample taken
Total alkalinity as milligrams of CaCO3/liter shown by Methyl orange = $\frac{A \times B \times 1000 \times C}{D}$

A= ml titration for sample to reach methyl orange and point
B= Normality of acid
C= Equivalent weight of CaCO3 (50)
D= ml of sample taken

TOTAL SOLIDS

The glass dishes using for this test should be first cleaned well and afterwards washed with distilled water. They are to be dried in the oven at 103 degree c. After one hour they are to be taken out and cooled in a decicator to room temp. The dishes are numbered with a glass marking pencil.

The empty weight of the dishes is to be taken accurately. Exactly 100 ml of the sample is measured with a measuring jar and will be taken in glass dishes. Put them in the oven, and the oven temp. should be constantly maintained at 103 degree c. Weigh the dishes on the next day when they will be completely dried after cooling in a desicator. The difference of the weight of the dishes multiplied by 10,000

gives the total solids of the sample in PPM. the results are tabulated as follows :

Dish No.	Sample	Vol. of Sample	Empty Wt.	Final Wt.	Total Solids
A	X	100 ml	W1	W2	

KMnO4 Value at 37 degree c for 3 Hrs. 4hrs. at Room temp. (O.A. Values).

Oxygen absorption test reveals the amount of Oxygen required for the sample and this will be done by using a oxidising agent like KMnO4.

Cleaned 250 ml conical flasks are to be taken and sample is added according to the concentration and made up with distilled water so that the total volume is 100 ml. To this add 10 ml of 1:3 sulphuric acid. Then add accurately 25 ml of N/80 Potassium permanganate by means of a pipette. Stir well and keep them in a incubator maintained at 37 degree C for 3 hrs.

After three hours remove the flasks form the incubator and add 1gm of solid potassium iodide to each flask. Titrate with N/80 Sodium thiosulphate using starch as indicator. Conduct a blank test without sample simultaneously.

$$= \frac{(\text{Blank-Titre Value}) \times 1000 \times 0.1}{\text{Volume of sample RP}}$$

The following are the equations involved in the experiment.

$$2KMnO_4 + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$$
$$2KI + H_2SO_4 = K_2SO_4 + 2HI$$
$$2HI + (O) = H_2O + I_2$$
$$I_2 + 2NaS_2O_3 = Na_2S_2O_3 + 2NaI \quad \text{colorless}$$

Chemical oxygen Demand (C.O.D.)

It is defined as the amount of oxygen required to oxidise the matter chemically and completely.

For C.O.D. Two blanks with distilled water and two samples one is duplicate is to be taken in four round bottomed flasks. The table on the next page gives the details.

Sample volume	0.25 N Standard K2Cr2O7 So.ml.	Conc. H2SO4 with Ag2SO4 ml.	H2SO4 Grs.	Normality ofFe2(NH4)2 (SO4)	Final Vol. before Titration
10.0	5.0	15	0.2	0.05	70
20.0	10.0	30	0.4	0.10	140
30.0	15.0	45	0.6	0.15	210
40.0	20.0	60	0.8	0.20	280
50.0	25.0	75	1.0	0.25	350

In the table the second combination is preferred. For blank 20 ml of distilled water, and for sample 20 ml of sample is to be taken. (If the sample is concentrated take 5 or 10 ml and made upto 20 ml with distilled water). To each flask add 10 ml of N/4 Potassium dicromate. Then add 0.2 Gms of Mercuric sulphate and 0.1 gms of Silver sulphate to each of the flasks. In above 50% acid is to be maintained. So add 30 ml of Conc. H2SO4 to each. Stir well , add glass beds to avoid bumping. Digest the sample two hours under reflux. Allow it to cool to room temperature. Take the sample from round bottomed flask wash the condenser with distilled water and collect the washings. Dilute the sample upto 140 ml. Add Ferroin indicator two or three drops. Titrate against Ferrous ammonium sulphate of N/10 strength. From the color of K2Cr2O7 it turns to green then green to pale brick red. And note the readings.

Calculations

$$\text{Mg/l C.O.D.} = \frac{(a-b)c \times 8000}{\text{ml. of sample.}}$$

a = ml of Fe(NH4)2(SO4)2 used for Blank
b = ml of Fe(NH4)2(SO4)2 used for sample
c = Normality of Fe(NH4)2(SO4)2
8000 (Factor of oxygen in PPM)

Procedure to know the normality of Ferrous ammonium sulphate using 0.1 N $K_2Cr_2O_7$.

Take 10 ml of $K_2Cr_2O_7$ (0.IND and 100 ml of distilled water and 30 ml of conc. H_2SO_4 in a conical flask, cool it. Add Ferroin indicator. Now rundown the Ferrous ammonium sulphate solution. End point is $K_2Cr_2O_7$) color to green, green to pale brick red color. Note the reading. Fine the normality by using.

$$N1\ V1 = N2\ V2$$

Equations involved in the test

$$K_2Cr_2O_7 + 4\ H_2SO_4 = K_2SO_4 + Cr_2(SO_4)_3 + 4\ H_2O + 3\ (O)$$

Organic matter + (O) = CO_2

Eg., $C_6H_{12}O_6 + 12\ (O) = 6\ CO_2 + 6\ H_2O$

Titration with Ferrous ammonium sulphate or Mohr's salt.

$4\ Fe(SO_4)_2 + 2\ H_2SO_4 + 2(O) = 2\ Fe_2(SO_4)_3 + 2H_2O$

Oxidation from Ferrous to Ferric.

Bio Chemical Oxygen Demand (B.O.D.)

This will be the amount of oxygen required in PPM by the microflora to stabilize the organic mater in 5 days at 20 degree C.

In domestic sewage no seeding is required as it will contain the required microflora. But in certain wastes like chemical, paper industry wastes etc., the seeding is required to start the biochemical degradation. The choice of selection of seed is very important factor as otherwise, the results are not reliable. The best seeding matter is the one which is already acclamatized to that waste. The percentage of seed required also depends upon the B.O.D. of the actual waste as well as the B.O.D. of the seed.

For keeping the B.O.D. distilled water of fairly pure and good quality is required. The required quantity of distilled water is to be taken in a flat bottomed flask or a carboy. It should be aerated for 1 Hr. at least followed by stabilization at 5 degree C for 8 hours.

Before keeping the B.O.D. this distilled water should be brought to room temp. and the four neutrients namely phosphate Buffer, Ferric chloride solution, Magnesium sulphate solution and Calcium chloride solution should be added at the rate of 1 c.c. of each solution to each liter of distilled water. After adding the neutrients shake the distilled water for a few minutes until it is mixed well. Siphon out in a 1 liter standard volumetric flask and pour it into the B.O.D. bottles after rinsing them with the same distilled water. This is for blank as well as for the zero day. B.O.D. bottles for each sample should be filled.

The next sample to be taken is measured out and put in the volumetric flask and made up to 1 liter. Shake gently and transfer similarly into 3 bottles. This is in case of sample which do not require seeding like sewage final effluent, influents to biofilter one and biofilter two etc., when seeding is required the seed is measured out in a cylinder pipette out and added to the distilled water in the flask.

The distilled water is mixed gently and then a separate set of three bottles are filled for blank and zero day by siphoning.

For the sample the required sample is measured in a pipette and add to the 1 liter volumetric flask. If the waste is having high B.O.D. then small quantities cannot be pipetted out. In such cases it should be diluted before sample is to be taken. After adding the sample siphon out an make up the volume shake gently and transfer to three bottles.

Two bottles of each sample and seeded blank and if necessary blank should be incubated at 20 degree C for 5 days ensuring that there are no air bubbles in each bottle. On the 5th day the sample are taken out from the incubator and 2 ml of manganese sulphate solution 2 ml of alkali azide solution are added to each bottle and each bottle is to be shaken well. Aklow the precipitate to settle at the bottom and add 2 ml of Conc. H_2SO_4. Shake well until the precipitate dissolves completely. Measured out 100 cc and find out dissolved oxygen. The calculations are as follows.

$$\text{B.O.D. of sample} = \frac{(A-B) \times 100}{\text{Percentage of sample.}}$$

A = 0 day D.O. of sample - 5 Day D.O.
B = 0 day D.O. of blank - 5 D.O. of seed.

Equations

$MnSO_4 + 2\,NaOH = Mn(OH)_2 + Na_2SO_4$
$Mn(OH)_2 + (O) = MnO(OH)_2$
$2KI + H_2SO_4 = K_2SO_4 + 2HI$
$2HI + MnO(OH)_2 = Mn(OH)_2 + H_2O + I_2$
$I_2 + 2Na_2S_2O_3 + Na_2S_4O_6 + 2\,NaI$

Dissolved Oxygen (D.O.)

The sample for which D.O. is required is collected in a B.O.D bottle. Add 2 ml of Manganous sulphate and 2 ml of alkali iodide azide solution. Now if the brown precipitate comes proceed for further analysis. If the PPT is white it indicates the absence of D.O. and stop further analysis.

Shake well and keep 10 minutes to settle. Add 2 ml of conc. H_2SO_4. The precipitate dissolves by shaking. The color of the solution is of Potassium dichromate. Now titrate against N/80 Sodium thiosulphate by taking 100 ml of a sample. After running some thio sulphate slution light yellow color appears, now add a little starch solution. Bluish black color appears. Add drop by drop and the end point is bluish black to colorless. The reading on the burette directly gives the dissolved oxygen content in the sample.

Equations

$MnSO_4 + 2NaOH = Mn(OH)_2 + Na_2SO_4$
$Mn(OH)_2 + (O) = MnO(OH)_2$
$2KI + H_2SO_4 = K_2SO_4 + 2HI$
$2HI + MnO(OH)_2 = Mn(OH)_2 + 2H_2O + I_2$
$I_2 + 2Na_2S_2O_3 = Na_2S_4O_6 + 2\,NaI$

Determinations of Chlorides

Fill the burette with Silver nitrate solution whose normality is to be found out. Take 20 C.C. of Potassium chormate is to be added as indicator. Rundown the Silver nitrate solution. End point is yellow to just pink color.

Take the reading. Calculate the normality by using

$$N1V1 = N2V2$$

$$NaCl + AgNO3 = NaNO3 + AgCl$$

Procedure: Now we have the known strength of Silver nitrate solution. This is taken in burette and pipette out 20 ml of distilled water in one Flask and 20 ml of sample in another flask. Add 1 c.c. of potassium chromate indicator. Titrate one after the other. End point is just pink color. Note the readings.

Calculation:

$$mg/l \text{ Chlorides} = \frac{(A-B) \times N \times 1000 \times 35.45}{Ml. \text{ of sample}}$$

A = ml titration for sample.
B = ml titration for distilled water
N = Normality of AgNO3 solutions

Microscopic Examination of the Biofilter film

The Biofilter film will be examined daily by means of microscope. The microscope is first adjusted with the mirror attached to it, until the light is clearly visible through eyepiece. The film under examination is to be taken on the side and is spread uniformly. We can see the number of micro-organisms if the film is in good condition. The following are the more frequently appearing micro-organisms in the biofilter film.

Paramoecium Caudatum:

Peristone oblique. Body elongated, slightly flattened, rounded at both sides or slightly truncated infornt. Celiation regular. Contractile Vacnole in either extremity.

Vorticella Campenule : Body bell shaped, cutioxl often ringed. Series of strong celixencirole the elivated cilixry disk. Surface smooth. Mouth eccentric between the peris tone a id clixry disk. Surgace smooth. stalk thick.

Rotifer citranus : Eyes in the dorsyl probescis.
Phelodina noseola : Eyes in the neck, directly over the brain, just above the Jams.

Cyclons Albidus : Abdomen of Female with sensory club on 12th anten segment. Egg sacs standing out from adodomen.

Enistylis Flavicama : Bell shaped stem hollow except at joints. Paleyellow bodies. 506 circles of strong colix about the disk. Necleus band like curved.

Colpidium striatum : Body not flexible. Mouth lateral, triangular. Following a small peristone and with an undulating membrane in front.

Preparation of Reagents Indicators

1. Potassium chromate solution for chlorides : Dissolved 50 g K2Cr2O7 in a little distilled water. Add AgNO3 solution until a definite red precipitate is formed. Allow to stand 12 Hrs. Filter and dilute filtrate to 1 liter with distilled water.

2. Methyl orange solution : Dissolved 0.5 g methyl orange in one liter distilled water.

3. Starch solution : To 5 g of starch add a little cold water and grind in a mortor to a thin paste. Pour into one liter of boiling distilled water, stir, and allow to settle overnight. Use the clear supernatant. Preserve with 1.25 g of salicylic acid or 5 ml of chloroform to one liter of starch solution.

4. Ferro-in-indicator : Dissolve 1.485 g 1,10 phenonthroline monohydrate, together with 0.695 g of FeSO4 7H2O in distilled water and dilute to 100 ml.

Reagents

1) CO2 Free distilled water : The distilled water is to be used for preparing all standard solutions, and dilution purpose. The pH of this is not less than 6.5 and more than 7.5. If the water has a lower pH it should be boiled for 15 minutes and cooled to room temperature.

2) N/8 Potassium permanganate : Dissolve 3.95 g of KMnO4 make up 1 liter with distilled water.

3) N/8 (0.125N) Sodium thiosulphate : Dissolve 31.02 g of Sodium thiosulphate and make up to one liter with distilled water and standardise with Potassium dicromate for 10 ml of 0.1 N Potassium dicromate titre value should come to exactly 8 ml.

4) 1:3 H2SO4 : Take 250 ml of Conc. H2SO4 in 750 ml of distilled water. Add 5 g of Sulphonic acid to remove nitrate interference.

5) Potassium Iodide : Solid can be used as it is (1g)

6) N/4 or 0.25N Potassium dichromate : 12.259 g of K2Cr2O7 previously dried at 103 degree C for half an hour is dissolved in distilled water and make up one liter.

7) N/10 or 0-1N Ferrous Ammonium Sulphate : Dissolve 39.2 g of Fe(NH4)2(SO4)2 6H2O in distilled water. Add 20 ml of Conc. H2SO4, cool and dilute to 1 liter. This solution must be standardised against the standard Potassium Dichromate solution (0.1) daily.

8) Silver sulphate : Reagent sold in the market can be used as it is.

9) Mercuric sulphate : Analytical grade powder is used as it is.

10) Distilled water of B.O.D : The distilled water to be used for B.O.D. must be of highest quality and free of chlorine, Caustic alkali, organic material and acids.

11) Phosphate buffer : Dissolve 8.5 g of Potassium digydrogen phosphatee 21.75 g of dipotassium hydrogen phosphate 33.4 g of disodium hydrogen phosphate hepta hydrate and 1.7 g of Ammonium chloride in about 500 ml of distilled water and dilute to one liter. The PH of this solution should be 7.2

12) Magnesium sulphate solution : Dissolve 22.5 g of MgSO4 7HO in distilled water and dilute to one liter.

13) Calcium Chloride solution : Dissolve 27.5 g of anhydrous Cacl2 in distilled water and dilute to one liter.

14) Ferric Chloride solution : Dissolve 0.25 g of FeC136H2O in distilled water and dilute to one liter.

15) Manganese sulphate solution : Dissolve 480 g of MnSO44H2O or 400 g of MnSO42H2O or 364 g of MnSO4H2O in distilled water filter and dilute to one liter.

16) Alkali - Iodide - azide solution : Dissolve 500 g of Sodium hydroxide and 150 g of potassium iodide or 135 g of Sodium Iodide in distilled water and dilute. To this solution add 10 g of Sodium azide dissolved in 40 ml distilled water. If necessary filter it through a filter paper and dilute to one liter.

REQUIPMENT AND CHEMICALS

All the chemicals used in preparation of reagents must be of at least 'C.P.' quality or other standard grades. All the instruments must be of standard quality and tested for accuracy before use. For some of the chemical tests and biological work, ordinary distilled water must be re-distilled or it must be de-mineralised by passing it thorough a mixed-bed-ion-exchanger. For further information, standard works on the subject may be consulted.

The apparatus and chemicals listed below include the basic requirements for equipping the laboratories intended for water, sewage and waste-water analysis. in the list. As the

quantitative requirements entirely depend on the nature and volume of work to be done in a laboratory, the analyst has to indent for the required quantities of chemicals and equipment based on his specific needs.

It is perhaps necessary to enclose some area for special chemical work and also provide for air conditioning to secure good results in bacteriological work or alternatively a walk-in cooler may be installed in the laboratory.

EQUIPMENT

Balance, analytical	*	Hot plate	*
Balance, trip	*	Hydrogen-ion comparator	*
Balance weights	*	Incubator, B.O.D.	*
Burner, Bunsen	*	Magnetic stirrers	*
Colorimeter		Motors; 0.5 H.P. & other	
Centrifuge		sizes Oven, laboratory	*
Chloroscope		pH meter	*
Conductivity meter	*	Sieves, standard	
De-mineraliser	*	Shaker	*
D.O. Sampler	*	Soxhlet extraction	
Drying oven	*	apparatus	
Flocculator		Stop-watch	*
Furnace, muffle	*	Thermometer	*
Gas cylinder		Turbidimeter	*
Gutzeit generator		Water-still, gas-heated	
Homogeniser	*	or electrical	
		Water bath	*
		Vaccum pump	*

Equipments marked * are essential

	EQUIPMENT
Ferroin indicator	(bacteriological tests)
Ferrous ammonium sulphate	Arnold's steam steriliser
Fuller's earth	Auroclave
Hexa methylene tetramine	Balance, single pan
Hydrazine sulphate	Counter-hand tally
Hydrochloric acid	Colony counter
Hydroxylamine hydrochloride	Hot air oven
Iron chlorite	Membrane filter assembly
Lead acetate	Microscope-monocular &

Managanous sulphate
Mercuric bromide
Mercuric chloride
Methyl red indicator
Sodium meta arsenate
Sodium nitrite
Sodium pyro sulphite
Sodium suphite
Starch
Stanous chloride
Sulphuric acid
Sulphanilic acid
Zirconium alizarin
Zirconium oxychloride-
octo hydrate
Murexide
Nitric acid
Naphthylamine hydrochloride
Ortho tolidine
Phenol
Phenolphathalein indicator
Phenanthroline
Potassium biphthalate
Potassium Chloroplatinate
Potassium chromate
Potassium dichromate
Potassium dihydrogen phosphate
Potassium cyanide
Potassium hydroxide
Potassium iodide
POtassium permanganate
Potassium sulphate
Silver nitrate
Sodium acetate
Sodium arsenate
Sodium bisulphate
Sodium carbonate
Sodium chloride
Sodium fluroide
Sodium hydrogen phosphate
Sodium hydroxide

Binocular
Needles, innoculating
pH comparator with
standards
Spirit lamp
Suction pump
Water bath

CHEMICALS

(bacteriological tests)

Acetone
Agar-agar
Bacto-beef extract
Bacto-20% bile brilliant
Green lactose both (BGB)
Bacto-Endo's medium
Bacto-eosin methylene
blue agar
Bacto-nutrient agar
Bacto-nutrient lactose
Broth
Bacto-peptone
Basic fuschin

ACCESSORIES

Bottle polyethene
Clamps-condenser, holder, pinch
Clamps-burette
Corks
Files
Forceps
Fume cup-board
Gloves, rubber
Imhoff cone support
Iron supports
Jar brushes
Nessler tubes support
Rubber stopper
Rubber tubing
Spatula
Support rings & stands
Support for burettes and funnels
Test kit A floc type
Test tube brush
Tongs, stainless steel
Tripod

GLASS WARE

Beaker, (50 to 1,000 ml)
Bottle, jug form, one gln
Bottle, wide mouth, (1,00 ml)
Bottle, dropping (1 oz)
Bottle wash (16 oz)
Burette, (50 ml)
Condensers
Crucibles, Gooch (25 ml)
Crucible holder
Cylinder, graduated (10-10,000 ml)
Dessicator (250 mm)
Digestion apparatus-Kjeldahl
Dish, evaporating
Flasks, Erlenmeyer (125-1,000 ml)
Flasks, filtering (500ml)
Flasks, volumetric (100 ml-1,000 ml)
Funnel, Buchner
Gas dispersion rubes
Glass beads
Glass-wool
Glass-tubing
Glass-stiring rods
Imhoff cone
Pipettes (5-50 ml)
Pipettes, measuring ((1-10 ml)
Reflux apparatus, glass
Test tubes, different sizes
Watch glass-different sizes
wire gauge

CHEMICALS

Acetric acid glacial
Aluminium hydroxide
Amino-naphthol-sulfonic acid
Ammonium acetate
Ammonium chloride
Ammonium hydroxide
Ammonium molybdate
Batho cuproine di-sulfonate solution
Calcium carbonate
Calcium chloride
Carbon tetra chloride
Chlororform
Chrome Black T-indicator
Cobaltous chloride
Dithizone
Di-Phenyl thio carbazone

Di-Potassium hydrogen phosphate
Ethyl alcohol
Ethylene diamine tetra acetic acid
Brilliant green
Cedar oil, immersion
Crystal violet
Dextrose
Dipotassium phosphate
Eosin, yellowish
Ethyl alcohol 95%
Lactose
Malachite green
Methyl violet
Ox-gall
Potassium iodide & biniodate
Ringer's solution
Saffranin O
Sodium sulfate
Sodium sulphite
Tryptone Glucose yeast agar

GLASS WARE

Bottles, ground-glass
Bottles, staining
Bottles, winchester
Bottles, dilution
Cotton, non-absorbent
Culture rubes (Durham)
75 X 10 mm
Dishes, petri 60 mmx15 mm
Glass rubing
Needles, innoculating
Pipettes, graduated
Platinum wire (loop)
Reagent bottles
Spirit lamps &
Fermentation
Test tubes, 175 x 22 mm, 150 x 18 mm
Wooden racks for culture tubes

CHAPTER III

Need for a perspective plan to control the air water pollution

(A note prepared for the consideration of the Ministries of Health, Environment, Forest)

Industrial safety of pollution control

Tehran is growing at a very fast rate. In addition to rapid increase in population a large number of industries have come up. These industries may use hazardous chemicals and produce chemicals which may be or may not hazardous. In addition to many bye products are also to be produced in the course of chemical processing.

It is therefore, recommended that a continuous recording type of system for identifying and measuring the concentration of toxic gases in the environment may be set up. This monitoring will help knowing the type, place and degree of pollution. And will be helpful to plan the safeguards against pollution and face it in a systematic manner with confidence. In absence of permanent stations for recording the pollution a mobile system may be planned. the mobile systems are now available that all the analysis also can be done there only.

All the chemical industries may be asked to prepare plans to meet any chemical emergency arising out of the chemicals handling during use storage and transportation by the company. Since this type of emergencies have a tendency to engulf the public living in the vicinity of chemical plants.

On the basis of these individual plans to handle chemical emergencies, an overall plan may be prepared. This plan may involve, the identification of emergency services, fire fighting , chemical safe handling advice, ambulance, first

aid centers hospitals, transport ::, civil and public administration and experts to gi. guidance etc at very short notice. A quick reliable communication system is a prerequisite of these emergency plans.

Water pollution

Coming to the water pollution problem, it may be pointed out that the present practice of letting in the municipal waste into wells is being followed in Tehran. It may not be possible to continue so in future. With the increase in population and industries the generation of municipal and industrial waste water will, increase, the untreated disposal of which by above method will increase water borne diseases spreading faster.

It may therefore, be appropriate to prepare a long term plan to face this formidable challenge.

A more appropriate answer to the problem may be that first each industry may treat it effluent to their permissible limits before it is mixed with municipal waste. A system for collecting municipal waste in industrial areas wherever it is possible may be made and this municipal waste may be combined with pretreated industrial wastes. The combined waste mater may be treated in a biological treatment plant and the effluent mater may be further treated by application on land. The land treatment process is described below in brief :

Development of land treatment system

Land treatment of waste water involves the use of plants, the soil surface and solid matrix for the treatment of waste water. Although the land treatment of waste water has been practiced for centuries, its full potential has only recently been recognized.

Evidence of land treatment systems for waste water in western civilization extends back as far as ancient Athens (7).

A waste water irrigation system is reported to be in operation more than 300 years, beginning from 1559 in Bunzlaw Germany (8).

The greatest proliferation of land treatment system occurred in Europe in second half of the nineteenth century. Sewage farming, the practice of transporting untreated waste water into the rural areas for irrigation and disposal was commonly used by many european cities. In 1870 the practice was recognized in England as an acceptable form of treatment (9).

Land treatment system in United States also dates from 1870 (10).

As in Europe the sewage forming became relatively common as a first attempt to control water pollution. In US the number of municipalities using land treatment increased from 304 in 1940 to 571 in 1972 (11).

Land treatment of waste water

Irrigations

Where the water is valuable (due to scarcity) crops can be irrigated at rate 2.5 to 7.5 cm/week. The crops grown under high rate irrigation (i.e. 6-10 cm/week) are usually water tolerant grasses with the lower potential for economic return but with high nutrient uptake capacities.

Rapid infiltration

In this system effluent is applied to the soil at high rates by spreading in basins or by sprinkling where the ground water quality is getting degraded by salinity intrusion, ground water recharge can be used to revers it.

Over land flow is essentially a biological treatment process in which waste water is applied over the upper reaches of slopes, terrace and allowed to flow across the vegetated

surface to run off into collection ditches. The renovation is accomplished by physical, chemical and biological means as the waste flows in a thin sheet down the relative by impervious slope.

Important inspects of crops for irrigation system are :

1) Nitrogen removal capability
2) Water needs and tolerances
3) Sensitivity to waste water constituent
4) Public health regulation and crop management considerations.

Successful forages used in waste water irrigation include reed canary grass, brome grass, tall fescue, perennial rye grass and costal Bermuda grass. These grasses take high nutrition uptake, are water tolerant and are relatively high tolerant of total disovled solids.

Forage crops are often perennial and require relatively little management.

Landscape vegetation

Application of effluent on land scape areas such as high ways median, border strips, airport strips golf courses, parks, recreational areas, wild like sanctuaries has several advantages.

The maintenance of land scape projects generally require less water than other vegetation (since watering in these areas is based on vegetative maintenance). Therefore, the waste water can be spread over a greater are. Irrigation of golf courses and parks is reported practiced extensively.

Wood land irrigation

Siviculture, the growing of trees, is being conducted with waste water on at least 11 sites. Forest offers several advantages as potential sites for land treatment. Forest offers several advantages as potential sites for land treatment of effluent.

1. Infiltration properties of forest soils are often

better than those agricultural soils.

2. The site acquisition costs for forest are usually lower than acquisition costs of agricultural land.

3. During cold weather soild temperatures are often higher in forest than in comparable agricultural land.

Recommendation

It is therefore recommended the Government of Islamic Republic of Iran may formulate a long-term plan to counter act the water pollution before it assumes unmanageable proportions.

1. It may insist the industries to install their waste treatment plants to treat their effluents to achievable limits.

2. Install and put into operation infrastructure, for waste treatment plants for municipal waste water for mixing with pretreated industrial waste water wherever it is possible.

3. Land scape vegetation and forestry Surrounding Tehran a lot of high land is seen devoid of vegetation. These areas may be developed into forests with perennial grasses grown in between the trees with the land application of treated waste water slopy lands.

The road sides may be converted into green belts by planting trees in rows of 5-6 on each side of road. Even the sides of railway track can be covered with green trees. Incidentally in case of landscape vegetation on either side of road there is no land acquisition problem.

IN addition to this the nutritive value of treated waste water may be made known to farmers to use the treated waste water for crop irrigation.

The enthusiasm among general public may also be generated through innovative approaches. Such as encouraging individual to plant and maintain the trees in the memory of their dear ones or as mark of remembrance of their achievements.

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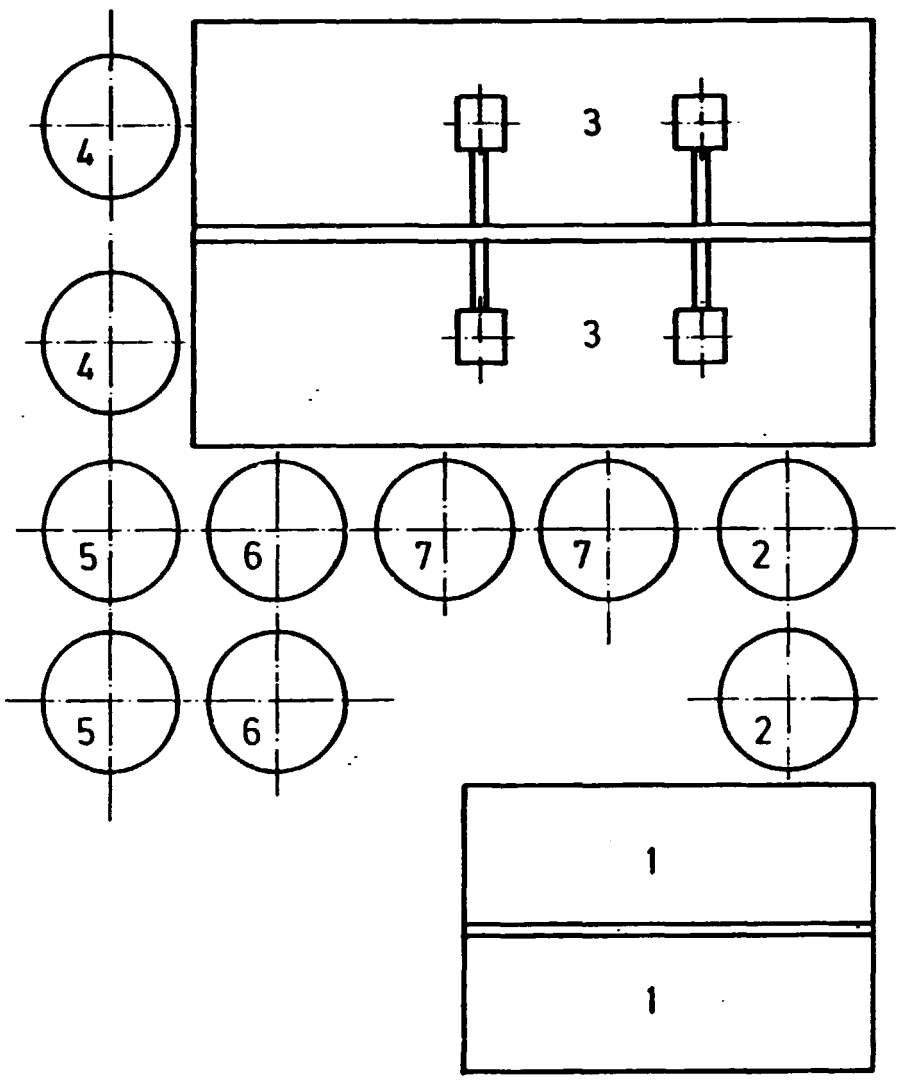


SC.1:500

PROPOSED BIOLOGICAL TREATMENT PLANT

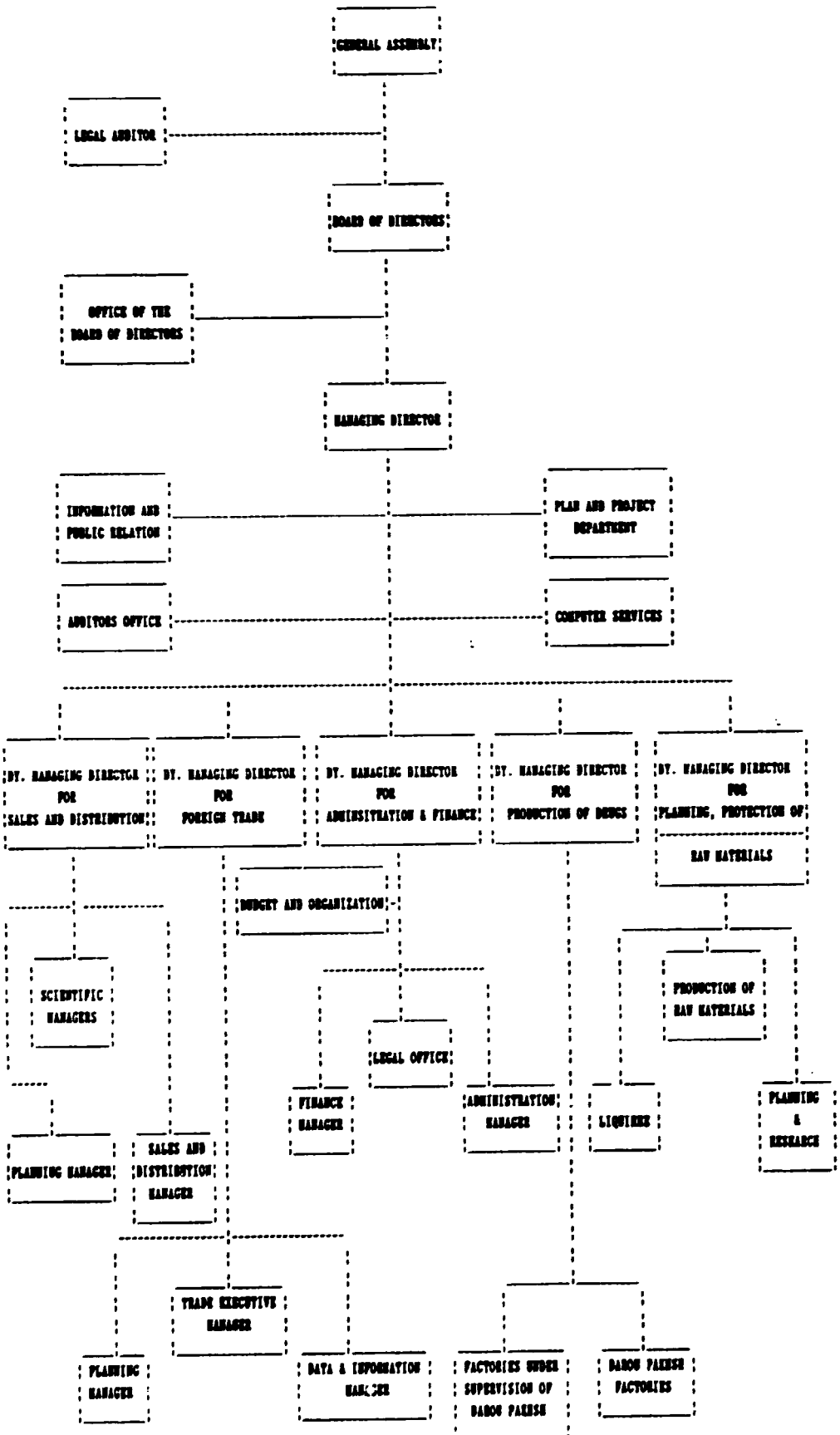
1) EQUALISATION TANKS 2) PRIMARY CLARIFIERS

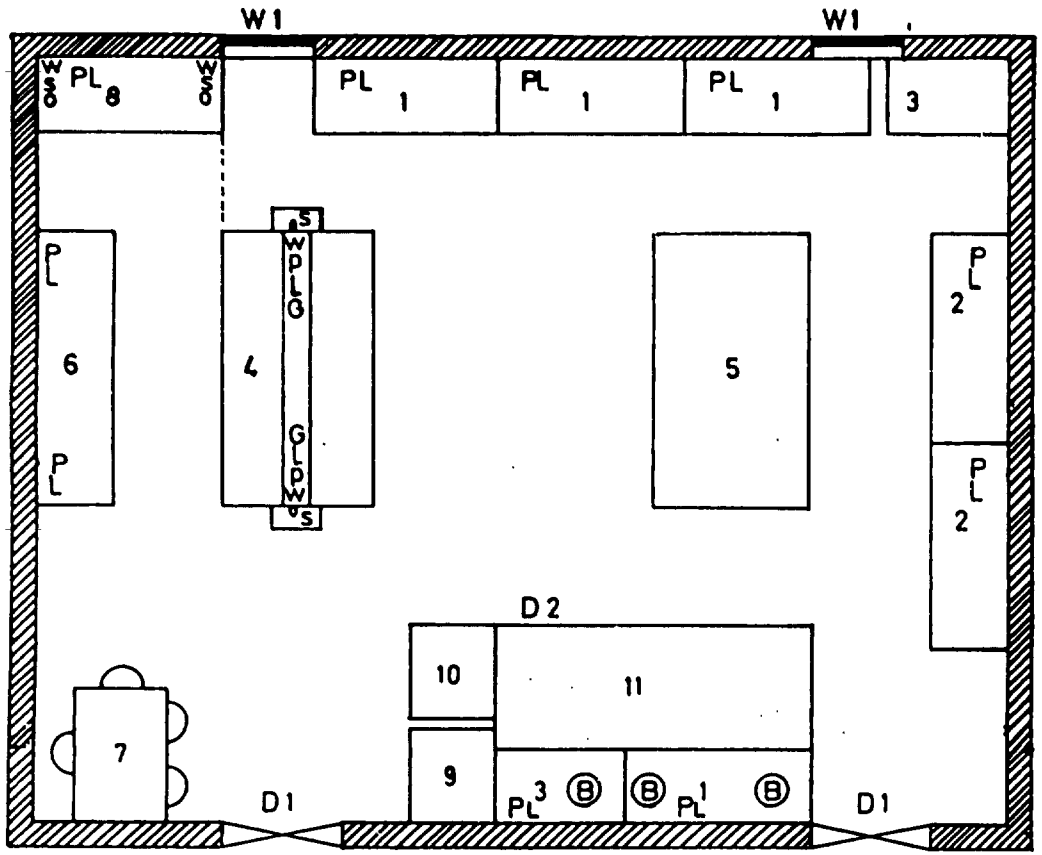
3) SURFACE AREATED LAGOONS 4) SECONDARY CLARIFIERS

5) SAND FILTERS 6) CARBON FILTERS

7) DEIONISERS

ORGANIZATION CHART OF BADOU PAKESE COMPANY





LAYOUT FOR LABORATORY... SC.1:50

1 TEAK WOOD WORK BENCH
2 TEAK WOOD WORK BENCH
3 TEAK WOOD TABLE
4 TEAK WOOD TABLE WITHRACKS, SINKS
5 TEAK WOOD TABLE
6 TEAK WOOD TABLE
7 TEAK WOOD TABLE
8 FUME CUPBOARD
9 REFRIGERATOR
10 BOD INCUBATOR
11 BALANCE ROOM
12 GLAZED WALL SHELVES FOR REAGENT BOTTLES
W1 WINDOW
D1 DOOR
D2 DOOR
P POWER
L LIGHT POINT
G GAS
S SINK
W WATER
FD FLOOR DRAIN
B BALANCE, FIRST AID EQUIPMENT

QUESTIONNAIRE I

(To be filled by Pharmaceutical, Chemical Multipurpose Plant)

1.1 Name of the Industry : -

1.2 Address for correspondence : -

2.1 Process details : -

2.1.1 List of main products to be produced with designed daily production capacity.

2.1.3 Time phasing for achieving full production capacity.

2.2 Raw materials consumption

2.2.1 List of all the raw materials with daily consumption at full production capacity.

2.2.2 List all the intermediates consumed with approximate quantities.

2.2.3 Is any recycled material from waste of industry or any other industry used in the process if so specify quantities and source.

2.2.4 Is any materials salvaged from your waste stream reusable economically for any other purpose ? If so please specify details of quantities and probable use.

2.3 Manufacturing processes

2.3.1 Source of process
know how
in house/national/foreign/other (specify)

2.3.2 Have you considered less polluting
process alternatives ? If yes
list our the reasons for adopting the
present process.

2.3.3 Give brief description of the process
Technology to be utilized with a flow
chart.

2.3.4 Is any foreign collaborations involved
is to have they provided know how and
equipment for industrial waste treatment ?

2.4 Energy consumption

2.4.1 Source of energy

a) in plant generation
b) public supply

2.4.2 If energy generated in plant type and
quantity of fuel daily consumed.

- -

Fuel	coal	fueloil	diesel	Natural gas	Wood	Other specify

- -

Daily consumption
in tons

calorific value
Ash content %

Sulphur content %
Other specify

- -

3. LOCATION

3.1 Where the plant is supposed to be located, attach map

3.1.1 Elevation above mean sea level

3.2 Area of land proposed to be acquired

3.2.1 Area proposed to be developed

3.3 Present use of the land — Agriculture/forest/grazing/ settlement follow and population

3.4 Indicate the nature of topograph near the site — plans/valley/hilly

3.4.1 Specify location — coastal/stuary/river/land located

3.5 Indicate climate conditions at the site (e.g. arid semi arid)

3.5.1 Rain fall yearly average range

3.5.2 Temperature yearly average range

3.5.3 Information on speed & direction of wind

3.6 Is the land situated within and municipal or corporation jurisdiction ? If so please specify.

3.7 If the land is situated in an approved industrial zone or estate - if so please specify.

3.8 What of the following features exist within 20 kms of the site ?

1. Agricultural land specify crops
2. Grazing land

3. Fisheries
4. Forest/sanctuary/natural park/biosphere reserves

3.8.5 Nullah/streams/rivers

6. Ponds/lakes/dams
7. Estuary/sea
8. Hills/mountains
9. Monuments
10. Settlement and population
11. List of industries

4. Township

4.1 Do you propose to build a township/housing/quarter for your employee ?

4.1.1 Area allocated for above

4.1.2 Population to be accommodated.

4.1.3 Distance from township to plant site

4.1.4 Services provided in the township

1. Water supply daily
2. Sewer system
3. Sewage treatment

5. <u>Water requirements</u>

5.1.1 Source of water-public supply ground/river/lake/bay/estvary

5.1.2 Is any pretreatment necessary for use if yes please specify ?

5.1.3 Average daily quantities consumed
Process & wash
Cooling
Sanitary
Total

5.1.4 Are adequate quantities available

1. At present
2. For future expansion

6.1 Waste water discharges

6.1 Waste water discharges per day

from 1) Process & wash
2) Cooling
3) Sanitary
4) Total

6.1.2 How do you propose to discharge waste water separate/combined streams

6.1.3 Type of treatment proposed to be adopted. Give details and flow charts.

6.1.4 What standards for quality of treated effluents have you proposed to be adopted, give details & flow charts (Iranian/WHO/)

6.1.5 Mode of final discharge
open channel/pipe line
covered drains others

6.1.6 Mode of final discharge
land/agricultural land
swer/river/lake/bay/estvary
sea

6.1.7 What methods do you propose ?

6.1.8 Indicate available information on waste water characteristics as given below :

a) Physical	b) Chemical
Temperature	Acidity - total, pH
PH	Total alkalinity & pH
Color	Total hardness
turbidity	BOD
Odor	COD

Total solids	Oil & grease
Total volitile solids	Total nitrogen Total phosphate Total chlorides Sodium Potassium Calcium Magnesium

6.1.9 What other toxic substances are discharged, if so please specify the nature and concentration (in-organics, organo chlorine compounds, phenol, higoun mercaptens, heavy metals and radioactive substances

7. Solids waste Process Treatment

7.1 Total quantity of solids wastes in tons/day

7.2 Nature of waste lumps/granules/dusts/slurry/sludge

7.3 Approximate composition (e.g. organics, glass, metals etc.)

7.4 Method proposed for disposal including treatment plant sludges Land fill/dumping composting/solid

7.5 Have you considered the possibility of recovery and reutilisation of any portion of the solid wastes ? If so give details.

7.6 Have you any problems regarding collection handling and transport of solid wastes ? If yes specify.

7.7 Are there any problems of subsequent pollution of air, water or soil likely at the place of disposal of solid waste ? If yes, indicate the method proposed for the prevention of such pollution.

8. Atmospheric emissions :

8.1 Emission from fuel burning expected quantity of stack emission. Temp. of emission composition of emission

a) Particulate
b) Gases
   Sulphur dioxide
   Nitrogen oxides
   Hydro carbons
   Carbon monoxide
   Moisture
   Others specify

8.2 Emission from process expected emissions

Quantity
Temperature

a) Particulates
b) Nature and quantity
c) Gases
   Sulphur dioxide
   Nitrogen oxide
   Carbon monoxide
   Ammonia
   Acid mists
   Halogens
   Hydrocarbons
   Mercaptons
   Others specify

8.3 Height of stack(s) for atmospheric emission

8.4 Proposed air pollution control system

Give detailed specifications (eg. collectors, precipitators, scrubbers)

8.5 Proposed method of handling and disposal of waste trapped by pollution arresting equipment

Other sources of pollution

9.1 Is your industry likely to cause noise pollution ? If yes what noise abatement programmes have you planned ?

9.2 Is there any odor problem likely to occur from your industry ? If yes what measures are proposed to be taken ?

10. Pollution control management

10.1 Give details of organizational setup for control you proposed to have.

10.2 What is the level of expertise of the person in charge of pollution control ?

10.3 Do you propose to monitor the pollution from your industry ? If yes give details.

10.4 What laboratory facilities you propose to have for above ?

10.5 Give details of operation and maintenance of facilities you propose to have pollution control equipment treatment plants

11. Cost of pollution control

11.1 Total expenditure proposed for pollution monitoring and control

12. Any other additional information about beneficial or adverse environmental impacts from your industry.

Signature
Name
Designation
Address

QUESTIONNAIRE II

(To be filled by Pharmaceutical Plant)

Please give detailed answers to the following questions

1. Are accumulations removed regularly ?
2. Is scum removal equipment cleared regularly ?
3. Is hosing down and removal of all sewage and sludge spills is done ?
4. Do the pump leak badly spilling sewage on the floor ?
5. Do you have a lubrication chart ?
6. Do you inspect underwater portion of sedimentation tank? If so what is the frequency ?
7. Do you replace defective broken and badly worn parts ?
8. Do you check for corrosion - what is frequency of checking ?
9. Do you have floating sludge ?
10. Are the contents black & odourous ?
11. Do you have excess sedimentation in inlet channel ?
12. Do you have excess fouling of surface and weirs with sewage solids or growth ?
13. Do you have intermittent surging of flow ?
14. Is sludge hard to remove from hopper

14. a) How do you dispose of sludge ?

15. Did you observe filter ponding ?

16. Did you counter filter fly nuisance ?

17. Did you get obnoxious odors ?

18. Does ice gets formed on the filter surface ?

19. Do you observe iceing in final settling tank ?

20. Do you observe bulking of sludge ?

21. Do you observe rising sludge or brothing in secondary tanks ?

22. What are the safety provisions provided for ?

23. Is the hydraulic load in excess ? What are your suggestions to reduce these loads ?

24. Is the organic load in excess ? What are your suggestions to reduce these loads ?

25. What are C.O.D. and B.O.D. values for influent and effluent (two samples of incoming and outgoing wastewater after treatment may be taken in any one day at 10.00 hrs and 15.00 and are analyzed for C.O.D. and B.O.D. Values ?

26. What is your expansion programme for next 5, 10, 15 years in terms of number of products and their quantities.

LIST OF RAW MATERIALS TO BE USED IN PHARMACEUTICAL, CHEMICAL, MULTIPURPOSE PLANT

		Tons/year
1.	2-amino-5-chlorobenzophenone	3.00
2.	Chlorophenol	2.87
3.	(O-chlorobenzotrichloride (chloro-2-trichloramethl benzene)	3.04
4.	P-anisidine	1.430
5.	3,4-diaminobenzophenone-HCl	2.700
6.	2-methylimidazole	12.30
7.	Naphthyridine ester	11.52
8.	4 Hydroxy azobenzene	11.97
9.	P-ntrobenzoic acid (4-nitrobanzoic acid)	9.6
10.	3-amino-5-methylisoxazole	5.4
11.	3:4,5 trimethoxy benzaldehyde	18.1
		82.12

Other solid chemicals

1.	Active carbon	5.20
2.	Tartaric acid	0.55
3.	Butyl malonic acid	8.80
4.	Guanidine hydrochloride	17.30
5.	Hydroxyl amine - HCl	2.85
6.	Levulinic acid	1.66
7.	N-acetyle-sulphonyl chloride	11.50
8.	Sodium methylate	39.10
9.	Oxalie acid	0.10
10.	P-toluene-sulphonic acid-chloride	12.40
11.	S-methyl, thiocarbamide H2SO4	3.00
12.	Selection B2	0.16
		102.62

morganic compounds

1.	Aluminium chloride arihydrous	1.92
2.	Celite	0.40
3.	Potassium carbonate anhydrous	3.84
4.	Sodium actate	0.89
5.	Sodium dithionite	3.26
6.	Sodium carbonate	0.18
7.	Sodium chloride	0.80
8.	Sodium nitrite	0.96
9.	Sodium pyrosulphite	9.00
10.	Sodium sulphide	6.40
11.	Sodium sulphite	4.75
12.	Sodium hydroxide (98%)	8.50
13.	Pearlite	1.20
14.	Selcat (catalyst)	0.655
		92.755

Liquid raw materials	tons
1. Methanol	261.1
2. Ethanol absolute	158.5
3. Ethanol 96%	74.0
4. N-butanol	7.90
5. Tertiary butanol	21.40
6. Methylamine methanol solution (25%)	10.10
7. Diethyl amino etanol	6.50
8. Dielhyl elner	6.30
9. Petroleum ether	4.80
10. Acetone	43.40
11. Ethylene oxide	15.60
12. Formic acid	85.40
13. Acetic acid	91.00
14. Acetic anhydride	12.00
15. ethyl acetate	12.25
16. N. butyl-malonic acid	16.00
17. Acetonitrite	11.00
18. P-methoxy propionitrile	16.20
19. Triethylamine	0.90
20. Imidxazole	0.60
21. Dimethyl formanide	23.00
22. Dichloro methane	36.50
23. Chloroform	33.700
24. Chloroformic acid methyl ester	1.85
25. Chloro acetylchloride	2.60
26. P-chlorobenzoyl chloride	2.00
27. Triethyl phosphate	15.40
28. Benzene	48.20
29. Xylol	37.00
30. Pyridine	31.400
31. Kerosene	4.00

Inorganic compounds

1. Ammonium hydroxide	32.00
2. Calcium chloride (solution 31%)	76.3
3. Sulphuric acid (98%)	58.00
4. Nitric acid (67%)	33.60

Gaseous raw materials

1. Hydrogen	1900 m3

Summary of industrial waste generation and treatment
of Pharmaceutical Chemicals Multipurpose Plant, Tehran

	S.N.O. PRODUCT	DILUTED WATER EVA	WASTE TO THE TOWER	CONCENTRATED WASTEWATER TO THE EVA BASIN		WASTE TO THE INCENTRATED				WASTE WATER TO THE HYDRANT	
						Solid		Liquid			
		kg/Batch	kg/day	Batch/kg	kg/day	kg/Batch	kg/day	kg/batch	kg/day	kg/Batch	kg/day
1	Nalidixic Acid	4747	19100	1896	7584	18	72	80	320	15000	60000
2	Mebendazole	4827	7080	2900	4253	295	433	150	220	40900	60000
3	Indenethacin	9155	6248	4909	3342	54	37	125	86	88000	60000
4	Propranolol Hcl					15	15	1110	1110		
5	Trimethoprim	2750	5500	2160	4320	6	12	4408	8836	30000	60000
6	Metronidazole	2750	5500	946	1892	1	2			6000	12000
7	Clotrimazole	7445	7445	2810	2810	1805	185	623	623	6000	60000
8	Chlordiazepoxide	12280	8445	3510	2410	180	125	890	610	87270	60000
9	Sulphamethoxazole	5038	10076	2606	5211	36	72	132	264	30600	60000
10	Procaine Hydrochloride	10040				26	26	400	400	60000	60000
11	Oxy Phynyl Butazone	13050	7830	12240	7342	57	34	2940	1760	100000	100000
12	Clofibrate	16300	7340	9770	41400	7	3	180	80	133300	60000