“Root Zone Technology for Campus Waste Water Treatment

R.A. Bandal[1], S.B. Bhagat[2], N.S. Bhapkar[3], S.A. Dhaigude[4], S.P. Dikekar[5], N. S. Valekar[6], Swati A. Birajdar[7]
[1] Mr. Rohit Bandal, UG students affiliated to Department of Civil Engineering, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[2] Mr. Santosh Bhagat, UG students affiliated to Department of Civil Engineering, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[3] Mr. Nikhil Bhapkar, UG students affiliated to Department of Civil Engineering, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[4] Mr. Sagar Dhaigude, UG students affiliated to Department of Civil Engineering, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[5]Mr. Sanket Dikekar, UG students affiliated to Department of Civil Engineering, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[6]Prof. Navanath Valekar, affiliated to Department of Civil Engineering, Head of Civil Engineering Department, Dattakala Group of Institution Faculty of Engineering, Maharashtra, India
[7]Prof. Birajdar S.A. affiliated to Department of Civil Engineering, ass.Prof. of Civil Department,Dattakala Group of institution, Faculty of Engineering, Maharashtra, India

Abstract:- Water quality on earth is depleted due to over increasing human development activities that over exploits and affect the quality and quantity of the water resources. The rapid urbanization has resulted in pollution of fresh water bodies due to increase generation of domestic waste, sewage, industrial waste etc. This study investigated the effectiveness and feasibility for vertical surface flow constructed Root Zone Unit which was constructed at Dattakala college canteen, swami chincholi. In present study samples of wastewater from Inlet and Outlet of Root Zone System situated at Dattakala college canteen, swami chincholi were collected. Some physico-chemical parameter namely dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), pH and Alkalinity were analyzed using standard methods. The result obtained indicates that the Root Zone System works effectively and treated water can be used for recreational activities like washing clothes, fishing, swimming, irrigation etc.

This RZT project should be expanded for side business such as Aquaponic and organic farming, because lot of clean water available in RZT plant. So this RZT plant clean water in aquaponic tank for fish production. Further this excreta contents water use for organic farming. The raw waste water and treated waste water were collected and tested for quality.

I. INTRODUCTION

Water quality on earth is depleted due to over increasing human development activities that over exploits and affect the quality and quantity of the water resources. The rapid urbanization has resulted in pollution of fresh water bodies due to increase generation of domestic waste, sewage, industrial waste etc. In this treatment process domestic (kitchen waste) waste and Bath Effluent will be used in fish production and organic farming.

Selection of Plant Species Following list of species can be tried:

- Phragmites austrails (reed)
- Phragmites Karka (reed)
- Arundo donax (Mediterranean reed)
- Typha latifolia (cattail)
- Typha augustifolia (cattail)
- Iris pseudacorus
- Schoenopletus lacustris (bulrush)
- Canna species

So generally canna indica used in India because available in market in India (Maharashtra).

Aquaponics is the combined culture of fish and plants in recirculating systems. Nutrients, which are excreted directly by the fish or generated by the microbial breakdown of organic wastes, are absorbed by plants cultured hydroponically (without soil). Fish feed provides most of the nutrients required for plant growth. As the aquaculture effluent flows through the hydroponic component of the recirculating system, fish waste metabolites are removed by nitrification and direct uptake by the plants, thereby treating the water, which flows back to the fish-rearing component for reuse.

Some physico-chemical parameter namely dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate and phosphate were analysed using standard methods. The result obtained indicates that the Root Zone System works effectively and treated water can be used for recreational activities like washing clothes, fishing, swimming, irrigation etc.

A. PROCESS

Aquaculture refers to the production of fish, The use of wastes in aquaculture can help communities to grow more food, increasing household food security and improving nutrition for poor households in rural and peri-urban communities. Waste-fed aquaculture is centuries old in several countries in East, South and Southeast Asia, especially China. It has been developed mainly by farmers and local communities to use nutrients contained in wastes to produce aquatic food.

The Root Zone process functions according to the laws of Nature, to effectively purify domestic effluent. Root Zone encompasses the life interactions of various species of bacteria, the roots of the reed plants, Soil, Air, Sun and of course water. Reed Plants have capacity to absorb oxygen from ambient air and creating numerous bacteria. Same bacteria oxidize and purify the waste water. Since the process occur underground inducing different types of chemical reactions, the process functions as a mirror of self regulating, purifying process found in nature. Three integrated components are essential in this system.

- The reeds
- The reed beds
- Microbial organisms.

The process involves the raw effluent which is passed horizontally or vertically through a bed of soil having impervious bottom. The effluent percolates through the bed that has all the roots of the wetland plants spread very thickly. Nearly 2,500 types of bacteria and 10,000 types of fungi, which harbor around roots get oxygen from the weak membranes of the roots and aerobically oxidize the organic matter of the effluent. The characteristics of plants of absorbing oxygen through their leaves and passing it down to roots through their stems which are hollow, is utilized as a bio-pump.

Anaerobic digestion also takes place away from the roots. The filtering action of the soil bed, the action with fungi etc. and chemical action with certain existing or added inorganic chemicals help in finally obtaining very and clean water. The system of plants regenerates itself as the old plants die and form useful humus. Hence the system becomes maintenance free and can run efficiently for several years.

Aquaponics is the combined culture of fish and plants in recirculating systems. Nutrients, which are excreted directly by the fish or generated by the microbial breakdown of organic wastes, are absorbed by plants cultured hydroponically. Fish feed provides most of the nutrients required for plant growth.

➢ *Materials*

1. Auqaponic /Aquaponic tank: - There should be chilapi, talipa etc. used in fish production. Dry waste used to growthing the fish and the excreta used for organic farming. This fish should stay in tank upto temperature of$18-30$°C.

Fig 1:- Auqaponic

2. Canna Indica: - There should be used for killed bacteria from root and get oxygen mixed in waste water.

Fig 2:- Canna Indica

3. Soil: - There should be used to growth of plant and remove the oil from waste water.

Fig 3:- Soil

4. Sand:- 0.3-0.5 mm size white sand are used for RZT, This size of sand promote movement of water and prevent clogging.

Fig 4:- Sand

5. Coal: - To reduce the hardness of waste water.

Fig 5:- Coal

6. Gravel: - 0.6mm size & it's used remove the sediment, odour and smell of waste water.

Fig 6:- Gravel

7. Brick pieces:-Remove the fluorides in waste water.

Fig 7:- Brick Pieces

8. Organic farming: -Too many vegetables methi, potato, gobi, etc. should be used in organic farming.

Fig 8:- Organic Farming

9. Storage tank: - this tank should used for treated waste water storage.

Fig 9:- Storage Tank

B. SIZE OF TANK

Root Zone Treatment the size should for the experimently design, so tank should be taken for 1.0x0.6x0.6m.

C. OBJECTIVE

- In this treatment process of wastewater, we can achieve better quality water.
- Large quantity of waste water gets treated.
- Side business – maximum produce fish, vegetable and recycle waste water.
- Maximum efficiency as compare to conventional treatment plant.
- To study the effectiveness of the wetland plant canna indica in the treatment of domestic waste water.

D. APPLICATION

That excesses water should used to any other purpose, this filtered water used for

- Gardening
- Fire Fighting
- Washing
- Toilet Flushing
- Construction
- Aquaponic
- Vehicle Washing.

II. LETERATURE REVIEW

A. Aquaponic

- Third edition of the Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture Guidance note for Programme Managers and Engineers –

Aquaculture refers to the production of fish, the use of wastes in aquaculture can help communities to grow more food, increasing household food security and improving nutrition for poor households in rural and peri-urban communities. Waste-fed aquaculture is centuries old in several countries in East, South and Southeast Asia, especially China. It has been developed mainly by farmers and local communities to use nutrients contained in wastes to produce aquatic food.

- Abdelraouf Ramadan Eid1*, Essam M. A. Hoballah2 {2014}-International Journal of Scientific Research in Agricultural Sciences, 1(5), pp. 67-79,;Impact of Irrigation Systems, Fertigation Rates and Using Drainage Water of Fish Farm in Irrigation of Potato under Arid Regions Conditions

Aquaponics is the combined culture of fish and plants in recirculating systems. Nutrients, which are excreted directly by the fish or generated by the microbial breakdown of organic wastes, are absorbed by plants cultured hydroponically. Fish feed provides most of the nutrients required for plant growth.

B. Root Zone Technology

- Int.J.Curr.Microbiol.App.Sci (2015) 4(7): 238-247, ISSN: 2319-7706 Volume 4 Number 7 (2015) pp. 238-247, Root Zone Technology: Reviewing its Past and Present(A. A. Raval1* and P. B. Desai2) –

Increasing urbanization and human activities exploits and affect the quality and quantity of the water resources. This has resulted in pollution of fresh water bodies due to increased generation of domestic waste, sewage, industrial waste etc. This paper reviews the Root Zone Treatment System (RZTS) which are planted filterbeds consisting of soil. This Technology uses a natural way to effectively treat domestic and industrial effluents. RZTS are well known in temperate climates and are easy to operate having less installation, low maintenance and operational costs and incorporates the self-regulating dynamics of an artificial soil eco-system. This technology has been successfully running in several countries like Europe and America. Use of constructed wetlands can now be recognized as an accepted low cost eco-technology, especially beneficial as compared to costly conventional treatment systems. There is a need to exploit this technology in a developing country like India to its maximum to gain its benefits and for sustainable development. Root Zone technology is a solution to the modern industrialised world s water pollution problems. Growth of wetland plants called reeds in specially designed beds provides eco-friendly mode to use nature to Protect Nature .The root zone i.e. a filter plant is a biological filter, where biological treatment of wastewater takes place in a soil volume, which is penetrated by the roots of *Canna Indica.*

- Avinash Bajpaib , Kalpana Kumari Thakura, Etal. {2014}- International Journal of Applied Science and Engineeringm2014-12, 3: 169-175; Int. J. Appl. Sci. Eng., 2014. 12, 3 169 Wastewater Treatment through Root Zone Technology with Special Reference to Shahpura Lake of Bhopal (M. P.), India,

Water quality on earth is depleted due to over increasing human development activities that over exploits and affect the quality and quantity of the water resources. The rapid urbanization has resulted in pollution of fresh water bodies due to increase generation of domestic waste, sewage, industrial waste etc. This study investigated the effectiveness and feasibility for Horizontal surface flow constructed wetland/Root Zone Unit which was constructed by Environmental Planning & coordination organization (EPCO) at Ekant Park, Bhopal. In present study samples of wastewater from Inlet and Outlet of Root Zone System situated at Ekant park, Bhopal (M. P.) were collected quarterly from June 2011 to May 2012. Some physico-chemical parameter namely dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate and phosphate were analysed using standard methods. The result obtained indicates that the Root Zone System works effectively and treated water can be used for recreational activities like washing clothes, fishing, swimming, irrigation etc. The rapid urbanization has resulted in pollution of fresh water bodies due to increase generation of domestic waste, sewage, industrial waste etc. This study investigated the effectiveness and feasibility for Horizontal surface flow constructed wetland/Root Zone Unit which was constructed by Environmental Planning & coordination organization (EPCO) at Ekant Park, Bhopal.

- A. Abdul Rahaman, G. Baskar Etal. {2009)-Journal of Environmental Research And Development Vol. 3 No. 3, 695 root zone technology for campus waste water treatment

Root zone treatment is an engineered method of purifying waste water as it passes through artificially constructed wetland area. It is considered as an effective and reliable secondary and tertiary treatment method. The pollutants are removed by various physical, chemical and biogeochemical processes like sedimentation, absorption, and nitrification as well as through uptake by wetland plants.

It is seen that this pilot unit is reducing the concentrations of TSS, TDS, TN, TP, BOD, COD by 90%, 77%, 85%, 95%, 95%, 69%, respectively on an average. Root zone system achieves standards for tertiary treatment with no operating costs, low maintenance costs.

- Chamundeeswari, Md.Zafar Equbal {2012}- International Journal of Computer & Organization Trends – Volume 2 Issue 2 ISSN: 2249-2593 Waste water management by rootzone technology

The term root zone encompasses the life interactions of bacteria, the roots of the wetland plants, soil, air, sun and water. Root zone treatment is an engineered method of purifying waste water as it passes through artificially constructed wetland area. It is considered as an effective and reliable secondary and tertiary treatment method. The pollutants are removed by various physical, chemical and biogeochemical processes like sedimentation, absorption, and nitrification as well as through uptake by wetland plants. Root zone systems are reported to be most suitable for schools, hospitals, hotels and for smaller communities. The aim of this research is to study the effectiveness of the wetland plant *Phragmites australis* in the treatment of waste water generated in the SRM University premises. A pilot wetland unit of size 1.5X0.6X0.3m was constructed in the campus grounds. *Phragmites australis* species were grown in the field with fresh water. 3X3 rows of plants were transplanted into the pilot unit and subjected to waste water from the hostels and other campus buildings. The raw waste water and treated waste water were collected periodically and tested for quality. It is seen that this pilot unit is reducing the concentrations of TSS, TDS, TN, TP, BOD, COD by 90%, 77%, 85%, 95%, 95%, 69%, respectively on an average. Root zone system achieves standards for tertiary treatment with no operating costs, low maintenance costs, enhances the landscape, provides a natural habitat for birds, and does not have any odour problem. Root zone treatment is an engineered method of purifying waste water as it passes through artificially constructed wetland area. It is considered as an effective and reliable secondary and tertiary treatment method. The pollutants are removed by various physical, chemical and biogeochemical processes like sedimentation, absorption, and nitrification as well as through uptake by wetland plants.

C. Organic Farming

- D. Colacicco .R.I. Papendick {1986}-BRlo/ icol .I ;ricilttureand lorticulure.1986, Vol 3. pp. 115-130,0144-8765/86 1 A B Academic Publishers Printed in Great Britain Recycling of Organic Wastes for a Sustainable Agriculture efficient and

The purpose of this paper is to present some new perspectives and strategies form use of organic wastes to enhance sustainable systems of agriculiture in both developed and developing countries.

- Abdelraouf Ramadan Eid1, Essam M. A. Hoballah2{2014}–International Journal of Scientific

Research in Agricultural Sciences, 1(5), pp. 67-79, 2014; Impact of Irrigation Systems, Fertigation Rates and Using Drainage Water of Fish Farm in Irrigation of Potato under Arid Regions Conditions

Two field experiments were carried out during growing seasons 2011 and 2012, it executed in research farm of National Research Center in Nubaryia region, Egypt to study the effect of irrigation systems, fertigation rates and using the wastewater of fish farms in irrigation of potato crop under sandy soil conditions. Study factors were irrigation systems (sprinkler irrigation system ―SIS‖ and drip irrigation system ―DIS), water quality (irrigation water ―IW‖ and drainage water of fish farms ―DWFF‖) and fertigation rates (FR1= 20%, FR2= 40%, FR3= 60%, FR4 = 80% and FR5= 100% from recommended dose from NPK).The following parameters were studied to evaluate the effect of study factors:(1) Chemical and biological description of drainage water of fish farms. (2) Clogging ratio of emitters (3) Yield of potato, (4) water use efficiency of potato. Statistical analysis of the effect of the interaction between study factors on yield, water use efficiency of potato indicated that, maximum values were obtained of yield of potato under SIS x FR5 x DWFF, also indicated that, there were no significant differences for yield values under the following conditions: SIS x FR5 x DWFF > SIS x FR4 x DWFF > SIS x FR3 x DWFF > DIS x FR5 x IW this means that ruse drainage water of fish farming as a new resource for irrigation and rich with organic matter and it can improve soil quality and crops productivity and reduce the total costs of fertilizers by adding minimum doses from minerals fertilizers and sprinkler irrigation system is the best irrigation system which can be used. Ruse drainage water of fish farming as a new resource for irrigation and rich with organic matter and it can improve soil quality and crops productivity and reduce the total costs of fertilizers by adding minimum doses from minerals fertilizers and sprinkler irrigation system is the best irrigation system which can be used.

III. METHODOLOGY

Root zone treatment is an engineered method of purifying waste water as it passes through artificially constructed wetland area. It is considered as an effective and reliable secondary and tertiary treatment method. The pollutants are removed by various physical, chemical and biogeochemical processes like sedimentation, absorption, and nitrification as well as through uptake by wetland plants.

A. Influent of Water

Collection of waste water from kitchen and bath.

B. *Model Preparation:* - generally root zone treatment plant/ whole project worked after 3 months because stabilize or spread root of canna indica in plant.

Fig 10:- Assembly of Project: -

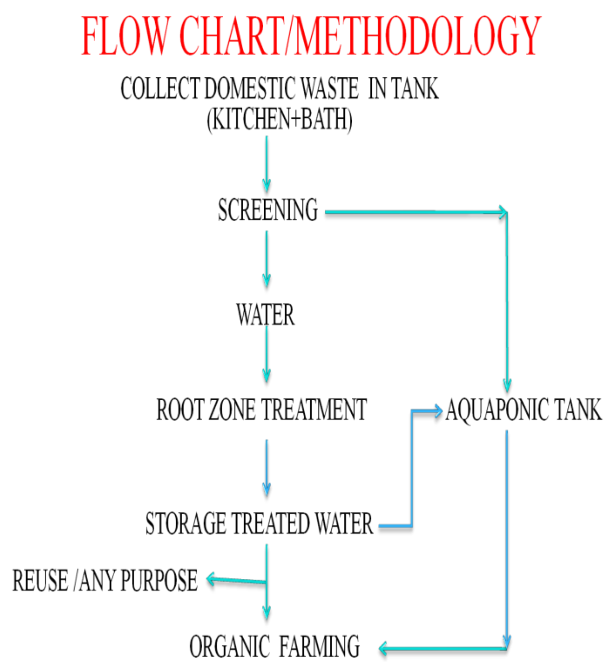


Fig 11:- Flow Chart

C. Test on Project

- pH,
- Alkalinity,
- Hardness,
- Turbidity,
- BOD,
- COD.

D. Determination of Ph in Waste Water Sample

- *Introduction*

P is "potenz"of hydrogen or power ion concentration of hydrogen(H is a very important parameter in water chemistry, with which water supply and sanitary engineers are very much concerned.

➢ *Definition*

pH = log {1/(H+)}. The pH of water or wastewater is a measure of its free acidity or alkalinity. The pH scale extends from 0 to 14. At pH 7, equal concentration of H+ and OH- ions are present in pure water at 250C. This is the pH for neutrality. Acidity or (H+) increases as pH drop from 7 to 0 and alkalinity or (OH-) increases as pH rises from 7 to 14. pH for exact neutrality, however , varies with temperature from 7.47 at 00 C through 7.0 at 250 C to 6.765 at 400 C . With acidity and alkalinity having great significance in water supply and sanitary engineering, pH 7 does not have much relevance as a reference value.

➢ *Significance of Ph in Water Supply*

1. pH is one of the important parameters considered in evaluating the quality of a raw water source to be used for

water supply. A source with a PH range of 6.5 - 8.5 is considered excellent.

2. pH is important in coagulation - It is necessary to maintain an optimum PH range of 6.5 - 8 for effective coagulation with alum. (pH 6.5 is significant because that is the minimum permissible pH of drinking water).

3. pH is important in chlorination - At pH 7, 80% of applied Cl2 is HOCl and 20% is OCI- and At pH 8, 29% of applied Cl2 is HOCl and 71% is OCI-. (HOCl being 80 times more potent than OCI- as a disinfectant, lower pH values provide higher efficiencies of disinfections.)

4. pH is important in corrosion control - pH values below 6.5 are highly corrosive . Alkaline waters are less corrosive and neutral waters are least corrosive. Treated water with pH less than 6.5, corrodes iron pipes and valves in the distribution system . Lead which is used in processing of plastic pipes can dissolve and cause plumbism (slow poisoning because of lead), when plastic pipes are used for supplying acidic water.

5. pH is an important factor for removal of dissolved iron manganese in water supply. Aeration, with pH raised above 6.5 precipitates iron and pH raised above 8.5, removes manganese.

6. pH is important in softening hard water. The principal cations producing hardness Ca2+ and Mg2+ are precipitated at pH 9.5 and 10.8 respectively.

Fig 12:- Ph Meter

➢ *Standards Ph Recommended for Drinking Water*

Authority	Desirable Range	Maximum Permissible Range
BIS	6.5-8.5	No relaxation
GOI	7-8.5	6.5-9.2
WHO	7-8.5	6.5-9.2

Note: When pH is beyond the maximum permissible range, taste may change; Gastro intestinal irritation may be caused. Water may affect the mucus membrane of the consumers. Water supply systems may be exposed to corrosion. MPL is relaxation given under extreme conditions when alternate source of water is not available.

➢ *Ph Determination*

- Equipment– pH meter
- *Glass Ware*- Beakers–250 ml, 2 Numbers.
- *Chemicals*

1. Standard buffer solutions for calibration at pH – 4.5, pH – 7 and pH – 9.2

2. pH papers

- *Salient Features of Ph Meter–*

The pH meter is based on potentiometric measurement of hydrogen ion concentration in a sample. The meter consists of a pair of electrodes: the glass electrode and a reference electrode. The glass electrode is an indicator electrode. It is composed of a glass tube with a bulb containing a standard buffer solution (HCl + KCl) with an electrode of silver wire, coated with AgCl, sealed within it. This electrode shows the potential proportional to the hydrogen ions concentration of the surrounding solution.

The second electrode is a reference electrode, known as the calomel electrode. It consist of a paste of mercurous chloride and mercury, immersed in saturated KCL solution This electrode has a fixed and know potential (0.2444 V) compared to the standard hydrogen electrode at 250 C These electrodes may be independent or combined as in some modern instrument. The instrument needs calibration with a solution of known pH. The display of PH value is on an indicator or digital scale.

- *The pH meter also consist of*
- ✓ Functions Selector – This facilitates reading of pH (or mv) or puts the instrument on "stand by" when not in use.
- ✓ Calibration Control – Compensates for drift in value of pH with temperature between 00C and 1000C.

➢ *Procedure*

- Dip the electrode in distilled water, switch on the pH meter and allow it to warm up for 15 minutes. (F should be on „standby" w electrodes are exposed or the instrument is not in use).
- Immerse the pH electrodes in a buffer solution of known pH (preferably7, 4 AND 9.2 for water analysis).
- Adjust T to read the temperature of buffer. (The buffer should be at room temperature at the time of use).
- Switch F to pH and operate C to read the known pH value on display.
- Put F on standby, remove the buffer solution, wash the electrodes with distilled water and dry with a blotting paper.
- Now introduce the electrodes into the test sample at room temperature, put F on H, allow the reading on display to stabilize and then record the pH of the sample.

➢ *Determination of Ph Using Ph Papers*

The pH papers are cheaply commercially available in the form of book –lets, the cover strip carrying coolers varying with reference to pH values. A booklet with pH varying from 2 (red) through 7 (green) to 10 (blue) is satisfactory for water analysis work. pH papers are most useful in field studies.

- *Method of Use*

Tear out 1/3rd or ½ of a pH paper, dip it in the test sample, allow a reaction time of 10 –20 seconds and match the colour developed with the coloured cover strip and read out the pH value. (Some experience is required in estimating pH between consecutive pH values, especially between 4 and 5 8 and 9, as the results are very significant in water analysis).

E. Determination of Alkalinity in Sample

➢ *Introduction*

Alkalinity is an important chemical property of water. Its concentration determines the extent to which acids can be neutralized. Alkalinity is chiefly caused by bicarbonates, carbonates and hydroxides of alkali earth metal Ca, Mg, and Na. Principally alkalinity is expressed in three forms – hydroxide alkalinity, carbonate alkalinity and bicarbonate alkalinity. Of these, bicarbonates of Ca, Mg, K, and Na. are most predominant in natural underground water bodies.

$$CO2+H2O + CaCO3 \text{ or } MgCO3 \rightarrow (HCO3)2 \text{ or } (HCO3)2$$
$$Na2CO3 \text{ or } 2NaHCO3$$

In natural surface water bodies such as rivers and lakes, CO2 – a product of microbial oxidation of organic matter and vegetative respiration – is removed by algal photosynthesis and surface aeration. These results in conversion of a part of bicarbonate alkalinity into carbonate alkalinity and even into hydroxide alkalinity, if there is an algal bloom.

$$2HCO3 \rightarrow CO32- + H2O + CO2\uparrow \rightarrow 2OH + CO2\uparrow$$

➢ *Importance Of Alkalinity Determination -*

- Alkalinity is important during coagulation - It buffers the water in the PH range most suitable for effective coagulation.
- Alkalinity is important in water softening - It is used for calculating the quantities of chemical required such as lime and soda ash.
- Alkalinity is important in corrosion control - Slightly alkaline water is less corrosive than acid water in the distribution system.
- Alkalinity determination is also important in maintaining high efficiency of anaerobic digesters and also in determining suitability of wastes and waste water for biological treatment.

➢ *Standards of Alkalinity Recommended for Drinking Water*

Authority	HDL, mg/lasCaCO3	MPL, mg/l asCaCO3
BIS	200	600

➢ *Determination of Different Forms of Alkalinity*

- *Precise Method*

Equipment - pH meter with standard buffer solutions.
Glassware - Beakers - 250 ml (2 no's)
Conical flask - 250 ml (2 no's)
Burette - 50 ml (1 no's)
Chemicals - H2SO4– 0.02 N (Titrant), Phenolphthalein Indicator (PP)
Miscellaneous - Thermometer, blotting paper and distilled water.

Procedure

- ✓ Determine the temperature of the sample.
- ✓ Determine the pH of the sample accurately.
- ✓ Take 25 ml of the sample in a conical flask.
- ✓ If pH of the sample is above 8.3 add two drops of pp indicator. Pink colour is obtained.
- ✓ Titrate against 0.02 N H2SO4 till pink colour disappear (PP end point)
- ✓ Record x ml of titrant used uptopp end point.
- ✓ To the same flask content, add 2 drops of MO indicator. Yellow colour isobtained if alkalinity is present.
- ✓ Continue titration against .02 N H2SO4 until a light orange colour is obtained (MO end point).

- ✓ Record the amount of titrant used (y ml) between PP end point and MO end point.

- *Calculation*

x = ml of Titrant used upto PP end point
y = ml of Titrant used between PP end point and MO end point.

$$\text{Alkalinity (Before) CaCO3} = \frac{(x+y)(ml)X0.02\left(\frac{mg}{ml}\right)X\ 50X1000\left(\frac{ml}{l}\right)}{Volume\ of\ sample\ taken(ml)}$$

$$= \frac{6.75\ X\ 0.02\ X\ 1000\ X\ 50}{25}$$

= 270 mg/l

$$\text{(After) CaCO3} = \frac{(x+y)(ml)X0.02\left(\frac{mg}{ml}\right)X\ 50X1000\left(\frac{ml}{l}\right)}{Volume\ of\ sample\ taken(ml)}$$

$$= \frac{2.15\ X\ 0.02\ X\ 50\ X\ 1000}{25}$$

= 86 mg/l

F. *Determination of Hardness In Sample*

- *Introduction -*

Hardness is a property of water, which represents the total concentration of Ca and Mg ions expressed as CaCO3. (The old definition, that hardness is a measure of the lack of capacity of water to form lather with soap is now obsolete.) There are two forms of hardness Carbonate hardness and Non-Carbonate hardness. Carbonate hardness in natural waters is derived by the action of CO2 (which is a bye product of microbial action on organic matter in top and sub soil) on lime stone deposits. So soluble bicarbonates, carbonates of Ca and Mg contribute to carbonate hardness. Once carbonates of lime stone dissolves in waters acidified by CO2, excess of Ca2+ and Mg2+ ions combine with available chlorides and sulphates to form non carbonate hardness. Some hardness is also caused by cations Sr2+, Fe2+, and Mn2+ and anions NO3-, and SiO2 but this is negligible and is relatively of less significance in water supply schemes.

- *Recommended Standards For Total Hardness In Drinking Water, Mg/L.*

Authority	HDL	MPL
BIS	300	600
GOI	200	600
WHO	100	500

- *Determination of Hardness by Complexometric Titration:-*

Using Ethylene Diamine Tetra Acetic Acid (EDTA)

- *Principle*

Eriochrome Black T, an organic indicator dye, forms a sky blue coloured solutions when added to a sample of hard water at pH 10, this forms a weak wine red complex with hardness

producing cations principally Ca2+ and Mg2+.

To this complex, if EDTA is added, EDTA extracts Ca2+ and Mg2+ ions to form a stable complex. When all the Ca2+ and Mg2+ ions are extracted, the indicator is totally released in its natural sky blue colour at the end point. The amount of EDTA used to a measure of Ca2+ and Mg2+ and other ions causing hardness.

- ➢ *Apparatus -*

Burette -50ml (1 no's)
Conical flask -250 ml (2 no's)
Pipette -25 ml.

- ➢ *Chemicals* - Hardness buffer - (to maintain pH = 10± 0.1), Eriochrome Black T - (indicator), EDTA - (Titrant), Standard CaCO3 – (0.02N).

- ➢ *Procedure*

A. *Sample Titration*

1. Take 25 ml of hard water Sample in a conical flask.
2. Add 100 ml distilled water (this will reduce conc. of CaCO3which may precipitate out at pH of titration and mark the end point, especially if the overall titration is prolonged beyond 5 min).
3. Add 1 to 2 ml of hardness buffer to give a pH of 10.
4. Add a few grains of dry indicator and mix (or a few drops indicator solution. till a wine red colour is obtained).
5. Titrate vs. EDTA solution.
6. End point, sky blue colour (A sharp end point is obtained at pH 10).

B. *Standardization of Edta*

1. Take 10 ml of 0.02 N standards CaCO3soln in the flask.

2. Repeat steps 2 to 6 of (A).

3. Record z ml Titrant used for 10 ml of CaCo3.

10× 0.02 = $z - y \times N$

$$CaCO3\ EDTA, N = \frac{10x0.02}{Z-Y}$$

C. *Blank Correction*

1. Take 100 ml of distilled water and repeat steps 3-6 of (A)
2. Record y ml of EDTA used for 100 ml of distilled water

NOTE: Use 10 ml Sample, if hardness expected is more than 200 mg/l as CaCO3 and use 100 ml of distilled water for dilution.

➢ *Calculation*

Total Hardness(mg/l) (Before) ,as CaCO3=

$$\frac{(x-y)(ml) X\ N\left(\frac{mg}{ml}\right) X\ 50X1000(\frac{ml}{l})}{Volume\ of\ sample\ taken(ml)}$$

$$= \frac{(18.1-10.85\ )\ X\ 0.02\ X\ 50\ X\ 1000}{25}$$

= 290 mg/l

Total Hardness(mg/l) (After) ,as CaCO3=

$$\frac{(x-y)(ml) X\ N\left(\frac{mg}{ml}\right) X\ 50X1000(\frac{ml}{l})}{Volume\ of\ sample\ taken(ml)}$$

$$= \frac{(6.175-3.3\ )\ X\ 0.02\ X\ 50\ X\ 1000}{25}$$

= 115 mg/l

C. Determination of Turbidity in Sample

➢ *Introduction*

Turbidity is a characteristic of suspended matter in water, which offers obstruction to the passage of light through it. The grater the obstruction offered, the greater is the turbidity of water. Turbidity in water is caused chiefly by inorganic matter such as clay, silt and rock debris and to a lesser extent by organic matter such as sewage solids, algae, bacteria, protozoa and other micro organism. Turbidity is more in rainy season (because of erosion of soil by rain fall run off) than in winter and summer. It is more in river water than in water from underground sources.

➢ *Importance of Turbidity Measurement*

Turbidity studies of source of water supply, around the year, indicate the unit operation to be provided during treatment. Turbidity measurement of raw water samples is used in estimating the quantities of chemical coagulants required for treatment. High turbidity load on filters reduces filter runs by clogging filter beds faster , increases frequency of filter washing and increases operational cost of filter. Turbid particles in water absorb or reduce disinfectants and increase the cost of disinfection. Turbid particles shelter pathogens and decrease the efficiency of disinfection. Turbid water is unattractive in domestic supply. Drinking water will be aesthetically appealing, if it is clear and sparking. Water with high inorganic turbidity, when consumed, is suspected to cause gastro intestinal irritation.

Fig 13:- Turbidity Meter

➢ *Discussion*

For effective removal of turbidity, following pre-treatment is essential–

- If raw water turbidity is more than 1000 NTU, it is essential to provide plain sedimentation (PS), without which chemically assisted sedimentation (CAS) unit and filters fail to operate satisfactorily.
- If raw water turbidity is more than 500 NTU, it is desirable to provide PS followed by CAS (Coagulation, flocculation and clarification) and multilayer or mixed bed filtration.
- If raw water turbidity is between 100 and 500 NTU, PS may be omitted and only CAS may be provided, followed by multilayer or mixed bed filtration.
- If raw water turbidity is between 50 and 250 NTU, PS may be omitted and only CAS may be provided followed by rapid sand gravity filtration.
- If raw water turbidity is generally 10 NTU most of the time but not exceeding 50 NTU under rare condition, then PS and CAS units may be omitted. Direct filtration using multilayer or a mixed bed may be adopted. It is desirable to apply a nominal 5 mg/l dose of a coagulant to raw water before pumping it to filtration.
- The coagulant ripens and maintains the efficiency of filters. It is advantageous to use a gravel bed to flocculate coagulated particles before direct filtration.
- If raw water turbidity is generally 5 NTU most of the time but not exceeding 25 NTU, then direct rapid sand gravity filtration may be adopted with a nominal coagulant dose.

➢ *Standard Of Turbidity Recommended For Drinking Water*

Authority	HDL	MPL
BIS	5NTU	10NTU
GOI	2.5JTU	10JTU
WHO	5mg/l	25mg/l

➢ *Determination of Turbidity*
Using a Nephelometer–

- *Principle*

This instrument measures the intensity of light scattered by turbid particlesat right angles to the incident beam of light in comparison with the intensity of light passing through the sample. Scattering of light is a function of Tyndall effect exhibited by colloidal suspended particles. The output of (I1 / I 2) is indicated as the turbidity of the sample. For low turbidities, I2 is high and I 1 is correspondingly low. For high turbidities I2 is low and I1 is correspondingly high.

- *Equipment and Standard Suspensions.*

Nephelometer with sample tubes Suspension of,

1. 4 NTU
2. 10 NTU
3. 40 NTU
4. 100 NTU.

- *Procedure*

1. Switch on the Nephelometer.

2. Fill up a clean sample tube A with distilled water (short of overflowing) and insert it into the sample holder. Close the lid.

3. Operate "set Zero" knob and adjust the in

4. Set range selector on 4 NTU / 10 NTU/ 40 NTU / 100 NTU, within which the turbidity of the test sample is expected.

5. Take out the sample tube a (containing distilled water) and insert another sample tube B filled with a standard suspension of 4 NTU/ 10 NTU / 40 NTU/100 NTU.

6. Operate "set 100" knob and maximum adjust treading the i 100/40.
(Check by repeating steps (2) to (6) above.)

7. Fill up a sample tube C with vigorously shaken turbid water sample, insert it in the sample holder, close the lid and read out the turbidity of the sample immediately.

D. Determination of Biochemical Oxygen Demand in Waste Water Sample

➢ *Apparatus:* BOD incubator (range 5 to 50°C) BOD bottles, burette, pipette, measuring cylinder, air compressor, mixing apparatus etc.

➢ *Reagents*

1. Distilled water.
2. Phosphate buffer solution
3. Magnesium sulphate solution
4. Ferric chloride solution
5. $MnSO_4$ solution
6. Alkali, iodide azide solution
7. Calcium chloride solution
8. Conc. H_2SO_4
9. Standard sodium thio-sulphate solution (N/40)
10. Starch indicator

➢ *Significance*

The BOD test is widely is used to determine the pollutional strength of sewage and industrial waste in terms of the oxygen that they will require if condition exists. The test is most important in stream pollution control activities and by its use, it is possible to determine the degree of pollution of streams at any time. This test is of importance in regulatory works and in designing, evaluating the performance & efficiency of sewage treatment units.

➢ *Theory*

General: - BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic condition.
BOD test is an oxidation process in which diverse groups of living organisms serve as the medium for oxidation of the organic matter to CO_2 and water. Therefore, it is important that a mixed grouped of organisms commonly "seed" be present in the test. The rate of reaction depends upon the population number of microorganisms and temperature.

Fig 14:- Bod Incubator

- *Procedure*

1. Prepare the dilution water by aeration of distilled water with compressed air up to saturation and by adding 1ml

2. each of phosphate buffer solution, magnesium sulphate solution, calcium chloride, ferric chloride, Mgo4 solution.

3. Add 2ml of settled sewage in dilution water.(for seeding if necessary).

4. Aerate the dilution water with the help of air compressor for about 10 to 15 minutes.

5. Find the dissolved oxygen of sample and designate as Dos.

6. Prepare the desired percent mixture by adding sample in dilution water.

7. Find BOD bottles with desired mixture with different dilution factor and another with dilution water (blank).

8. Put all these bottles in a incubator at 20°c for 5 days.

9. Find out the dissolve oxygen of both the bottles after incubation. Designate mixer as DOi and blank as DOb.

E. Precautions

1. At least three dilutions should be prepared.

Sample NO.	Description Of Sample	Dilution Adopted	Bottle No.	DO Of Seed blon	DOs	BODs
1	10 ml + BOD Sample+990ml dilute water	1:100	A	45	42.7	230 mg/l

2. The distilled water should be aerated and significant
3. amount of nutrients should be added.
4. The sample should be seeded with domestic settled sewage if necessary.

F. Calculation of Bod (Before)

$$DO = \frac{45\ X\ 0.025\ X\ 8}{200}\ X\ 1000$$

= 45 mg/l

$$DOs = \frac{42.7\ X\ 0.025\ X\ 8}{200}\ X\ 1000$$

= 42.7 mg/l

BOD mg/l @ 20°c for 5 days,

= $(DO_b - DO_i)$ X 100

= (45 – 42.7) X 100

= 230 mg/l

Sample NO.	Description Of Sample	Dilution Adopted	Bottle No.	DO Of Seed blon	DOs	BODs
1	10 ml + BOD Sample+990ml dilute water	1:100	B	12.9	12.65	25 mg/l

- *Calculation of Bod (After)*

$$DO = \frac{12.9\ X\ 0.025\ X\ 8}{200}\ X\ 1000$$

= 12.9 mg/l

$$DOs = \frac{12.65\ X\ 0.025\ X\ 8}{200}\ X\ 1000$$

= 12.65 mg/l

BOD mg/l @ 20°c for 5 days,

= $(DO - DO_s)$ X 100

= (12.9 – 12.65) X 100

= 25 mg/l

G. Determination of Chemical Oxygen Demand Cod of Waste Water Sample

➢ *Apparatus:*

Burette with stand, pipette, 250 ml capacity beakers, measuring cylinder, digestion and reflux apparatus, hot plate etc.

➢ *Reagents;*

1. Con. Sulphuric acid.36N
2. 0.25N potassium dichromate solution.
3. 0.1N ferrous ammonium sulphate solution.
4. Ferroin indicator.
5. Silver sulphate.
6. Mercuric sulphate.
7. Glass beads.

➢ *Significance:*

The chemical oxygen demand is a measure of the oxygen equivalent of the organic matter content of a sample that is subjected to oxidation by strong chemical oxidant.

The COD test data is used for the following

1. It is used in the analysis of industrial wastes.
2. Results may be obtained with in a relatively short time and measures taken to correct errors on the day they occur.
3. In conjunction with BOD test, the COD test is helpful in indicating the presence of biologically resistant organic substances.
4. The test is widely used in the preparation of treatment facilities because of the speed with which results can be obtained.

➢ *Theory*

The chemical oxygen demand (COD) test is widely used as a means of measuring the pollutional strength of domestic and industrial wastes. It is the measurement of waste in terms of the total quantity of oxygen requirement for oxidation to carbon dioxide.

Fig 15:- Cod Digestion Apparatus

➢ *Relation Between Bod and Cod*

During the determination of COD organic matters are oxidize completely regardless of their biological assimilability. Hence, COD values are greater than BOD. Ratio of COD – BOD to BOD is called treatment ability index. It ranges from 0.4to0.8 for untreated domestic waste.

➢ *Procedure*

1. ferrous ammonium sulphate is standardized as follows;

- 10 ml of .25KN $K_2CR_2O_7$ solution is diluted to 100 ml with distilled water.
- 30 ml of conc.H_2SO_4 is added and cooled to room temperature.
- It is titrated against given ferrous ammonium sulphate using pheroin as indicator.
- Normality of ferrous ammonium sulphate is determined as

N= .25 x 10/(Volume of titrant used).

2. Two COD flasks A and B are taken.
3. About 0.4 gm of mercuric sulphate is placed in each flask to suppress the interference of chloride ion.
4. 20 ml of distilled water is added to in flask A and 20 ml sample in flask B.
5. 10 ml of standard (0.25N) $K_2Cr_2O_7$ is added to each flask.
6. 30 ml of conc. H_2SO_4 is added to each flask.
7. About 0.2 gm of silver sulphate is added to each flask.
8. There are 4 glass leads are added to each flask to prevent bumping during boiling.
9. The contents of each flask are boiled for 2 hours.
10. Each condenser is cooled and washed down with 20 ml of distilled water.
11. 80 ml of distilled water is added to each flask and cooled to room temperature.
12. The content of each flask is titrated against ferrous ammonium sulphate using ferrion as indicator. Colour change is blue green to reddish brown at the end.

➢ *Precautions*

- Strong waste should be diluted.
- Mixing of conc. H_2SO_4 should be done carefully.
- Reflux apparatus should be assembled properly.
- Ferrous ammonium sulphate solution should be standardized at the time of titration.

Sample NO.	Sample Description Dilution	ml of for blan (X)	Titrate Used for Sample (Y)	COD Mg/l	Dilution
1	20 ml + 30 ml dilute water	23.25	13.00	410	1.5

➢ *Calculation of Cod (Before)*

$$:\text{-}COD\left(\frac{mg}{l}\right)=\frac{[(x-y)\times N\times 8\times 100]}{mi\ of\ sample\ taken}$$

$$=\frac{[(23.25-13.00)\times 0.1\times 8]}{20}X\,1000$$

= 410 mg

Calculation of Cod (After)

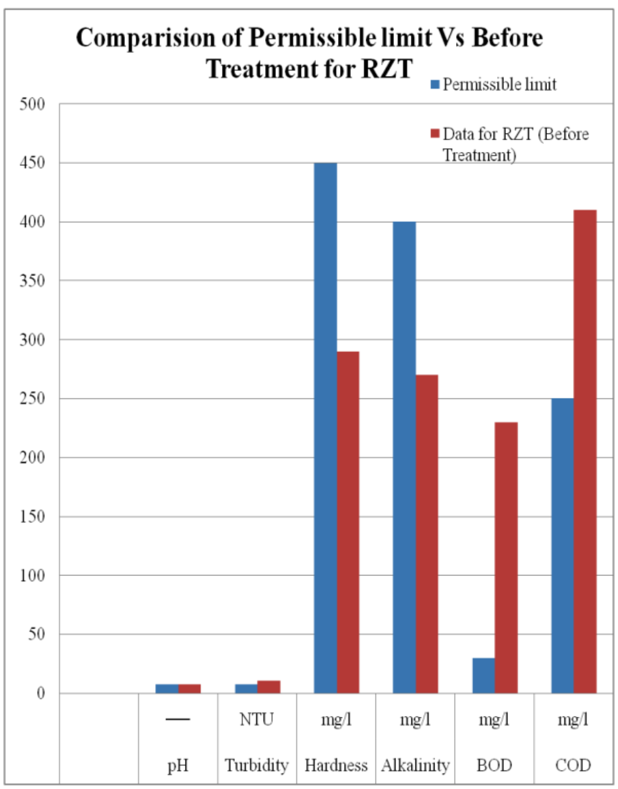
$$COD\left(\frac{mg}{l}\right)=\frac{[(x-y)\times N\times 8\times 100]}{mi\ of\ sample\ taken}$$

$$=\frac{[(12.75-11.125)\times 0.1\times 8]}{20}X\,1000$$

= 65 mg

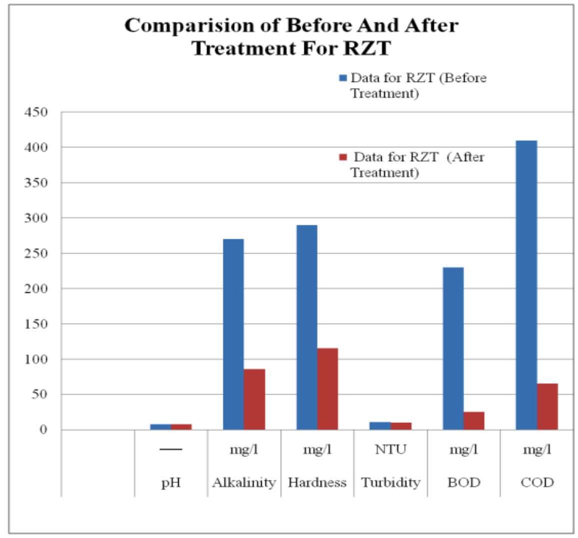
IV. RESULT ANALYSIS AND DISSCUSION

Table 4.1:- Before Treatment Parameters of waste water sample with domestic waste water limit (Permissible).



Graph 1. Before Treatment Parameters of waste water sample with domestic waste water limit (Permissible).

Table 4.2:- Before and After Treatment Parameters of waste water sample from Root Zone Technology.



Graph 2. Before and After Treatment Parameters of waste water sample from Root Zone Technology.

Sample NO.	Sample Description Dilution	ml of for blan (X)	Titrate Used for Sample (Y)	COD Mg/l	Dilution
1	20 ml + 80 ml dilute water	12.75	11.125	65	1.5

V. CONCLUSION

The present study clearly proves that the water quality during Root Zone treatment improves a lot which is indicated by reduction in BOD, COD, TURBIDITY, HARDNESS, pH value and increase in DO value. Thus it stands effective in treating the wastewater.

It is concluded that the ROOT ZONE SYSTEM is working effectively to treat the domestic wastewater and the treated water can be reused for secondary purposes like fishing, swimming, irrigation etc. and safe disposal in nearby water bodies.

Based on the experimental results, the following conclusions are made.

1. This study demonstrated that the designed vertical flow constructed wetland system could be used for treatment of the domestic waste water. A constructed wetland system can be an effective treatment facility for domestic waste water.
2. Regarding the performance achieved, the vertical flow constructed wetland was able to reduce further the level of the main physicochemical pollution parameters. The plants do play an important role in the treatment.
3. The overall experimental results demonstrated the feasibility of applying vertical flow constructed wetland unit to treat domestic waste waters.

VI. FUTURE SCOPE OF PROJECT

1. Treatment of domestic waste water has been especially used for small towns, village resorts, hotels and hostels.
2. RZTS can also treating as bio-degradable industrial effluents especially from agro-based industries.
3. A trail purpose of Root Zone Treatment Technology is underway at Titagarh Generating Station.
4. RZTS technology can be applied in Urban Watershed Management by treating the open Nallah decentralized way and receiving the treated waste either for Irrigation or Dilution purposes.
5. Thus the root zone treatment can be utilized independently or as an addition to conventional treatment for complete treatment of waste water.

REFERANCES

[1]. Third edition of the Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture Guidance note for Programme Managers and Engineers.

[2]. Abdelraouf Ramadan Eid1*, Essam M. A. Hoballah2 {2014}- International Journal of Scientific Research in Agricultural Sciences, 1(5), pp. 67-79, 20 Impact of Irrigation Systems, Fertigation Rates and Using Drainage Water of Fish Farm in Irrigation of Potato under Arid Regions Conditions.

[3]. A. A. Raval1* and P. B. Desai2 {2015}- Int.J.Curr.Microbiol. App.Sci 4(7): 238-247, ISSN: 2319-7706 Volume 4 Number 7 (2015) pp. 238-247, Root Zone Technology: Reviewing its Past and Present.

[4]. Avinash Bajpaib, Kalpana Kumari Thakura Etal{2014}- International Journal of Applied Science and Engineering. 12, 3: 169-175; *Int. J. Appl. Sci. Eng., 12, 3* 169 Wastewater Treatment through Root Zone Technology with Special Reference to Shahpura Lake of Bhopal (M.P.), India.

[5]. A. Abdul Rahaman, G. Baskar Etal.{2009}- Journal of Environmental Research and Development Vol. 3 No. 3, 695 Root Zone Technology For Campus Waste Water Treatment .

[6]. Chamundeeswari Md.Zafar Equbal {2012}- International Journal of Computer & Organization Trends – Volume 2 Issue 2 ISSN: 2249-2593 Wastewater Management By Rootzone Technology.

[7]. j.F. Parr, R.I. Papendick {1986}- BRlo/ icol .I ;riciltureand lorticulure.1986, Vol 3. pp. 115-130 0144-8765/86 A B Academic Publishers Printed in Great Britain Recycling of Organic Wastes for a Sustainable Agriculture.

[8]. Abdelraouf Ramadan Eid1 Essam M. A. Hoballah2 {2014} - International Journal of Scientific Research in Agricultural Sciences, 1(5), pp. 67-79, ; Impact of Irrigation Systems, Fertigation Rates and Using Drainage Water of Fish Farm in Irrigation of Potato under Arid Regions Conditions.