Wrocław University of Science and Technology

erasmus

Wastewater Treatment Technology – laboratory

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1. PRIMARY SEDIMENTATION – THE IMHOFF CONE TEST

INTRODUCTION

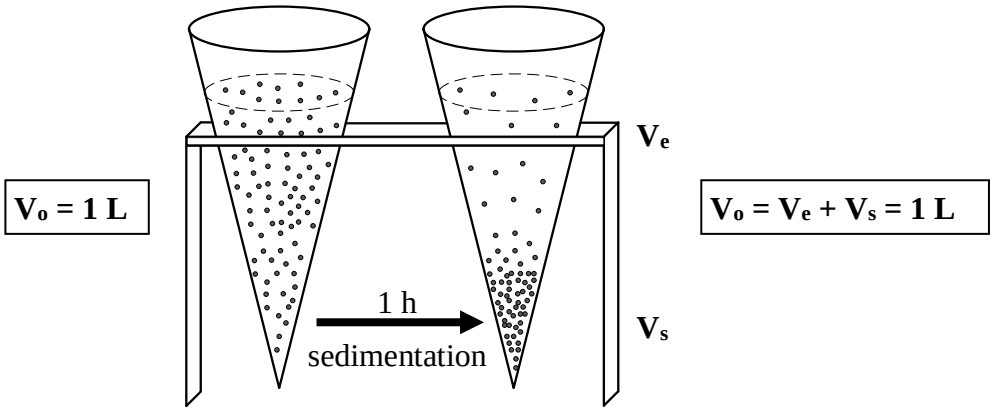
Organic and inorganic solids are present in wastewater, and both can be either suspended or dissolved. Settleable solids are the part of suspended solids that readily settle in a primary sedimentation tank when the wastewater velocity is reduced. Typically, 90-95% of settleable solids settle out during primary treatment step. Colloidal solids, which are finely divided solids, are too fine to settle within the usual retention times of a primary sedimentation tank. Colloidal solids pass through the primary treatment process and are removed in the secondary treatment process.

Primary sedimentation tanks reduce the wastewater velocity to less than 0.3 m/s and thus allow these settleable solids to separate from the waste stream. This process also removes a percentage of suspended solids as well as biochemical/chemical oxygen demand (BOD/COD) which are associated with these solids. In properly designed and operated primary treatment tank, the average removal efficiencies that can be achieved are as follows: 90-95% of settleable solids, up to 65% of suspended solids, 20-35% of BOD/COD, and 5-10% of N and P.

Primary treatment is often called clarification, sedimentation or setting, and thus primary treatment tanks are called respectively clarifiers, sedimentation basins, or settling tanks. Despite its location on a treatment plant or its shape, the purpose of all settling tanks is the same - to reduce wastewater velocity so that settling and flotation will occur.

In a laboratory, when wastewater is placed in a cone (such as an Imhoff cone) and allowed to sit, settleable solids settle to the bottom, and lighter floatable solids rise to the top. Basically, the same thing happens in a primary settling tank. The settling process relies on gravity to separate the solid material from the liquid.

Thus, the laboratory work aims to determine the efficiency of primary sedimentation in municipal wastewater treatment using the Imhoff cone setup and to understand the dynamics of sedimentation of settleable solids under static conditions.



Imhoff cone setup

Mass balance of Imhoff cone:

$$V_o \cdot C_o = V_e \cdot C_e + V_s \cdot C_s$$

where:
V_o – volume of raw wastewater, L
V_e – volume of supernatant, L
V_s – volume of settled solids (primary sludge), L
C_o – concentration in raw wastewater, mg/L
C_e – concentration after primary sedimentation (in supernatant), mg/L
C_s – concentration of settled solids (primary sludge), mg/L

MATERIALS & EQUIPMENT

- Conical flasks
- Graduated cylinders
- Evaporating dishes
- Filter papers
- Pipettes
- Timer/stopwatch
- Analytical balance
- Thermoreactor and photometer for COD measurement

PROCEDURE

- Pour 1 L of well-mixed raw wastewater into the Imhoff cone and allow the solids to settle for 1 hour.
- During 1 hour, at specified intervals, record the volume of the solids at the bottom of the cone (in mL of settleable solids per 1 L of wastewater) and write down the data in the table 1 (data sheet).
- In the meantime, in raw wastewater determine the initial concentration of phosphates, chemical oxygen demand (COD), total solids (TS) and total dissolved solids (TDS).
- After 1 hour of the process, measure the final concentration of phosphates, COD, TS and TDS in the supernatant.

DATA SHEET
PRIMARY SEDIMENTATION – THE IMHOFF CONE TEST

Table 1.

Settling time, minutes	1	2	3	4	5	6	7
Settled solids, mL/L							

8	9	10	15	20	25	30	35	40	50	60

Table 2.

	ID of evaporating dish	Mass of the empty dish, g	Mass of the dish with dry deposit, g
Raw wastewater			
Total solids (TS)			
Total dissolved solids (TDS)			
Treated wastewater			
Total solids (TS)			
Total dissolved solids (TDS)			

Table 3.

Raw wastewater	Dilution	Results, Abs	Results, mg/L
Phosphates (PO_4^{3-})		-	
Chemical oxygen demand (COD)			
Treated wastewater	Dilution	Results, Abs	Results, mg/L
Phosphates (PO_4^{3-})		-	
Chemical oxygen demand (COD)			

LABORATORY REPORT
PRIMARY SEDIMENTATION – THE IMHOFF CONE TEST

Date: …… Student: ……..……

Table 1.

Settling time, minutes	1	2	3	4	5	6	7
Settled solids, mL/L							

8	9	10	15	20	25	30	35	40	50	60

Table 2.

Raw wastewater	**Results**
Total solids (TS), mg/L	
Total dissolved solids (TDS), mg/L	
Total suspended solids (TSS), mg/L	
Phosphates (PO_4^{3-})	
Chemical oxygen demand (COD), mgO_2/L	
Treated wastewater	**Results**
Total solids (TS), mg/L	
Total dissolved solids (TDS), mg/L	
Total suspended solids (TSS), mg/L	
Phosphates (PO_4^{3-})	
Chemical oxygen demand (COD), mgO_2/L	
Efficiency of primary sedimentation	**Removal, %**
Total solids (TS)	
Total dissolved solids (TDS)	
Total suspended solids (TSS)	
Phosphates (PO_4^{3-})	
Chemical oxygen demand (COD)	

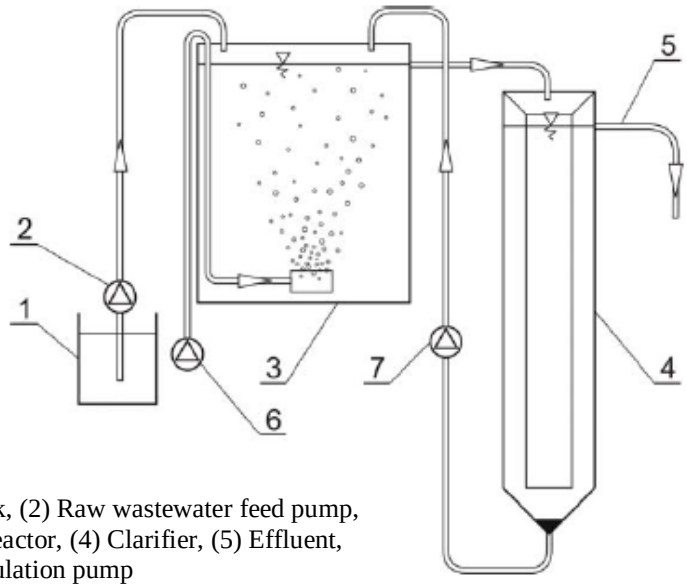
- Prepare the graph using the data from table 1 (settling time in min vs. volume of settled solids in mL/L) and calculate the mass balance for Imhoff cone in terms of TSS.
- Discuss and summarize obtained results.

2. WASTEWATER TREATMENT IN THE ACTIVATED SLUDGE PROCESS

INTRODUCTION

The activated sludge process is one of the biological wastewater treatment methods in secondary treatment. The general objectives of biological treatment are to stabilise the organic matter and to coagulate and remove the non-settleable solids found in domestic wastewater. Additional objectives include the removal of nutrients such as nitrogen and phosphorous, as well as trace organic compounds.

In activated sludge process, wastewater containing organic matter is aerated in an aeration basin in which microorganisms metabolise the suspended and soluble organic matter. Part of organic matter is synthesised into new cells, and part is oxidised to CO_2 and water to derive energy. In activated sludge system, the new cells formed in the reaction are removed from the liquid stream in the form of a flocculent sludge, in secondary clarifiers. A part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining forms waste or excess sludge. Activated sludge consists of sludge particles, teeming with living organisms, produced in either raw or settled wastewater by the growth of organisms (which include bacteria) in aeration tanks where dissolved oxygen is present.



(1) Raw wastewater tank, (2) Raw wastewater feed pump,
(3) Aerated biological reactor, (4) Clarifier, (5) Effluent,
(6) Aeration, (7) Recirculation pump

Setup for aerobic activated sludge process

The solids retention time (SRT) - the mean time the activated sludge flocs spend in the reactor. It is the most important parameter of the activated sludge process, which determines the effect of treatment, as well as oxygen requirement and sludge production. By ensuring long enough SRT in activated sludge process, the ammonium nitrogen oxidation to nitrite and nitrate may also be accomplished.
The SRT is given by the following equation:

$$\mathrm{SRT, d} = \frac{M_X}{\triangle X} = \frac{V \cdot X}{\triangle X}$$

where:
M_x – mass of activated sludge in a reactor in g; X – activated sludge concentration in g TSS/L; V – volume of a biological reactor in L; ΔX – wasted activated in g TSS/d.

The sludge volume index (SVI) is a laboratory method to empirically determine the settling ability of sludge based on amount of suspended solids (TSS) that settle out during a specified period of time. To determine the SVI, first the suspended solids content of sewage is determined, and then a graduated cylinder is filled with the sewage that is left to settle. After 30 minutes, the volume occupied by the settled sludge is recorded in mL/L.
The SVI is then calculated by dividing the volume of settled sludge (V_{SS}) by the total suspended solids concentration (in g/L), which gives the volume of settled sludge per gramme of solids.

$$\mathrm{SVI, mL/g\ TSS} = \frac{V_{SS}}{\mathrm{TSS}}$$

The lower SVI value, the better settlement properties of activated sludge – the sludge with SVI within the range of 50-100 mL/gTSS is considered as a sludge with good settlement properties.

The laboratory work aims to present the fundamentals of biological wastewater treatment, to evaluate the efficiency of municipal wastewater treatment in the aerobic activated sludge process, and to determine the most important parameters of the process.

MATERIALS & EQUIPMENT

- Conical flasks
- Graduated cylinders
- Glass or plastic beakers
- Filter papers
- Pipettes
- Timer/stopwatch
- Thermoreactor and photometer for COD measurement
- Spectrophotometer for N-compounds measurement

PROCEDURE

- You will receive in plastic bottle the raw municipal wastewater in plastic bottle and treated wastewater you have to collect directly from the activated sludge lab setup.
- In raw and treated wastewater determine the concentration of ammonium (NH_4^+), nitrate (NO_3^-) and chemical oxygen demand (COD), considering the sample dilution recommended in the data sheet.

- In the meantime, collect from the biological reactor about 300 mL of activated sludge.
- Use this sludge for determination of total solids (TS) and total dissolved solids (TDS) concentration and sludge volume index (SVI).
- Check the dimensions of the biological reactor and secondary clarifier to calculate their volume.

DATA SHEET
WASTEWATER TREATMENT IN THE ACTIVATED SLUDGE PROCESS

Table 1.

Raw wastewater	Dilution	Results, Abs	Results, mg/L
Ammonium (NH_4^+)	1:200		
Nitrate (NO_3^-)	1:5		
Chemical oxygen demand (COD)	-		
Treated wastewater	Dilution	Results, Abs	Results, mg/L
Ammonium (NH_4^+)	-		
Nitrate (NO_3^-)	1:100		
Chemical oxygen demand (COD)	-		

Table 2.

Activated sludge from reactor	Initial sludge volume, mL	Sludge volume after 30 min of clarification, mL
	100	

Table 3.

Activated sludge from reactor	ID of evaporating dish	Mass of the empty dish, g	Mass of the dish with dry deposit, g
Total solids (TS)			
Total dissolved solids (TDS)			

LABORATORY REPORT
WASTEWATER TREATMENT IN THE ACTIVATED SLUDGE PROCESS

Date: …… Student: ……

Table 1.

Raw wastewater	**Results**
Ammonium (NH_4^+), mgN_{NH4+}/L	
Nitrate (NO_3^-), mgN_{NO3-}/L	
Chemical oxygen demand (COD), mgO_2/L	
Treated wastewater	**Results**
Ammonium (NH_4^+), mgN_{NH4+}/L	
Nitrate (NO_3^-), mgN_{NO3-}/L	
Chemical oxygen demand (COD), mgO_2/L	
Efficiency of activated sludge process	**Removal, %**
Ammonium (NH_4^+)	
Nitrate (NO_3^-)	-
Chemical oxygen demand (COD)	

Table 2.

Activated sludge characteristic	**Results**
Total solids (TS), mg/L	
Total dissolved solids (TDS), mg/L	
Total suspended solids (TSS), mg/L	
Sludge volume index (SVI), mg/g	

- Prepare necessary graphs using the obtained data.
- Calculate the SVI (table 2).
- Discuss and summarize obtained results.

3. SLUDGE DEWATERING – THE BÜCHNER TEST

INTRODUCTION

The wastewater treatment plant sludge contains an enormous amount of bound water (up to 99.9%). Therefore, a mechanical dewatering and thickening are necessary for reducing the volume (mass) of sludge that needs to be further treated or managed. After the sludge thickening process, additional reduction of the water content is often necessary, and this can be done either naturally or by machine processes such as centrifugation or pressing. Technologies that are widely used for dewatering sludge and well recognised for wastewater management are the belt filter, the centrifuge, the frame filter press, and the screw press.

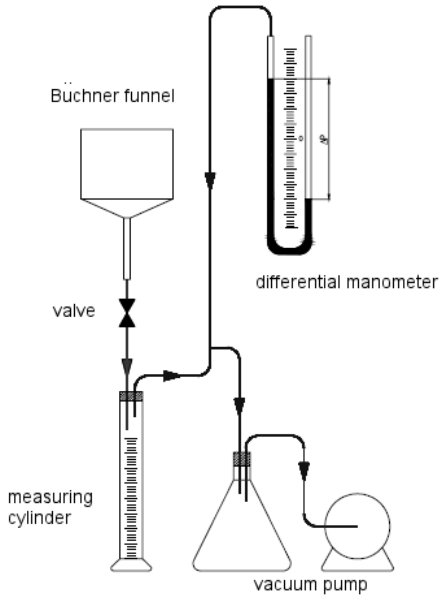
However, to facilitate the separation of liquid from the solid particles and thus to improve the efficiency and cost-effectiveness of sludge dewatering, a preliminary stage termed sludge conditioning is required. Sludge conditioning aims to release bound water and allow solids to agglomerate, and thus decrease the sludge resistance to filtration. Chemical methods are most widely used for sludge conditioning, and organic polymer coagulants (polyelectrolytes) are most frequently used chemicals.

Specific resistance to filtration is a parameter used to describe properties of sludge as far as dewatering is concerned. It also allows to compare different sludge samples. Sludge susceptibility to dewatering based on the specific resistance to filtration is classified as follows:

- easy mechanical dewatering $r < 5 \cdot 10^{12}$ cm/g
- medium mechanical dewatering $r = (5\text{-}10) \cdot 10^{12}$ cm/g
- difficult mechanical dewatering $r > 10 \cdot 10^{12}$ cm/g

Specific sludge resistance to filtration may be determined in the Büchner funnel test, which is also used to analyse the effectiveness of conditioning, and to select the most efficient polyelectrolytes.

Thus, the laboratory work aims to determine the sludge susceptibility to dewatering measured as specific resistance to filtration (r) and to evaluate the effect of filtration pressure and conditioning (polyelectrolyte addition) on the effectiveness of sludge dewatering.



Setup for Büchner test

CALCULATIONS

Water content in the sludge:

$$WC,\ \% = \frac{m_w - m_d}{m_w} \cdot 100\% \quad (1)$$

where:
m_w – mass of wet sludge, g
m_d – mass of dry sludge, g

Filtration pressure in Pa (FP_2):

$$FP_2,\ Pa = \rho_{Hg} \cdot g \cdot FP_1 \quad (2)$$

where:
ρ_{Hg} – density of mercury, 13 550 kg/m^3
g – acceleration due to gravity, g = 9.81 m/s^2
FP_1 – filtration pressure, m Hg

Sludge filtration is described by the following equation:

$$\frac{t}{V} = \frac{r \cdot \mu \cdot SC}{2p \cdot A^2} \cdot V + b \quad (3)$$

where:
t – filtration time, s
V – filtrate volume, mL
r – specific resistance to filtration, cm/g
μ – filtrate viscosity (assume the value of 0,001 Pa·s, water at 20 ºC)
p – filtration pressure, Pa
A – filtration area, cm^2
SC – solids concentration, g/mL

$$SC,\ g/mL = \frac{1}{\frac{WC_o}{100 - WC_o} - \frac{WC_e}{100 - WC_e}} \quad (4)$$

WC_o – water content in sludge before filtration (raw sludge), %
WC_e – water content in sludge after filtration, %

Equation (3) is a linear function: $y = a \cdot x + b$ (5)

which slope "a" can be determined by plotting (t/V) against V.

Moreover:

$$a,\ s/cm^6 = \frac{r \cdot \mu \cdot SC}{2p \cdot A^2} \quad (6)$$

and therefore:

$$r = \frac{2p \cdot A^2 \cdot a}{\mu \cdot SC} \quad (7)$$

MATERIALS & EQUIPMENT

- Glass or plastic beaker
- Evaporating dishes
- Graduated cylinder
- Filter papers
- Pipette
- Polyelectrolyte (organic polymer coagulant)
- Timer/stopwatch
- Drying oven
- Water bath
- Magnetic stirrer with a stirring bar
- Analytical balance

PROCEDURE

Before you start:

- Prepare filter papers (the filter diameter should be the same as the inner diameter of the Büchner funnel) and empty evaporating dishes (check the mass of empty dishes using the analytical balance).
- The sludge used during the exercise is a mineral sludge and is stored in a tightly closed glass bottle. Mix the sludge very well, then pour about 400 mL of the sludge into the beaker and place it on the magnetic stirrer, stirring it constantly.

Next:

- Familiarise yourself with the laboratory setup for the Büchner test.
- Close the valve under the funnel (the system must be air-tight!) and prepare the timer.
- Place the filter paper at the bottom of the funnel and moisten it with distilled water.
- Turn on the vacuum pump and set the first filtration pressure.
- Using the cylinder pour 50 mL of well-mixed sludge into the funnel.
- Start the process by opening the valve and turning on the timer.
- Collect the released water in a measuring cylinder under the funnel and record the time.
- Sludge dewatering is completed if the volume of filtered water in the cylinder does not change or the filtration pressure drops due to the breaking of the filter cake; then close the valve and turn off the pump.
- Carefully remove the filter cake from the funnel, put it in an evaporating dish and remove the filter paper.
- Immediately weigh the dish with the dewatered sludge and record the mass.
- Place the dish on the water bath to dry the filter cake, after that, dry the sample overnight at 105 °C in a drying oven and finally cool the dish in the desiccator.
- Using the analytical balance check the mass of the evaporating dish with dry sludge.
- Following the same procedure, repeat the sludge dewatering with the different filtration pressure and with addition of two different doses of polyelectrolyte.

Additionally:

- You need to know the water content in raw sludge (before filtration), therefore using a graduated cylinder measure 50 mL of well-mixed raw sludge and pour it into the pre-weighed dish.
- Immediately weigh the dish with the wet sludge and record the mass.
- Evaporate the raw sludge to dryness using the water bath.
- Place the evaporating dish in the drying oven for overnight and dry the sample at 105 °C. Cool down the dish in the desiccator.
- Using the analytical balance check the mass of the evaporating dish with dry sludge.

DATA SHEET
SLUDGE DEWATERING – THE BÜCHNER TEST

Table 1.

Filtration pressure, mm Hg	Poly-electrolyte	Time (t) to obtain the volume (V) of the filtrate, s							
		5 mL	10 mL	15 mL	20 mL	25 mL	30 mL	35 mL	40 mL
100	no								
300	no								
100	yes / 1st dose								
300	yes / 1st dose								
300	yes / 2nd dose								

Table 2.

Filtration pressure, mm Hg	Poly-electrolyte	ID of evaporating dish	Mass of empty dish, g	Mass of dish with wet sludge (m_w), g	Mass of dish with dry sludge (m_d), g
Raw sludge					
100	no				
300	no				
100	yes / 1st dose				
300	yes / 1st dose				
300	yes / 2nd dose				

LABORATORY REPORT

SLUDGE DEWATERING – THE BÜCHNER TEST

Date: …… Student: ……

Table 1.

Filtration pressure, mm Hg	Poly-electrolyte	Time (t) to obtain the volume (V) of the filtrate, s							
		5 mL	10 mL	15 mL	20 mL	25 mL	30 mL	35 mL	40 mL
100	no								
300	no								
100	yes / 1st dose								
300	yes / 1st dose								
300	yes / 2nd dose								

Table 2.

Filtration pressure		Poly-electrolyte	Mass of empty dish	Dish with wet sludge (m_w)	Dish with dry sludge (m_d)	Water content in sludge (WC)	Solids concentration (SC)	Slope "a"	Sludge resistance to filtration
mmHg	Pa	-	g	g	g	%	g/cm^3	s/cm^6	cm/g
raw sludge		-					-	-	-
100		no							
300		no							
100		yes / 1st dose							
300		yes / 1st dose							
300		yes / 2nd dose							

- Prepare the graphs using the data from table 1 separately for raw and conditioned sludge (filtrate volume in mL vs. value of t/V in s/mL) and determine the slope "a" for each filtration pressure.
- Calculate sludge specific resistance to filtration in cm/g.
- Prepare the graphs using the data from table 2 (filtration pressure in Pa vs. water content in sludge in %; polyelectrolyte dose vs. water content in sludge in %).
- Discuss and summarize obtained results.

4. ANALYTICAL METHODS

pH

Measure the pH at a room temperature with a properly calibrated pH-meter.

Equipment

- pH-meter with electrode
- Small glass beaker
- Magnetic stirrer with a stirring bar

Method

- Remove electrode from the storage solution and rinse it with distilled water.
- Place the beaker with the sample on the magnetic stirrer and then immerse the pH electrode in the solution.
- Turn on the stirrer (set a gentle mixing) and measure the pH with constant stirring.
- Wait until the stable value of pH will be displayed.

Chemical Oxygen Demand (COD)

Equipment and reagents

- COD vials with reagents
- Nessler cylinders
- Pipettes

Method

- You will determine COD in samples with and without dilution. In case when no dilution is recommended, simply pipette 2.5 mL of well-mixed wastewater to the COD vial with reagents.
- To prepare the indicated dilution of wastewater - pour the proper volume of well-mixed wastewater sample into the Nessler cylinder, next fill it with distilled water up to 100 mL and mix the content by turning closed cylinder upside down. Then pipette 2.5 mL of well-mixed diluted wastewater to the COD vial with reagents.
- Close the vial with a cap, mix the content by turning it upside down.
- Place the vial in a thermoreactor at the temperature of 148 °C for 2 hour.
- Let the vial cool down to room temperature.
- Place the vial in a photometer and read the absorption at 585 nm.
- Record the absorption as ”a”.

Calculations

$$\mathrm{COD, mg\,O_2/L} = \frac{(a - 0.1332) \cdot 100}{0.0004 \cdot V}$$

where:
a – absorption,
V – volume of wastewater used for measurement, mL

Ammonium (NH_4^+)

Equipment and reagents

- Spectrophotometer
- Glass cells with a light path length of 1 cm or 5 cm
- Nessler cylinder
- Pipettes
- Seignette salt
- Nessler reagent (K_2HgI_4)

Method

- Pour 100 mL of wastewater sample into the Nessler cylinder (or a proper volume resulting from the dilution and fill cylinder with distilled water up to 100 mL).
- Add 1 mL of Seignette salt and 1 mL of Nessler reagent.
- Mix the content of the cylinder by turning it upside down and wait 10 minutes (yellow color appears and its intensity is proportional to the ammonium concentration).
- Prepare the spectrophotometer and set the proper calibration curve.
- Use a blank cuvette with distilled water to remove the background.
- Pour the water sample into the cuvette and place it in the machine.
- Press the "start" button and record the result in mg/L.

Nitrate (NO_3^-)

Equipment and reagents

- Spectrophotometer
- Glass cells with a light path length of 1 cm or 5 cm
- Nessler cylinders
- Water bath
- Phenoldisulfonic acid ($C_6H_6O_7S_2$)
- Sodium hydroxide solution (NaOH)

Method

- Pipette the proper volume of the wastewater sample to the evaporating dish and evaporate the sample to dryness using a water bath.
- After that let the dish cool down.
- Add 1 mL of phenoldisulfonic acid and distribute it with a glass rod to dissolve deposit.
- Slowly add NaOH solution (6-9 mL) to get permanent yellow colour.
- Pour the content of the evaporating dish to the Nessler cylinder and rinse the dish with distilled water 3 times, every time pour the contents of the dish into the cylinder.
- Fill the cylinder with distilled water up to 100 mL.
- Mix the content of the cylinder by turning it upside down.
- Prepare the spectrophotometer and set the proper calibration curve.
- Use a blank cuvette with distilled water to remove the background.
- Pour the water sample into the cuvette and place it in the machine.
- Press the "start" button and record the result in mg/L.

Phosphates (PO_4^{3-})

Equipment and reagents

- Spectrophotometer
- Glass cells with a light path length of 1 cm or 5 cm
- Nessler cylinder
- Pipettes
- Ascorbic acid ($C_6H_8O_6$)
- Special reagent

Method

- Pour 100 mL of wastewater sample into the Nessler cylinder (or a proper volume resulting from the dilution and fill cylinder with distilled water up to 100 mL).
- Add 1 mL of ascorbic acid and 2 mL of special reagent.
- Mix the content of the cylinder by turning it upside down and wait 10 minutes (navy blue color appears, and its intensity is proportional to the phosphates concentration).
- Prepare the spectrophotometer and set the proper calibration curve.
- Use a blank cuvette with distilled water to remove the background.
- Pour the water sample into the cuvette and place it in the machine.
- Press the "start" button and record the result in mg/L.

Solids

Total Solids (TS) = Total Suspended Solids (TSS) + Total Dissolved Solid (TDS)

Equipment

- Graduated cylinder
- Evaporating dishes
- Filter papers
- Funnel
- Analytical balance
- Water bath
- Drying oven

Total solids (TS)

Method

- Weigh an empty evaporating dish; record the mass as "a".
- Using the cylinder measure 50 mL of well-mixed wastewater sample and pour it into the pre-weighed dish.
- Evaporate the sample to dryness on a water bath.
- Next place the evaporating dish in the drying oven and dry the sample at 105˚C for 24h.
- Cool the dish in a desiccator to balance the temperature.
- Using the analytical balance weigh the evaporating dish with the dried deposit; record the mass as "b".

Calculations

$$TS, mg/L = \frac{(b - a) \times 1000}{V}$$

where:
a – mass of empty evaporating dish, mg
b – mass of evaporating dish with dried deposit, mg
V – volume of sample, mL

Total Dissolved Solid (TDS)

Method

- Weigh an empty evaporating dish; record the mass as "a".
- Filter a well-mixed wastewater sample using a funnel and filter paper.
- Using a graduated cylinder measure 50 mL of filtrate and pour it into the pre-weighed dish.
- Evaporate the sample to dryness on a water bath.
- Next place the evaporating dish in the drying oven and dry the sample at 105 °C for 24h.
- Cool the dish in a desiccator to balance the temperature.
- Using the analytical balance weigh the evaporating dish with the dried deposit; record the mass as "b".

Calculations

$$TDS, mg/L = \frac{(b - a) \cdot 1000}{V}$$

where:
a – mass of empty evaporating dish, mg
b – mass of evaporating dish with dried deposit, mg
V – volume of sample, mL

Total Suspended Solids (TSS)

Calculations

$$TSS,\ mg/L = TS,\ mg/L - TDS,\ mg/L$$

NOTES