Characterization of Sewage and Design of Sewage Treatment Plant

Project Report submitted in partial fulfillment of the requirement for the degree of Bachelor in

Civil Engineering

under the Supervision of

Mr. Mani Mohan

By

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CERTIFICATE

This is to certify that the project report entitled **"Characterization of sewage and design of sewage treatment plant"** submitted by RISHI TIWARI, Roll No. 111677 and PRASHANT SHANKER, Roll No. 111626 in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Civil Engineering at the Jaypee University of Information Technology, Waknaghat is an authentic work carried out by them under my supervision and guidance.
We would like to express deepest appreciation towards **Prof. Dr. Ashok Kumar Gupta**, Head of Department of Civil Engineering.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date:

Signatures of Supervisors:

Prof. Dr. Ashok Kumar Gupta	Mr. Mani Mohan	
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ABSTRACT

The main purpose of this project is to design a sewerage system of capacity 1.5 MLD sewage treatment plant based on Extended aeration activated sludge process located in Solan district Himachal Pradesh.

The Sewage Treatment involves Preliminary, Primary, Secondary, Tertiary Treatment include Unit Operations and Unit Processes to remove physical, chemical and biological contaminants. The treated effluent can be discharged into a stream . The stabilized sludge can be used as a soil conditioner. Samples are collected regularly at the plant inlet as well as before and after each treatment process. The raw sewage is characterized by high dissolved solids, medium strength BOD, and low COD/BOD ratio.. These are typical characteristics of the sewage in this region. Theplant is designed, operated and maintained so as to ensure safety and reliability in the treated effluent quality. Any overloading of the treatment processes is handled effectively. The reclaimed water quality meets the international standards and guidelines for landscape irrigation and farming.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Solan town is situated on Kalka-Shimla National Highway no. 22 at a distance of 45 km from Shimla state capital of Himachal Pradesh. It is a district head quarter of District Solan. Solan is a fast developing city of Himachal Pradesh.Prior to independence Solan was known as Bhagat state .The climate of city is very pleasant during summer and moderate during winter,which attracts tourist from various parts of the countries.

- It is very popular h ill station in Himachal Pradesh approachable from other parts of the country by rail, road and air. The growth rate of this town is very high as compared to other town in state.
- The average elevation is about 1570 m above M.S.L
- The Latitude-Longitude is 30-50’ north 76-42’ east.
- Temperature ranges between 8 degree celcius in winter and 12 degree celcius to 23 degree celcius in summer. Maximum temperature so far recorded in summer is 38 degree celcius.
- Average annual rainfall is about 565.66 mm
- Economy of solan depends mainly on cash crop i.e vegetables and fruits.
- It includes some major educational institute and university.
- Spread of town is about 6 Sq. Km.

Need of the project

Presently there is one sewerage system/scheme in Solan town. The peoples have constructed their own septic tank for sanitation facility. In some areas of town the sewerage disposal is being done connecting the latrines to open drains or manually. The disposal of sewage is creating unhygienic and un-esthetic dilemma. The drains give bad smell causing breeding of flies and insects. Under these circumstances there is every chance of breaking the epidemic .Hence keeping in view the above facts and necessity of this essential amenity the sewerage system/scheme has been propose

1.2 Objectives of the study:

The principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. An environmentally-safe fluid waste stream is produced. No danger to human health or unacceptable damage to the natural environment is expected. Sewage includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage also includes liquid waste from industry and commerce.

The objectives of the study are:

1. Physical, chemical and biological characterization of the domestic waste water from Solan
2. Comparison with the prescribed standard
3. Design of the sewage treatment plant :

- Inlet chamber
- Bar Screen
- Grit Channels
- Aeration system comprising Aeration tank , settling tank ,return sludge system
- Sludge drying beds

1.3 Field Investigations:

Before preparing these proposals the detailed surveys in respect of following items have been carried out.

Topographical surveys

- Topographical survey of the town.
- Details of existing Drainage system
- Details of existing sewerage disposal
- Fixing of bench marks.(List of bench mark with value is enclosed)
- Topographical Survey of STP Land.
- Soil strata determination by bore hole (location shown on map)

Chapter 2

STUDY AREA

THE DETAILED STATEMENT SHOWING THE POPULATION SERVED AND ZONE WISE DETAIL AS PER PROJECT PROPOSAL AS UNDER:-

S.NO	ZONE	AREA COVERED	POPULATION COVERED	TREATMENT PLANT CAPACITY IN MLD
1.	A	MAIN BAZAR,OLD BUS-STAND,MALL ROAD,SHILLY ROAD,RESIDENCE JBT,HOSTELS,JAUNAJI ROAD, ST.KUKES,POST OFFICE AREAS, CHAMBAGHAT AREA ,TOURIST BANGLOW, MOHAN PARK, ETC AND ITS ADJOINING	5573 Person +593 staff +1500 students +30 Hostel beds	1.62 M.L.D
2.	B	MADHUBAN COLONY, TANK	9123 Persons +1638 staff	2.90 M.L.D

		ROAD, RESIDENCE LAKKAR BAZAR,CIRCULAR ROAD, HOSPITAL ROAD RESIDENCE, TEHSIL OFFICE SIDE RESIDENCE, KOTLA NALA , SUNNY SIDE, KALEEN SIDE RESSIDENCE, D.C OFFICE ETC	+2659 Students +264 Hostel beds +120 hospital beds	
3.	C	DISTT. EMPLOYEMENT OFFICE , RAJASTHAN BHAWAN, CHILDREN PARK I.T.I , NEW BUS STAND, KATHER SIDE, POLICE LINE, BYE PASS ARES, JAWAHAR PARK, SUNDER CINEMA	4225 Person + 1116 staff + 2495 Students +292 Hostel bed+ 38 hotel beds +1010cinema seats 96 bar seats	1.5 M.L.D

Table 1.

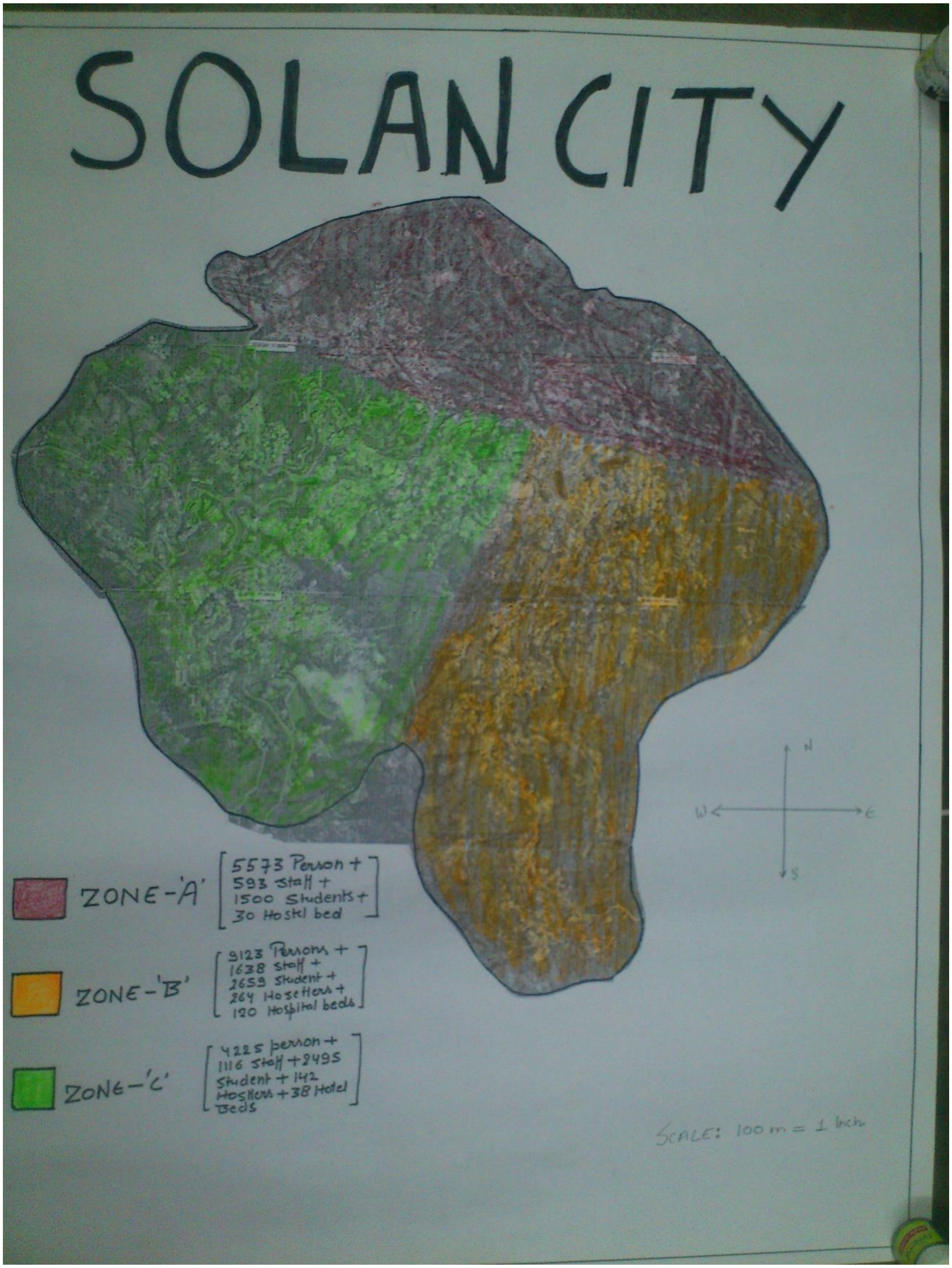

FIG 1. Zone Wise Detail

Chapter 3

SAMPLING TECHNIQUE

3.1 SAMPLING

A sampling can be done in two ways. These are:

a) Grab sampling:

Grab samples are single collected at a specific spot at a site over a short period of time (typically seconds or minutes). Thus, they represent a snapshot in both space and time of a sapling area. Discrete grab samples are taken at selected location, depth, time. (

Advantages:

1. It provides an immediate sample and thus is preferred.

2. These are very appropriate to small plants with low flows and where limited staff is available.

Disadvantages:

1. Grab sample takes snapshot of characteristic of water at specific point and time, so it may not be completely representative of entire flow.

b) Composite sampling:

Composite samples provide a more representative sampling of heterogeneous matrices in which the concentration of the analytes of interest may vary over short period of time or space. They are obtained by combining portions of multiple grab samples or by using specially designed automatic sampling devices. Sequential composite samples are collected by mixing equal water volumes collected at regular time intervals.

Advantages:

1. It includes reduced costs of analyzing large number of samples, more representative samples of heterogeneous matrices.
2. They give the snapshot of entire water sample.

Disadvantages:

1. It is a time consuming process and requires more staff.
2. It is not suitable where the analytes to be determined are not to be provided storage like temperature determination.

3.2 REASON FOR USING GRAB SAMPLING

Grab sampling is generally done when there is lack of time or staff to carry out the composite sampling. As the sites were far from our institute we had to restrict ourselves to grab sampling as it was not feasible to take samples after given after given interval from a single effluent source.

Chapter 4

EXPERIMENTS

4.1 LIST OF EXPERIMENTS

We have conducted the following lists of experiments in the laboratory using the guidelines specified for experiments on waste water *(Standard Methods-2005)* and find out the characteristics of influent coming from town.

S.NO.	**LIST OF EXPERIMENTS**
1	To determine pH of waste water samples.
2	To determine specific conductivity of waste water samples.
3	To determine total solids of waste water samples.
4	To determine total dissolved solids of waste water samples.
5	To determine total suspended solids of waste water samples.
6	To determine turbidity of waste water samples.
7	To determine acidity of waste water samples.
8	To determine the alkalinity of waste water samples.
9	To determine the concentration of chlorides in the waste water samples.

10	To determine DO of waste water samples.
11	To determine the BOD of waste water samples.
12	To determine the COD of waste water samples.

Table 2. List Of Experiments

4.2 NAME OF EXPERIMENT: pH

AIM: To determine pH of waste water samples.

PRINCIPLE:

Ph value denotes hydrogen ion concentration in the liquid and it is the measure of acidity or alkalinity of the liquid. According to law of mass action, in any liquid

Concentration of H ions × Conc. of OH ions/Conc. of undissolved HOH molecules

= constant = 10^{-14}

pH scale is taken from 0 to 14

ph of sample determined by using pH papers.

APPARAUS:

1. pH Strips.

PROCEDURE:

1) Dip a wide range pH strip into the solution whose pH o be found. The colour of litmus paper changes to thick red for highly acidic waters to dark green for highly alkaline waters and to any other colour depending on ph of solution. Compare the colour of paper with standard colours supplied.

pH meter

1. Switch on the pH meter on for 15 minutes.
2. After washing pH electrode and temperature probe is dipped in solution of pH 4.0 buffer. Change knob from standby to pH.
3. With CAL knob set the pH value to 4.0.
4. With pH 9.2 buffer, set the value to 9.2 using SLOPE knob.
5. Repeat the steps till pH meter standardized.
6. Take pH of different samples.
7. Note down the temperature.

We have used pH meter as it does not give stable values but within a range corresponding to results from pH paper

SIGNIFICANCE:

1. Determination of pH is one of the important objectives in biological treatment of waste water.
2. By knowing the pH of waste water we can make chemical adjustments to remove heavy metals and other toxic metals from industrial waste water.
3. Most organic matter and bacteria we are familiar with are best suited to a neutral or slightly basic environment which can be determined from pH.

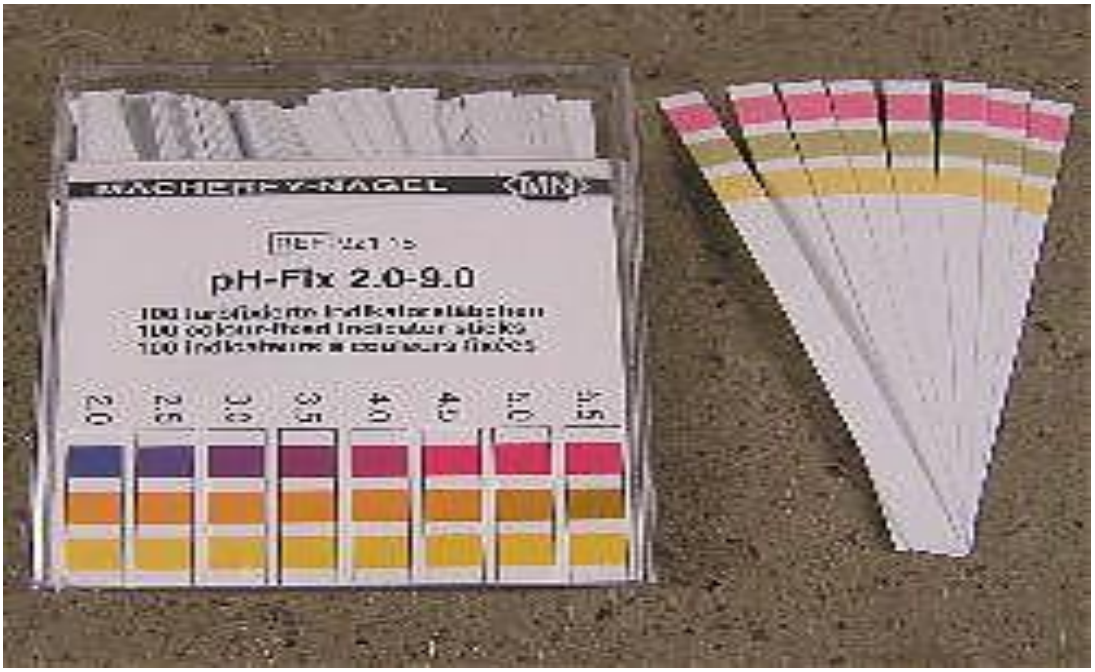

Fig.2. pH paper

4.3 NAME OF EXPERIMENT: SPECIFIC CONDUCTIVITY

AIM: To determine specific conductivity of waste water sample.

PRINCIPLE: The electrical conductivity is a total parameter for dissolved substances. Its value depends on concentration and degree of dissociation of the ions as well as temperature and migration velocity of ions in electrical field.

APPARATUS: Conductivity meter, beakers.

PROCEDURE:

1. Switch on the conductivity meter for 15 minutes
2. Take out the conductivity cell dipped in distilled water, wash it with distilled water and wipe it dry with a tissue paper.

3. Calibrate the cell with standard 0.1N KCl solution of conductivity 14.12 m mhos at 25ºC.

4. Take out the conductivity cell, wash it thoroughly with distilled water and wipe it dry.

5. Dip the cell into the sample solution, swirl the solution and wait up to 1minute for a steady reading.

6. Note down the instrument reading and also temperature.

SIGNIFICANCE:

1. Dissolved minerals and organics may produce aesthetically displeasing colours, taste and odours to water.

2. Significant changes in conductivity could be an indicator that a discharge or some other source of pollution has entered a stream.

3. Organic compounds present in waste water like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water.

4. Higher value of conductivity indicates the presence of chloride, phosphate, and nitrate.

Fig. 3 Conductivity meter

4.4 NAME OF EXPERIMENT: TOTAL SOLIDS

AIM: To determine total solids of waste water samples.

PRINCIPLE: Total solids are determined as the residual left after evaporation & drying of unfiltered sample.

APPARATUS:

1. Evaporating dish.

2. Oven

3. Water bath

PROCEDURE:

1.A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air it is cooled and weighted.

2.A 100ml of well mixed sample is placed in the dish and evaporated at 100ºC on water bath, followed by drying in oven at 103ºC for one hour

3.Dry to a constant weight at 103ºC, cool and weigh.

Significance:

1.Solids analysis are important in the control of biological and physical waste water treatment processes and for accessing compliance with regulatory agency waste water affluent limitations.

2. The amount of solids in waste water is frequently used to describe the strength of the water.

3. If the solids in waste water are mostly organic, the impact on a treatment plant is greater than if the solids are mostly inorganic.

4.5 NAME OF EXPERIMENT: TOTAL DISSOLVED SOLIDS

AIM: To determine total dissolved solids of waste water samples.

PRINCIPLE: It is determined as the residue left after evaporation and drying of filtered water sample.

APPARATUS:

1. Evaporating dishes

2. Oven

3. Whatman Filter paper No. 44 (0.45 micron)

PROCEDURE:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled at weighted.
2. A 100ml of filtered sample is placed in the dish and evaporated at 100ºC on water bath followed by drying in oven at 103ºC for 24 hour.
3. Dry to a constant weight at 103ºC, cool and weigh.

Significance:

1. Many industrial wastes contain unusual amount of dissolved inorganic salts and and their presence can be easily detected

4.6 NAME OF EXPERIMENT: TOTAL SUSPENDED SOLIDS

AIM: To determine total suspended solids of waste water samples.

PRINCIPLE: It is determined as the residue left on evaporating dishes after drying in oven.

APPARATUS:

1. Evaporating dishes

2. Oven

SIGNIFICANCE:

1. This test serves as the principal basis of determining whether primary sedimentation facilities are required for treatment.

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Fig. 4 Oven

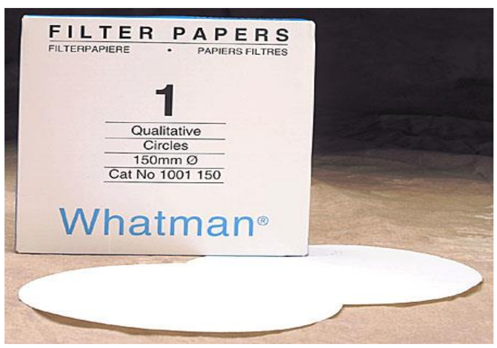


Fig. 5 Filter Paper

4.7 NAME OF EXPERIMENT: TURBIDITY

AIM: To determine turbidity of waste water sample.

PRINCIPLE: When light passes through a sample having suspended particles some of the light is scattered by the particles. The scattering of light is generally proportional to the turbidity. Turbidity of sample is thus measured from the amount of light scattered by the sample taking the reference with standard turbidity solution.

APPARATUS:

Nephelometric Turbidity meter, Sample tubes.

REAGENTS:

1. Dissolve 1g of Hydrazine sulphate and dilute to 100ml.
2. Dissolve 10g of hexamethylene tetra amine and dilute to 100 ml.
3. Mix 5ml of each of the above solution in a 100ml volumetric flask and allow standing for 24 hours a 25ºC and diluting to 1000ml. This solution has a turbidity of 40 NTU.

PROCEDURE:

1. Switch on the Nephelometric turbidity meter and wait for few minutes till it warm up.
2. Set the instrument at 100 on the scale with a 40 NTU standard suspension. In this case every division on the scale will represent (0.4) NTU turbidity.
3. Shake thoroughly the sample and keep it for some time to eliminate he air bubbles.
4. Take sample in Nephelometer sample tube and put the sample in sample chamber and find out the value on the scale.
4. Dilute the sample with turbidity free water and again read the turbidity

SIGNIFICANCE :

1. In plants employing chemical treatment, changes in chemical dosage have to make rather frequently. Turbidity measurements can be used to advantage, because of the speed with which they can be made, to gain the necessary information.

Fig. 6 Turbidity meter

4.8 NAME OF THE EXPERIMENT: ACIDITY

AIM: To determine acidity of waste water samples.

PRINCIPLE: The mineral acids present in the sample which are contributing mineral acidity can be calculated by titrating on neutralizing the samples with strong base NaOH to pH4.3. The CO_2 and bicarbonates present can contribute CO_2 acidity in the sample and can be neutralized completely by continuing the titration to pH 8.2.

APPARATUS:

1. Burette

2. Pipettes

3. Conical Flask

REAGENTS REQUIRED:

1. Standard sodium hydroxide
2. Phenolphthalein indicator
3. Methyl orange indicator
4. Sodium thiosulphate

5. Carbon free distilled water

PROCEDURE:

1. Pipette out 100 ml of the given water sample into a conical flask
2. Add 1 drop of 0.1N sodium thiosulphate solution to destroy any residual chlorine
3. Add 2 drops of methyl orange indicator. The sample turns pink.
4. Titrate against 0.02N standard sodium hydroxide solution until pink colour changes to yellow.
5. Note down the volume of the NaOH added.
6. Take another conical flask containing 100 ml of water sample, add 2 drops of phenolphthalein.
7. Proceed with titration until the sample turns pink.
8. Note down the total volume of NaOH added.

SIGNIFICANCE:

1. Industrial wastewater containing high mineral acidity is must be neutralized before they are subjected to biological treatment or discharge to water sources.

4.9 NAME OF EXPERIMENT: ALKALINITY

AIM: To determine the alkalinity of waste water samples.

PRINCIPLE: Alkalinity can be obtained by neutralizing OH^- , $CO_3^{--}$and HCO_3^- with standard H_2SO_4. Titration to pH 8.3 or decolourization of phenolphthalein indicator will show complete neutralization of OH^- and half of CO_3^{--}, while to pH 4.4 sharp changes from yellow to pink of methyl orange indicator will indicate total alkalinity.

APPARATUS:

1. Burette

2. Pipettes

3. Conical Flask

REAGENTS REQUIRED:

1. Standard sulphuric acid
2. Phenolphthalein indicator
3. Methyl orange indicator
4. Carbon dioxide free distilled water
5. Sodium thiosulphate

PROCEDURE:

1. Take 100 ml of the given water sample in a conical flask.
2. Add one drop of 0.1N sodium thiosulphate solutions to remove the free residual chlorine if present.
3. Add 2 drops of phenolphthalein indicator. The sample turns pink.
4. Run down .02N standard sulphuric acid till the solution turns colourless.
5. Note down the volume of sulphuric acid added.
6. Add 2 drops of methyl orange indicator till the sample turns yellow.
7. Resume titration till the colour of solution turns to pink.
8. Note down the total volume of sulphuric acid added.

SIGNIFICANCE:

1. The alkalinity acts as a pH buffer in coagulation and lime-soda softening of water.
2. In waste it is an important factor in determining amenability of wastes to the treatment process and control of process such as anaerobic digestion.

4.10 NAME OF THE EXPERIMENT: CHLORIDES

AIM: To determine the concentration of chlorides in the waste water samples.

PRINCIPLE: The Mohr method for the determination of chloride in water is based upon the fact that in solution containing chloride and chromate, silver reacts with all the chlorides and precipitates before the reaction with chromate begins. The appearance of brick red colour of the silver chromate precipitate is the end point of titration.

APPARATUS: Burette, Pipette and conical Flask.

REAGENTS:

1. Chloride free distilled water.
2. Potassium chromate colour indicator
3. Standard silver nitrate solution
4. Standard sodium chloride solution

PROCEDURE:

1. Take 100 ml of sample in conical flask.
2. Adjust the pH between 7.0 to 8.0 either with sulphuric acid or sodium hydroxide solution.
3. Add 1 ml of potassium chromate indicator to get light yellow colour.
4. Titrate with standard nitrate silver nitrate solution till the colour changes from yellow to brick red.
5. Note the volume of silver nitrate added.
6. For better accuracy, titrate 100 ml of distilled water in the same way after adding 1 ml of potassium chromate indicator to establish reagent blank.
7. Note the volume of silver nitrate added for distilled water.

BLANK TITRATION:

1. Take 20 ml of distilled water in a clean 250ml conical flask.
2. Add 1ml of potassium chromate indicator to get light yellow colour.

3. Titrate he sample against silver nitrate solution until the colour changes from yellow to brick red.

4. Note the volume of silver nitrate added.

SIGNIFICANCE:

1. Determination of disinfectant demand of waste water is important consideration in design.

2. It serves as the basis for determining the capacity of disinfection required, the amount of disinfectant needed.

4.11 NAME OF EXPERIMENT: DISSOLVED OXYGEN

AIM: To determine DO of waste water samples.

PRINCIPLE:

The principle involved in determination of DO is to bring about oxidation of potassium iodide to iodine with the dissolved oxygen present in the water sample after adding $MnSO_4$, KOH &KI, and the basic manganic oxide formed acts as an oxygen carrier to enable dissolved oxygen to take part in reaction.

The liberated iodine is titrated against standard sodium thio-sulphate solution using starch as a indicator. The blue colour disappears gives indication of dissolved oxygen present originally.

THEORY:

Determination of DO is important as it indicates purity of water. DO is needed for living organism to maintain their biological processes. If DO is less than required limit there is indication of pollution due to industrial waste. This test helps us to assess check on stream pollution. Oxygen is poorly soluble in water. The solubility of DO decreases with increase in concentration of salts at 1 atmospheric pressure.

APPARATUS:

1. BOD bottles
2. Pipettes
3. Burette

REAGENTS REQUIRED:

1. Standard sodium thio-sulphate solution (0.02N),
2. KMnO4 solution (N/10),
3. Potassiun oxalate solution (2%),
4. Manganous sulphate solution (4.8%),
5. Alkaline potassium iodide,
6. Freshly prepared starch solution,
7. Concentrated sulphuric acid

PROCEDURE:

1. Collect sample in a BOD bottle using Do sampler.
2. Add 0.9mL H_2SO_4 followed by 0.2mL of $KMnO_4$ reagent to a sample collected in 250 to 300mL bottle up to the brim. The tip of the pipette should be below the liquid level while adding these reagents. Rinse the pipettes before putting them to reagent bottles.
3. Add 0.5 ml of potassium oxalate solution, and mix well.
4. Now add 2ml of $MnSO_4$ solution followed by 3 ml of alkaline KI solution. Stopper and shake and allow the precipitate to settle.
5. Now add 1 ml of conc. H_2SO_4solution and mix until the precipitate is completely dissolved.
6. Measure 102.2 ml of this solution with measuring and titrate it against (N/50) hypo solution.
7. When colour of the solution is very light yellowish add 2ml of freshly prepared starch solution and continue the titration to the disappearance of the blue colour.

SIGNIFICANCE:

1. DO measurement are vital for maintaining aerobic condition in waste water that receives pollution matter and in aerobic treatment process intended to purify industrial waste water.
2. Determination of waste water serve as the basis of the BOD test, thus they are used to evaluate pollution strength of industrial wastes.
3. The rate of biochemical oxidation can be measured by determining residual dissolved oxygen in a system at various interval of time.

4.12 NAME OF THE EXPERIMENT: BIOLOGICAL OXYGEN DEMAND (BOD)

AIM: To determine the BOD of waste water samples.

PRINCIPLE: The BOD is an imperial biological test this BOD may be considered as wet oxidation procedure in which the living organisms serve as the medium for oxidation of the organic matter to CO_2 and water.

INTERFERENCE: Undesirable oxygen consumption via nitrification can be prevented by addition of an N-allyl-thio-urea solution. Free chlorine present in some waste waters after chlorination reacts with organic components within about 2hrs and does not interfere. Compounds which use up oxygen without the presence of microorganisms are oxidized by leaving the original sample for 2hrs with occasional shaking. Lack of nutrients in diluted water, lack of an acclimaed seed organisms and the presence of toxic substances can result in very low BOD values, despite the presence of sufficient degradable organic materials.

REAGENTS:

1. Distilled water.
2. Magnesium Sulphate solution.
3. Sodium thio-sulphite solution.
4. Calcium chloride solution

5. Phosphate buffer solution.

PROCEDURE:

1. Place the desired volume of distilled water in a 300 ml flask. Aeration is done by bubbling compressed air through water.

2. Add 1 ml of phosphate buffer, 1 ml of magnesium sulphate solution, 1ml of calcium chloride solution and 1ml of ferric chloride solution for every litre of distilled water (dilution water).

3. In the case of wastewaters which are not expected to have sufficient bacterial population, add seed o the dilution water. Generally 2ml of settled sewage is sufficient for 1000ml of dilution water.

1. Highly acidic or alkaline samples are to be neutralised to a pH of 7.

2. Add 2-3 ml of sodium thiosulphate solution to destroy residual chlorine if any.

3. Dilute the sample with the distilled water and mix he contents well.

4. Take diluted sample in 2 BOD bottles.

5. Fill another two bottles with diluted water alone.

6. Immediately find D.O of a diluted waste water and diluted water.

7. Incubate the other BOD bottles at 200ºC for 5 days. They are to be tightly stoppered to prevent any air entry into the bottles.

8. Determine D.O content in the incubated bottles at the end of 5 days.

SIGNIFICANCE:

1) Information concerning BOD of wastes is an important consideration in design of treatment facilities.

2) It is a factor which is used to determine the design of certain units, particularly trickling filters and activated sludge units.

3) This test is used to evaluate the efficiency of various treatment processes.(Sayers and McCarthy-2003).

Fig. 7 BOD Incubator

4.13 NAME OF THE EXPERIMENT: CHEMICAL OXYGEN DEMAND (COD)

AIM: To find out the COD of waste water samples.

PRINCIPLE: The organic matter present in sample get oxidized completely by $K_2Cr_2O_7$ in the presence of H_2SO_4 to produce CO_2 and H_2O the excess $K_2Cr_2O_7$ remaining after the reaction is titrated with $Fe(NH_4)_2(SO_4)_2$. The dichromate consumed gives the oxygen required to oxidatize the organic matter.

REAGENTS:

1. Standard Potassium dichromate 0.25N
2. Sulphuric acid with reagent (conc.H_2SO_4 + Ag_2SO_4)
3. Standard ferrous ammonium sulphate 0.1 N
4. Ferroin indicator.
5. Mercuric Sulphate.

PROCEDURE:

1. Place 0.4 gm of sulphuric acid in the reflux flask.
2. Add 20 ml of sample.
3. 10 ml of more concentrated dichromate solution are placed into flask together with glass beds.
4. Add slowly 30 ml of sulphuric acid containing Ag_2SO_4 and mix thoroughly.
5. Connect he flask to condenser. Mix the contents thoroughly before heating. Improper mixing results in bumping and the sample may be blown out.
6. Open reflux for a minimum period of 2 hours. Cool and wash down the condenser with distilled water.
7. Dilute the sample to make up 150 ml and cool.
8. Titrate excess $K_2Cr_2O_7$ with 0.1N $Fe(NH_4)_2(SO_4)_2$using ferroin indicator, sharp colour change from blue green to wine red indicates the end point.
9. Reflux the blank in the same manner using distilled water instead of sample.

SIGIFICANCE:

1. COD is useful to assess strength of wastes, which contain toxins and biologically resistant organic substances.

2. The ratio of BOD to COD is useful to assess the amenability of the waste for biological treatment. Ratio of BOD to COD greater than or equal to 0.8 indicates that wastewaters are highly amenable to the biological treatment.

Fig. 8 Spectrophotometer

Fig. 9 COD reactor

Test Results

Name of experiment	Influent	Effluent (Required)
pH	6.5-8.5	6.5-8.5
Total solids	240 mg/l	200 mg/l
Suspended solids	400 mg/l	30 mg/l
Turbidity	89 NTU	<10
Alkalinity	225 mg/l	200-600 mg/l
Acidity	85 mg/l	NA
Chloride Content	24.2 mg/l	600 mg/l
Chemical oxygen demand	577 mg/l	150 mg/l
Biological oxygen demand	270 mg/l	<20 mg/l
Dissolved oxygen	8 mg/l	5 mg/l (min)

Table 3. Test Results

Chapter 5

POPULATION & ZONE WISE DETAIL

Solan town has been divided into 3 nos. zones due to its geographical and topographical conditions .All the zones named A, B, C have been provided with treatment unit of different capacities as per design norms .The total population of the town on the basis of 1991 census is 21,751 persons except the institutions and other Govt. semi-govt. offices etc.

But the total population of 18,921 persons which has been served in the estimation of augmentation of water supply scheme a Solan has been taken in the proposed sewerage system and all other institution, Government offices etc. on their strength basis on the certificates from concerned 2 No. wards. Population having (1138 persons +1172 persons) total 2310 persons named Deoghat and Brewery has not been include in this system .Due to the unconditional topography of Deonghat ward and the separate system of Brewery area which the both ward has their own separate disposals and system according to M.C Solan.

5.1 Projection of Future Population

The population of Solan town under municipal limits for various decades as per Census are tabulated below :-

Year	Population	Decadal Increase	Incremental Increase	Percentage Increase	Remarks
1971	7356				The population growth is varying in different decades
1981	13130	5774		78.5	
1991	21751	8621	2847	65.65	
2001	34199	12448	3827	57.22	
2011	41935	7736	(-)4712	22.62	
	Total	34579	1962		
	Mean	**8645**	**654**	**50.82**	

Table 4. Old Data

5.2 The projections of population by different methods

Geometrical Mean = 0.5082

Population projections of the town for various years i.e. Base Year, Middle Year & Design Year have been done as below :

5.2.1 Arithmetical Increase Method

Population Base Year (2015) = 41935 + (4/10 x 8645) = 45393

Population Middle Year (2025) = 41935 + (14/10×8645) = 54038

Population Design Year (2045) = 41935+ (34/10 x 8645) = 71328

5.2.2 Geometrical Increase Method

Population Base Year (2015) = 41935 $(1+0.5082)^{0.4}$ = 49427

Population Middle Year (2025) =41935 $(1+0.5082)^{1.4}$ =74545

Population Design Year (2045) =41935 $(1+0.5082)^{3.4}$ = 169565

5.2.3 Incremental increase Method

Future Population P = Po + nd + ½ n (n+1) C Where Po = Population of last decade

n = No. of decade

d = Average of decadal increase

c = Incremental increase

Population for Base Year 2015 :

= 41935 + 0.4 x 8645 + 0.4 (0.4 +1) x654/2

= 45576

Population for Middle Year 2025 :

= 41935 + 1.4 x 8645 + 1.4 (1.4+1) x (654)/2

= 55136

Population for Design Year 2045 :

= 41935 + 3.4 x 8645 +3. 4 (3.4 + 1) x (654)/2

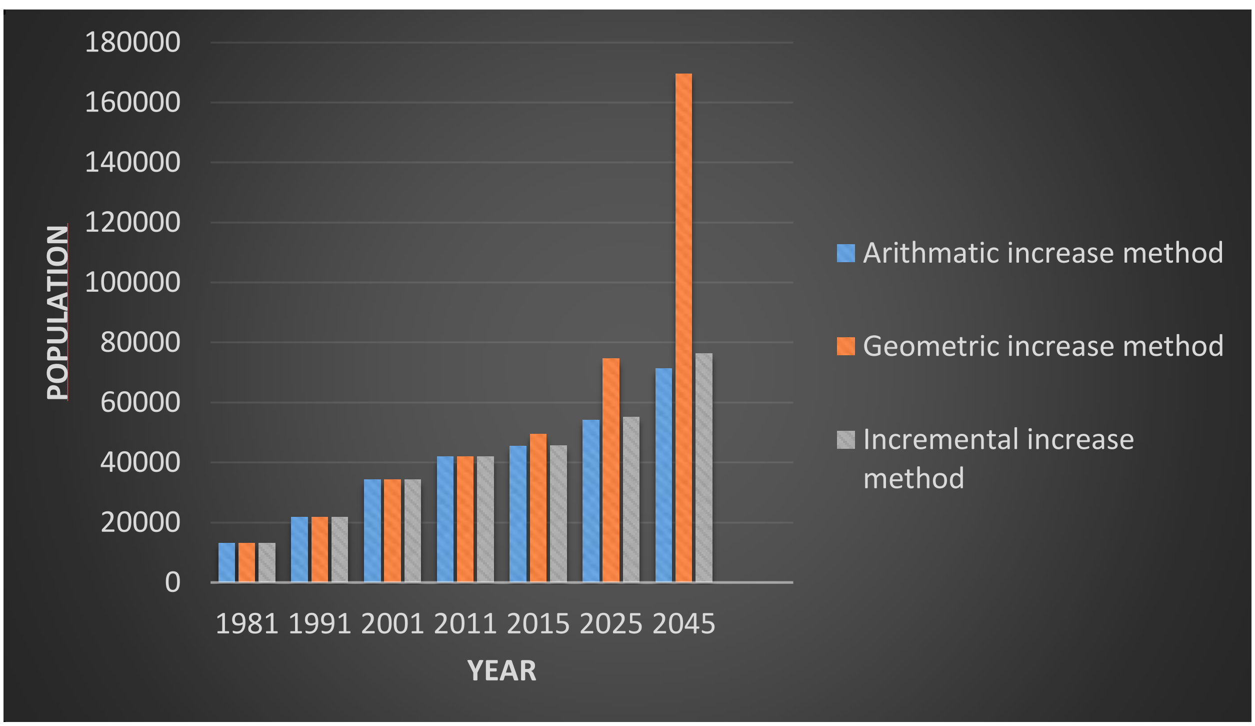
= 76220

Population projection by various method for different year are tabulated below :-

Sl. No.	Description of Method	Population in the year		
		2015	**2025**	**2045**
1.	Arithmetical Increase Method	45393	54038	71328
2.	Geometrical Increase Method	49427	74545	169565
3.	Incremental Increase Method	45576	55136	76220

Table 5. Population projection by various method for different year

Graphical Representation :



Conclusion of Population Projection

Different population projection methods have been adopted as given in the table above. After considering floating population and analyising these figures it appears that the **incremental increase method** provides best suitable projection and hence adopted for designing of sewerage system of Solan town. Consequently population of various years is as follows.

(1) Population for Base year 2015 - 45576

(2) Population for Middle year 2025 - 55136

(3) Population for Design year 2045 – 76220

5.3 Overview of Process for Sewage Treatment :

5.3.1 Primary Treatment Units

Primary treatment consists solely separating the floating materials and also the heavy settable organic and inorganic solids. It also helps in removing the oils and grease from the sewage.This treatment reduces the BOD of the wastewater by about 15 to 30%. The operations used are screening for removing floating papers, rages, cloths, etc., grit chambers or detritus tanks for removing grit and sand, and skimming tanks for removing oils and grease; and primary settling tank is provided for removal of residual suspended matter. The organic solids, which are separated out in the sedimentation tanks in primary treatment, are often stabilized by anaerobic decomposition in digestion tank or incinerated. After digestion the sludge can be used as manure after drying on sludge drying beds or by some other means.

5.3.2 Bar Screens

Bar screen is a set of inclined parallel bars, fixed at a certain distance apart in a channel. These are used for removing larger particles of floating and suspended matter. The wastewater entering the screening channel should have a minimum self-clearing velocity 0.375 m/sec. Also the velocity should not rise to such extent as to dislodge the screenings from the bars. The slope of the hand-cleaned screens should be between 300 and 450 with the horizontal and that of mechanically cleaned screens may be between 450 and 800. The submerged area of the surface of the screen, including bars and opening should be about 200% of the c/s area of the extract sewer for separate sewers and 300% for combined sewers.

Clear spacing of bars for hand cleaned bar screens may be from 25 to 50 mm and that for mechanically cleaned bars may range from 15 mm to 75 mm. The width of the bars, facing the flow may be 8 mm to 15 mm and depth may vary from 25 mm to 75 mm, but sizes less than 8 x 25 mm are normally not used.

5.3.3 Grit Chamber

Grit chambers are designed to remove grit consists of sand, gravel, cinders or other inert solid materials that have specific gravity about 2.65, which is much greater than those of the organic solids in the wastewater. In this chamber particles settle as individual entities and there is no significant interaction with the neighboring particles. This type of settling is referred as free settling or zone-I settling. For proper functioning of the grit chamber, the velocity through the grit chamber should not be allowed to change in spite of the change in flow. One of the most satisfactory types of automatic velocity control is achieved by providing a proportional weir at the outlet. The horizontal flow grit chambers should be designed in such a way that under the most adverse conditions, all the grit particles of size 0.20 mm or more in diameter should reach the bed of the channel prior to reaching outlet end. The length of the channel depends on the depth required which again depends on the settling velocity. A minimum allowance of approximately twice the maximum depth should be given for inlet and outlet zones. An allowance of 20-50% of the theoretical length of the channel may also be given. Width of grit chamber should be between 1 m to 1.5 m and depth of flow is normally kept shallow. For total depth of channel a free board of about 0.3 m and grit space about 0.25 m should be provided. For larger plants two or more number of grit chambers in parallel may be used. In grit chambers the recommended detention time is about 30 to 60 seconds.

5.3.4 Skimming Tank

The floating solid materials such as soap, vegetables, debris, fruit skins, pieces of corks, *etc.* and oil and grease are removed from the wastewater in skimming tanks. A skimming tank is a chamber designed so that floating matter rises and remains on surface of the wastewater until removed, while the liquid flows continuously through outlet or partition below the water lines. The detention time in skimming tank is 3 minutes. To prevent heavy solids from settling at the bed, compressed air is blown through the diffusers placed in the floor of the tank. Due to compress air supply, the oily matters rise upward and are collected in the side trough, from where they are removed. In conventional sewage treatment plant separate skimming tank is not used and these materials are removed by providing baffle ahead of the effluent end of the primary sedimentation tank.

5.3.5 Primary Sedimentation Tank

Effluent of the grit chamber, containing mainly lightweight organic matter, is settled in the

primary sedimentation tanks. The objective of treatment by sedimentation is to remove readily settleable solids and floating material and thus to reduce the suspended solids content when they are used as preliminary step to biological treatment, their function is to reduce the load on the biological treatment units. The primary sedimentation tanks are usually designed for a flow through velocity of 1 cm/sec at average rate of flow. The detention period in the range of 90 to 150 minutes may be used for design. These tanks may be square, circular, or rectangular in plan with depth varying from 2.3 to 5 m. The diameter of circular tanks may be up to 40 m. The width of rectangular tank may be 10 to 25 m and the length may be up to 100 m. But to avoid water currents due to wind, length is limited up to 40 m. The slope of sludge hoppers in these tanks is generally 2:1 (vertical: horizontal). The slope of 1% is normally provided at the bed for rectangular tanks and 7.5 to 10% for circular tanks. This slope is necessary so that solids may slide to the bottom by gravity.

5.3.6 Secondary Treatment

The effluent from primary treatment is treated further for removal of dissolved and colloidalorganic matter in secondary treatment. This is generally accomplished through biochemical decomposition of organic matter, which can be carried out either under aerobic or anaerobic conditions. In these biological units, bacteria's decompose the fine organic matter, to produce clearer effluent. The end products of aerobic decomposition are mainly carbon dioxide and bacterial cells, and that for anaerobic process are CH4, CO2 and bacterial cells.

The biological reactor in which the organic matter is decomposed (oxidized) by aerobic bacteria may consist of:

1) Filters (tricking filters),

2) Activated Sludge Process (ASP),

3) Oxidation ponds, *etc.*

The bacterial cells separated out in secondary setting tanks will be disposed after stabilizing
them under aerobic or anaerobic process in a sludge digestion tank along with the solids settled in primary sedimentation tanks

5.3.7 Trickling Filter

Trickling filters can be used for complete treatment for domestic waste and as roughing filter for strong industrial waste prior to activated sludge process. The primary sedimentation tank is provided prior to trickling filter so that the settleable solids in the sewage may not clog the filter. The trickling filter is followed by secondary settling tank for removal of settleable biosolids produced in filtration process. As the wastewater trickles through the filter media (consisting rocks of 40 to 100 mm size or plastic media), a biological slime consisting of aerobic bacteria and other biota builds up around the media surface. Organic material in the sewage is absorbed on the biological slime, where they are partly degraded by the biota, thus increasing the thickness of the biofilm.

Eventually there is a scouring of the biofilm and fresh biofilm begins to grow on the media.This phenomenon of detachment of the biofilm is called sloughing of the filter.

The trickling filters are classified as low rate and high rate depending on the organic and hydraulic loadings. Low rate filters are designed for hydraulic loading of 1 to 4 m3/m2.d and organic loadings as 80 to 320 g BOD/m3.d. The high rate trickling filters are designed for hydraulic loading of 10 to 30 m3/m2.d (including recirculation) and organic loading of 500 to 1000 g BOD/m3.d (excluding recirculation). Generally recirculation is not adopted in low rate filter and recirculation ratio of 0.5 to 3.0 or higher is used in case of high rate trickling filters. The depth of media varies from 1.0 to 1.8 m for high rate filters and 2.0 to 3.0 m for low rate filters. The bed of trickling filter is provided with slope 1 in 100 to 1 in 50. The under drainage system consists of 'V' shaped or half round channels, cast in concrete floor during its construction. Revolving distributors are provided at top with two or four horizontal arms of the pipe having perforations or holes. These rotating arms remain 15 to 25 cm above the top surface of the media. The distribution arms are rotated by the electric motor or by back reaction on the arms by the wastewater, at about 2 rpm. The head of 30 to 80 cm of wastewater is required to rotate the arms.

5.3.8 Activated Sludge Process

It is aerobic biological treatment system. The settled wastewater is aerated in an aeration tank for a period of few hours. During the aeration, the microorganisms in the aeration tank

stabilize the organic matter. In this process part of the organic matter is synthesized into new cells and part is oxidized to derive energy. The synthesis reaction followed by subsequent separation of the resulting biological mass and the oxidation reaction is the main mechanism of BOD removal in the activated sludge process.

The biomass generated in the aeration tank is generally flocculent and it is separated from the aerated wastewater in a secondary settling tank and is recycled partially to the aeration tank. The mixture of recycled sludge and wastewater in the aeration tank is referred as mixed liquor. The recycling of sludge helps in the initial built up of a high concentration of active microorganism in the mixed liquor, which accelerates BOD removal. Once the required concentration of microorganism in the mixed liquor has been reached its further increase is prevented by the regulating quantity of sludge recycled and wasting the excess sludge from the system.

Aeration units are main units of activated sludge process, the main aim of which is to supply oxygen to the wastewater to keep the reactor content aerobic and to mix up the return sludge with wastewater thoroughly. The usual practice is to keep the detention period between 6 to 8 hours for treatment of sewage or similar industrial wastewater. The volume of aeration tank is also decided by considering the return sludge, which is about 25 to 50% of the wastewater volume. Normally liquid depth provided should be between 3 and 4.5 m. A free board of 0.3 to 0.6 m is also provided. The mode of air supply in aeration tank can be either diffused air aeration, by supplementing compressed air from tank bottom, or by mechanical aerators provided at surface or by both diffused aeration and mechanical aerators. Depending on flow regime the activated sludge process can be classified as conventional (plug flow) and completely mixed activated sludge process. The modification of activated sludge process such as extended aeration is popularly used for treatment of wastewaters. The extended aeration is design for higher hydraulic retention time (18 h) and low F/M ratio (0.05 to 0.15 kg COD/kg VSS.d).

5.3.9 Secondary Settling Tank (SST)

Design of secondary settling is somewhat different than that of the primary settling tanks. In the secondary settling tank the function served is clarification as well as thickening of the sludge. This type of settling which takes place in secondary settling tank is refereed as zone settling followed by compression. The SST is designed for detention period of 1.5 to 2.5 h. The depth of the tank can be between 2.5 and 4.5 m. The area of the tank is to worked out on the basis of surface overflow rate, overflow rate for SST of trickling filter should be 15-25 m3/m2.d and for SST of ASP 15-35 m3/m2.d at average flow. The length of effluent weir should be such that the weir loading rate is less than 185 m3/m.d.

5.3.10 Sludge Treatment

Sludge drying beds are commonly used in small wastewater treatment plants to dewater the sludge prior to final disposal. Two mechanisms are involved in the process, such as filtration of water through the sand, and evaporation of water from sludge surface. The filtered water is returned to the plant for treatment. The process is well suited to sludge, which have undergone proper aerobic or anaerobic digestion. Sludge from the conventional activated sludge, contacted stabilization, trickling filter, and rotating biological contactor processes usually contain a large amount of volatile solid, which tend to unpleasant odour problem. Therefore this method is generally not suitable for handling this sludge without prior stabilization, and digestion of sludge is essential prior to application of sludge on sludge drying beds. A typical sludge drying bed consist of 15 to 30 cm of coarse sand layer underlain by approximately 20 to 45 cm of grade gravel ranging in size from 0.6 to 4 cm. Open jointed tubes of 10 to 15 cm diameter spaced at 2.5 to 6 cm are laid in the gravel to provide drainage for liquid passing through the bed. Sludge is applied to the drying bed in layer of 20 to 30 cm, depending upon local climatic conditions the sludge is allowed to dry for two to four weeks. Enclosing drying beds with glass can improve the performance of the dewatering process, particularly in cold or wet climates. For an enclosed bed the area required for a bed may get reduced to two third as compared to area required for open beds.

5.3.11 Tertiary Treatment

This treatment is sometimes called as the final or advanced treatment and consists of removing the organic matter left after secondary treatment, removal of nutrients from sewage, and particularly to kill the pathogenic bacteria. Disinfection is normally carried out by chlorination for safe disposal of treated sewage in water body which is likely to be used at downstream for water supplies. However, for other reuses tertiary treatment is required for further removal of organic matter, suspended solids, nutrients and total dissolved solids as per the needs. The sewage treatment is generally confined up to secondary treatment only. Various physical chemical and biological processes are available for treatment, depending upon the particular requirements. The choice of treatment methods depends on several factors, including the disposal facilities available.

Actually, the distinction between primary, secondary & tertiary treatment is rather arbitrary, since many modern treatment methods incorporate physical chemical and biological processes are available for treatment, depending upon the particular requirements. The choice of treatment methods depends on several factors, including the disposal facilities available. Actually, the distinction between primary, secondary & tertiary treatment is rather arbitrary, since many modern treatment methods incorporate physical, chemical, and biological processes in the same operations. The secondary treatment can be achieved by aerobic process or anaerobic process.

Conventionally the aerobic process i.e. activated sludge process is used for sewage treatment. As a low cost treatment option, oxidation pond can also be used for sewage treatment. With the advent of the energy crises, the use of anaerobic process are being taken into consideration in greater depth as a substitutes for the traditional energy dependent activated process or large area demanding oxidation ponds. The application of anaerobic process for wastewater treatment is attractive only if large volumes of wastewater can be forced through the system in a relatively short period of time. This will give low hydraulic retention time and therefore anaerobic reactor becomes space efficient.

Today majority of wastewater treatment plants use aerobic metabolism for the removal of organic matter. The most well known aerobic processes are the activated sludge process, oxidation ditch, oxidation pond, trickling filter, and aerated lagoons.

CHAPTER 6

DESIGN Of SEWAGE TREATMENT PLANT

6.1 SALIENT FEATURES OF PROPOSED SEWERAGE SCHEME

POPULATION OF SOLAN TOWN AS PER CENSUS 1981	13,130 PERSON + NON DOMESTIC POPULATION
POPULATION OF SOLAN TOWN AS PER CENSUS 1991	21,751 PERSON +NON DOMESTIC POPULATION
PRESENT POULATION AS PER CENSUS 2001	34,199 PERSON +NON DOMESTIC POPULATION
DESIGN POPULATION UP TO THE YEAR 2045	76220 PERSON + NON DOMESTIC POPULATION
DESIGN PERIOD	30 YEARS

TIME PERIOD OF COMPLETION	5 YEARS
PEAK FACTOR	2.5
PER CAPITA SEWER FLOW	80% OF WATER FLOW (RATE OF WATER SUPPLY)
VOLUME OF MANNING CO-EFFICIENT-n-	0.013(C.I.PIPES CLASS LA)
MINIMMUM VELOCITY FLOW	0.48 M.P.S.
MAXIMUM VELOCITY	2.44 M.P.S
NO OF TREATMENT UNITS	3 NOS.
NO OF ZONES	3 NOS. A, B,C

TREATMENT PLANT CAPACITY	ZONE A=1.62 MLD ZONE B=2.90 MLD ZONE C=1.5 MLD
DIA OF PIPE (AS PER DESIGN)	150 MM (MINIMUM) C.I.LA 250MM (MAXIMUM) CI LA

Table 6. Salient Features Of Proposed Sewage scheme

6.2 Design of a complete sewage treatment plant

Hydraulic design and detailing of a complete sewage treatment plant of 1.5 MLD (Average annual flow) to be constructed at solan town.

Average flow=1.25 MLD=1250 CUBIC METER PER DAY

Peak flow=3.125 CUBIC METER PER DAY

Parameter	In raw sewage	After treatment	What it mean……
BOD	295 mg/l	<20 mg/l	Normally, the biodegradable material in the sewage consumes oxygen when it degrades. If this sewage is released in lakes/rivers, it would draw naturally dissolved oxygen from water, depleting the oxygen in the lake/river. This causes death of fish and plants. But the STP provides enough oxygen to digest the biodegradable material

			in sewage. The treated sewage does not need oxygen any longer. Thus it does not affect the aquatic life in lakes and rivers.
SUSPENDED SOLIDS	4653 mg/l	30 mg/l	If cloudy water is allowed to reach the lakes and rivers, it blocks the sunlight from reaching the bottom of the water body. This stops the photosynthesis process of the aquatic plants, killing them. That in turns stops generation of oxygen as a byproduct of the photosynthesis process. Depletion of dissolved oxygen in water kills all fish. Thus low turbidity in discharge water ultimately sustains aquatic life in lakes and rivers.
PH	Around 7.5	Around 7.5	The acidity/alkalinity balance is not affected/altered.

Table 7. Parameters and Their Meaning

Reason choosing the type of secondary treatment

Since the desired quality of the treated effluent was of a high standard and the available land area for the construction of plant was limited ,it was decided to design the S.T.P. using activated sludge process for the secondary treatment instead of using trickling filters.

Moreover, considering the various advantages offered by extended aeration process,specially for smaller plants up to 4 MLD capacity , it was decided to use extended aeration type of activated sludge plant ,which eliminates primary settling tank as well as sludge digestion plant .

6.3 TREATMENT UNITS

The proposed S.T.P will hence contain the following units .

1. Inlet channel

2. screen chamber

3. grit chamber

4. aeration tank for activated sludge treatment

5. secondary clarifier

6. sludge drying beds

6.3.1 Design of inlet chamber

Inlet chamber is designed for a detention period of 60 seconds ultimate peak flow:

Peak flow =3125 cubic meter/day =0.038 meter cube /day
plan dimension of inlet chamber =1.3x1m
Free-board =0.3m;

Size of the bypass chamber by the side of inlet chamber =1.3x 1 (minimum size)

The outflow from the inlet chamber shall be taken to the screen chamber. A bypass channel 0.60mx 1m or 400 dia. pipe should be provided from bypass chamber up to final effluent channel to meet with any exigencies of the S.T.P.

6.3.2 Design of screen chamber

2Nos. screen chambers shall be provided as per sound engineering practice

The flow from the inlet chamber to screen channels shall be controlled by C.I. penstock gates.

Qmax=0.038 cubic meter /second

Assumptions:

Shape of bar =M.S. flats

Size =10 mm x 50mm (10 mm facing flow)

Clear spacing between the bars=20 mm

Inclination of bars with horizontal=80 degree (cleaning manually)

Assuming velocity normal to screen=0.8 m/sec

At peak flow, net inclination area required=0.038/0.8 =0.047 sqm

Gross inclination area =0.047x1.5=0.070 sqm

Gross vertical area required=0.070xsin (80) =0.069 sqm

Provide submerge depth = 0.3 m

Width of channel=0.069/0.3=0.23 m

Provide 0.30 m

Check velocity in duct =0.038/(0.30x0.3)

=0.42 m/sec

(Approach velocity u/s of screen)>0.4 m /sec

Provide 20 bars of 10mmx50mm at 20 mm clear spacing

Screen chamber shall be 60 cm wide.

u/s of screens ,2 nos. C.I. pen stock gates shall be provided (one for each channel).

Min. drop of 150 mm shall be provided in the bed of screen channel.

Size of penstock gates:

2 nos. of 130x 450 mm size be provided.

6.3.3 Design of grit chamber

Flow from screen channel shall be taken into grit chamber, provided in duplicate .2 no. C.I. gates , one each at inlet and outlet, are provided at the inlet to bye-pass channel in between two grit chambers.

Design flow=2.5 x 1.5/2=1.56 MLD= 1560 cubic meter /day

To account for turbulence and short circulating , reduce the surface loading to about 800 cubic meter/sqm/day .

Area required=1560/800=1.95 sqm.
Provide 1.70 m dia. Chamber, or 1.70x 1.70 m square chamber.
Detention time =60 sec

Volume = 1560x 60/24x3600 =1.08 cum

Liquid depth = 1.08/1.95 =0.554 m

Size of grit chamber = 1.70x1.70 m (or 1.70 dia.) x 1.2 m (i.e. 0.554 + 0.6 FB= 1.2 m) depth.

Check for Horizontal velocity
Cross sectional area of grit chamber
=1.7 x 0.554= 0.942 sqm

Velocity =1560/1.7 x 0.554 x 24 x 3600 = 0.0192 m/sec
=1.9 cm/sec <18 cm /sec. hence o.k.

Grit generation = 0.05 cubic meter /1000 cubic meter of sewage flow (assume)
Even though grit is continuously raked, still 8 hrs. grit storage is provided for average flow .

Storage volume required = (1250x8/24)(0.05/1000)=0.028 cubic meter

Grit storage area =22x1.7x1.7/7x4 =2.27 sqm

Grit storage depth =0.028/2.27=0.012 m

Total liquid depth =0.554+0.012=0.566; say 0.6 m

Provide grit chamber of size : 1.7 x 1.7 x (0.06 + 0.60 FB) depth, or
=1.7 m x 1.7 m x 1.2 m size.

Outflow from grit chamber shall be carried to aeration tanks through a 600 mm wide range R.C.C. channel provided with fine bar screen (manually operated).the clear spacing between the bars shall be10 mm.

6.3.4 Design of Aeration Tank

No. of tanks =2

Average flow to each tank= 1.5 MLD/2

=0.625 MLD

Q=625 cubic meter/day.

The total BOD entering S.T.P. = 295 mg/l

Assuming that negligible BOD is removed in screening and grit chamber (since it removes suspended solids),the BOD of sewage coming to aeration

Yo=295 mg/l

BOD left in the effluent Ye=2 mg/l

Therefore ,BOD removed in activated plant =295-2=275 mg/l

Therefore, minimum efficiency required in the activated plant

=275/295=93% O.K

Since adopt the extended aeration process can remove BOD up to 95-98%

Volume of the aeration tank can be designed by assuming a suitable value of MLSS and Ɵc (or F/m ratio)

Let us assume MLSS=3000 mg/l

F/M ratio =0.12

Now,

F/M=Q x Yo/Xt x V

V=625 x 295 / 0.12 x 3800

=512 cum

Aeration tank dimensions. Let us adopt an aeration tank of liquid depth 3.5 m and 9 m width. Then,

The length of tank

=V/B.D=512/9 x 3.5

=16.25m; say 16 m

Therefore V provided=16m x 9 m x 3.5 m= 504 cum

(i)check for aeration period or H.R.T. (t)

T=(V/q) x24 h

=(54/625)x 24 h=19.35 h,say 20 hr ; ok,

Since it lies between 10 to 20 h

(ii) check for volumetric loading.

=Q.Yo/V gm of BOD/cum vol of tank

=625 x 295/504 gm/cum

=366 gm/cum

=0.36 kg/cum.O.K,

Since it should lie between 0.2 to 0.4

(iii)check for return sludge ratio (for SVI ranging between 50-150 ml/gm)

Qr/Q=Xt/((100000/100)-3000)=3000/7000

=0.43;but it should be within 0.5 to 1.0

Hence we will provide 50% sludge recirculation ,giving SVI=111,OK.

(iv)check for S.R.T(ϴc)

V.Xt=(αy. Q.(Yo-Ye).ϴc)/1+Ke.ϴc

Where αy=1.0 (constant for municipal sewage w.r.t to MLSS)

Ke=0.06

Yo=295 mg/l

Ye=2 mg/l

V=512 cum

Xt=3000 mg/l

504x3000=1.0x625(295-20)ϴc/1+0.06ϴc

ϴc=18.6 days;OK

Since it is between 1 to 25 days.

The adopted tank size is thus O.K. Hence, adopt an aeration tank having an overall size of 16 m x 9 m x (3.5 + 0.6) m overall depth, with 0.6 m of free-board.

The outlet weir shall be of adjustable type.

The effluent from the aeration tank will be taken to the final (Secondary) clarifier. The inflow to the secondary clarifier shall be by means of 250 mm dia C.L pipes, which will give a velocity of 0.78 m/sec at peak flow.

Aerators Sizing:

BOD5 applied to each tank

= 295 mg/I

Average flow in each tank

= 625 m3/day

BOD5 to be removed in each tank

= 625 x 0.295 = 184.3 75 kg/day; say 184 kg/day

=8 kg/hr

Oxygen requirement

= 1.2 kg/kg BOD applied

Peak oxygen demand

= 125%

Oxygen transfer capacity of the aerator in standard conditions

=1.9kg/kWh .

= 1.41 kg/HP/hr

Oxygen transfer capacity of aerators at field conditions

= 0.7 x 1.41 = 0.98 kg/HP/hr

oxygen to be applied in each tank

=1.2x8x1.25

= 12 kg/hr

H.P of aerators required

= 12H.P./.98 = 12.24 ; say 14 H.P.

provide 2 Generators, each of 7 HP.

Check for mixing Consideration

as per practices power required for mixing

= 0.02 kW/cum

Volume of each A.T.

= 504 m3

SHP required = 0.02 x 504 kW = 10.08 KW

providing 2 aerators, and considering gear efficiency as 97%

HP. of each aerator required

= 10.08/2x0.97 = 5.2 HP

Considering a power margin of 25% on motor rating

Motor H.P. required

=5.2x 1.25=6.50;say7

provide no. of 7 H.P. motors/aerators in each tank.

The dimension of the tank selected on the basis of suitable aerator motor in the zone of influence. The zone of influence for each aerator will be about 11 m sq. with 3.5 m deth. The suitable aerator be selected, and accordingly, the depth and

size of aeration tank adjusted. The submergence of the a will be between 75 mm to 115 mm.

Design of Secondary Clarifier

Secondary Clarifier:

No of secondary clarifier = 1 No.

Average flow= 1250 m3/day

Recirculated flow,say 50%

= 625 m3/day

Total inflow= 1875 cum/day

Provide hydraulic detention time

= 2 hrs.

Volume of tank(exclusive of hopper portion)

=1875x(2/24)=156.25 cum

Assume liquid depth= 3.5m

Area (Superficial) = 156.25 / 3.5 = 44.64 m^2

Surface loading rate of average flow = 15 m^3/m^2/day

Surface area to be provided = 1250/15 = 83 m^2

Dia. of Circular tank (d) = sqrt((83 * 4) / 3.14) = 10.28m ; say 11m.

Actual are provided = 95 sq. m.

Check for Weir loading:

Average Flow = 1250 m^3/day

Weir loading = 1250 / (3.14*11) = 36.2 m^3/day/m; O.K. as it is less than 185 m^3/day/m

Provide a peripheral launder

Check for Solids Loading:

Recirculated Flow = 625 m^3 / day

Average Flow = 1250 m^3 / day

MLSS in the tank = 3000 mg/l

Total solids inflow = (1250 + 625) * 3 = 5625 kg / day

Solids loading = 5625 / 83 = 67.80 kg/day/m^2

Provide a clarifier of 11m dia. having liquid depth as 3.5m, Hopper slope shall be 1 in 12.

Free board will be 0.3m

Sludge will be withdrawn from the clarifier through a C.I pipe. The sludge will be taken to the return sludge pump house. The treated effluent from the secondary clarifier can be disposed of it the nearby valley.

Return sludge Pump House:

Total return flow = 625 m^3 / day = 0.434 m^3 / min

Detention time = 15min

Volume of wet well = 0.435 * 15 = 6.5 m^3

Provide wet well = 2.5 * 1.5 * 1.8 m SWD

Provide dry well = 2.5 * 2.5 m

Size of annexe control room = 2.5 m * 2.5 m

Provide 2 Nos. pumps, each of 0.625 MLD capacity in the dry well for returning the sludge to aeration tank.

The return sludge pipe line shall be 150 mm (dia.).

Excess sludge shall be taken to the sludge drying beds by providing necessary fittings in the main return sludge header. The sludge feed line to the sludge drying beds shall be 150 mm (dia.) C.I. pipe.

6.3.5 DESIGN OF SLUDGE DRYING BEDS

Sludge applied to drying beds @ 100 kg/ MLD

Sludge applied = 125 kg/ day

Sp. Gravity = 1.015

Solid contents = 1.5 %

Volume of sludge = (125 / 1.5%) * 1 / (1000* 1.015)

Considering monsoon etc. total no. of cycle in one year = 33

Period of each cycle = 365/ 33 = 11 days

Volume of sludge / cycle = 8.2 * 11 = 90.2 m^3

Spreading a layer of 0.3m / cycle area of beds required = 90.2 / 0.3 = 300.67

Provide 4 beds of 1.2 m * 7m

Thus, Providing = 336 sqm. Area

FILTERATE PUMP HOUSE AND SUMP

Actual BOD_5 20 deg. C removed per day = 1250 * (295 -20) / 1000= 343.25 kgm.

Excess Wasted Sludge: $\theta_c = V * Xt/Qw * Xr$

Thus, excess sludge produced = 81.3 kg/d

Assuming the excess sludge to contain 1% solids and specific gravity = 1.015

We have ,

Volume of excess sludge = 81.3 / 1% * (1000 * 1.015) m^3 / d

= 81.3 * 100 / 1000 * 1.015

= 8 m^3 / d

= 0.34 m^3 / hr

Taking detention time as 8 hrs.

Volume of wet well = 8 * 0.34 = 2.64 m^3 for 1% concentration .

Provide liquid depth = 1.0 m

Area required for 1% concentration of solids

= 2.64 /1.0 = 2.64 m^2

Dia of wet well = sqrt (2.64 * 4 / 3.14) = 1.83m ; provide 2.0 m (dia)

Hence, provide 2 m (dia) of the wet well for (worst condition) filtrate stump with 1.2 m liquid depth below incoming pipe line. This will be covered on top and a 4m high pump room shall be constructed over it. 2 No. vertical non-clog pumps, each of 1H.P CAPACITY , shall be provided in this pump house. The filtrate from the pump house shll be pumped to distribute chamber upstream of Aeration Tank through 100mm (dia) C.I. pipe line.

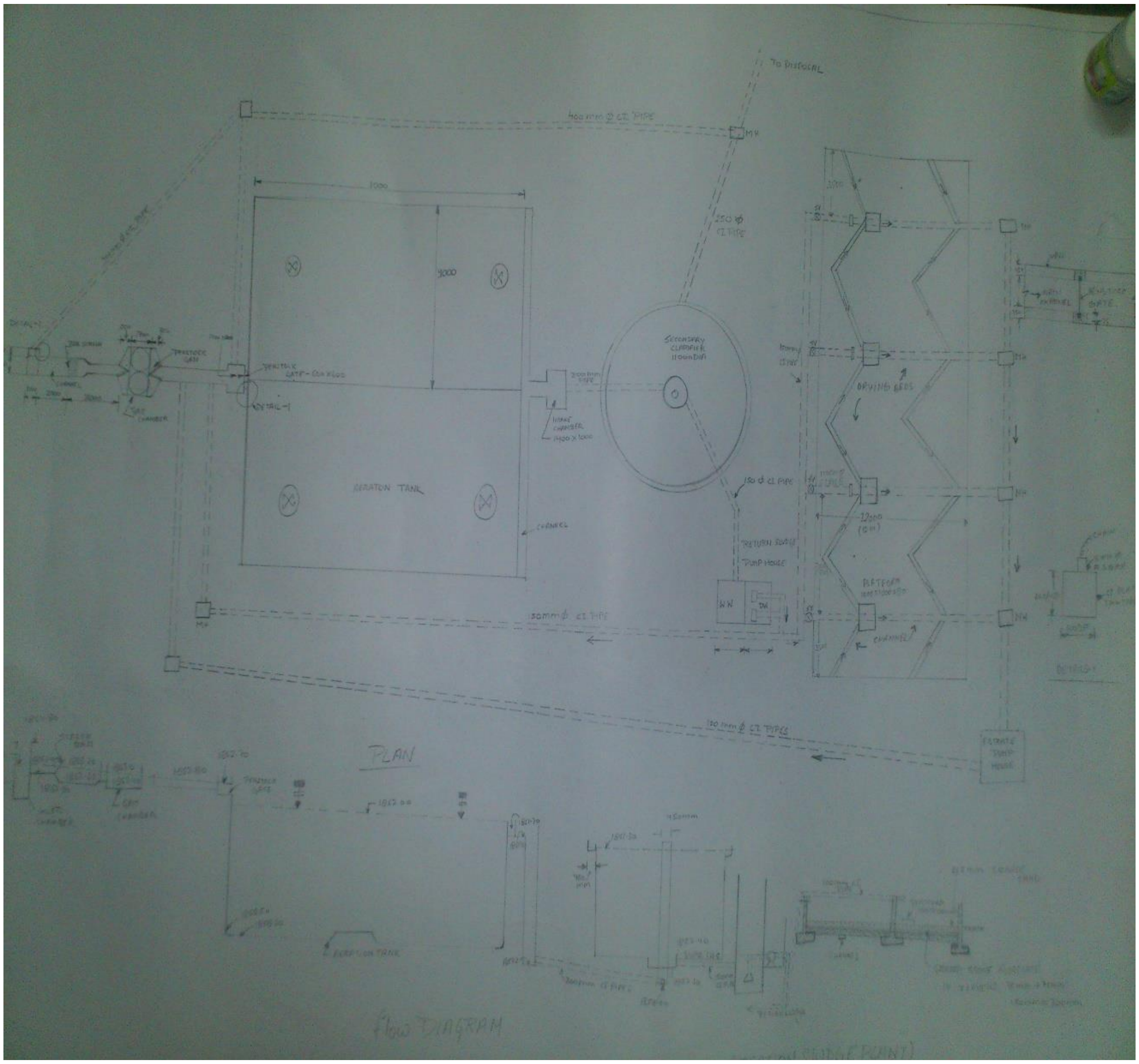


Fig. 10 Design Detail Of Sewage Treatment Plant

Conclusion:

During this project,we took samples of raw sewage from Solan town and did various tests such as BOD test,suspended solid test and pH test to calculate the quality of sewage and thus design sewage treatment plant according to the data interpreted from various tests. We got information about the population of solan town from Municipal Council of solan. Then according to the population of the town we calculated water demand through which we calculated the amount of daily sewage produced. Now getting the amount of daily sewage produced we designed the sewage treatment plant according to extended aeration activated sludge process. This is because we get higher efficiency using this process, capital cost is less as less area is required, processing cost is less. Since we are getting the value of sewage produced is 1.5MLD,so we can use the above process as it can be used for sewage less than 4MLD.To design the treatment plant we firstly designed inlet chamber, then bar screen, grit channels, aeration system comprising of aeration tank, settling tank and return sludge system, sludge drying beds & labatory cum pump house building.

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