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Study of Waste Water Characteristics and Bio-Solid Recovery in Pudukottai District

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ABSTRACT

This Increase in population leads to increase in demands. Driven by environmental, economic and ecological benefits, resource recovery from waste water draws worldwide attention. Biotechnological processes offer an economic and versatile way to concentrate and transform resources from wastewater into valuable products, which is a prerequisite for the technological development of a cradle-to-cradle bio-based economy. There are many emerging technologies that enable resource recovery from waste water treatment cycle. Bioenergy can be obtained as well as bio solids which can be utilized for agricultural practice. As a result, vermiculture can also be introduced to reduce heavy metals. Anticipating the next generation of wastewater treatment plants driven by biological recovery technologies, this review is based on the generation and re-synthesis of energetic resources and key resources.

KEYWORDS: Bioenergy, Cradle to Cradle bio based economy, characteristics of manure, Resource recovery, parameters of waste water.

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INTRODUCTION

The earth's surface is enveloped by water to about 71% and amidst that only 2.5% comprises of freshwater[1]. Still about 1.1 billion people consume unsafe water due to lack of economic technologies[2]. The waste water is produced from micro industries, macro industries and household activities which ultimately comprises of Industrialization and Urbanization.

According to WORLD BANK, 21% of the communicable diseases are water related. Treatment of waste water tends to be quite expensive so to resort to economical means, Green technical methods are practiced. Some of the traditional methods are Removal of metals by filtration, flocculation, activation of charcoal and ion exchange process.

The study says that the recovered resource- bio solids which can otherwise be called as manure can be tested and utilized as plant feed and also in vermicomposting. It was found that the metal concentration was less in later stages than the initial period. By this method we can provide natural fertilizers for plants and also recover useful resources like from the waste water.

The study was conducted in the district of Pudukottai, Tamil Nadu. Around 1900-1970, people focused on removal of suspended, floatables, BOD andpathogens[3]. Later aesthetic and environmental concerns were targeted but now recovering any resource from waste water is the active task. Since there are drastic changes in the environment, scientists have purposed to recover maximum resources from the waste water by any means necessary. This led to the invention of economic technique of recovering the resources and other chemicals like heavy metals, detergents and pesticides.

Waste water and treatment has been in use for a long time and has been evolved in stages throughout the human history. The recent technology has led to treatment of waste water where the resources recovered can be used as a raw material. This concept serves as a substitution for the 3R's (Recycle, Reuse and Recover) concept. This is better known as a cradle to cradle concept[4,5]. With wastewater being increasingly recognized as a valued source of renewable resources, the EPA is urging wastewater treatment facilities, which treat human and animal waste, to be viewed as Renewable Resource Recovery Facilities that produce clean water, recover energy and generate nutrients so as to provide a satiable solution for the waste water from the sewer lines that gets drained to the nearby pond which may cause problems to groundwater in the latter days.

PARAMETERS OF WASTE WATER

Table No 1: "Major Constituents of Typical Waste Water"

Constituent	Strong	Medium	Weak
Total solids	1200	700	350
Dissolved solids	850	500	250
Suspended solids	350	200	100
Nitrogen	85	40	20
Phosphorus	20	10	6
Chloride	100	50	30
Alkalinity	200	100	50
BOD5	300	200	100

The municipal wastewater comprises of 99.9% water and the rest with dissolved organic and inorganic solids. Among the organic substances are the carbohydrates, lignin, fats, soaps, proteins, synthetic detergents etc. and certain other organic chemicals are also present in few percentages. The tabulation[6] above shows the various level of concentration of the constituents in waste water.

Total salt concentration

Total salt concentration is one of the most important agricultural water quality parameters. This is because the salinity of the soil water is related to, and often determined by, the salinity of the irrigation water. Accordingly, plant growth, crop yield and quality of produce are affected by the total dissolved salts in the irrigation water. Equally, the rate of accumulation of salts in the soil, or soil salinization, is also directly affected by the salinity of the irrigation water. Total salt concentration is expressed in milligrams per litre (mg/l) or parts per million (ppm).

Electrical conductivity

Electrical conductivity is widely used to indicate the total ionized constituents of water. It is directly related to the sum of the cations (or anions), as determined chemically and is closely correlated, in general, with the total salt concentration. Electrical conductivity is a rapid and reasonably precise determination and values are always expressed at a standard temperature of 25°C to enable comparison of readings taken under varying climatic conditions. It should be noted that the electrical conductivity of solutions increases approximately 2 percent per °C increase in temperature.

Sodium absorption ratio

Sodium is a unique cation because of its effect on soil. It has the ability to disperse soil, when present above a certain threshold value, relative to the concentration of total dissolved salts. Dispersion of soils results in reduced infiltration rates of water and air into the soil. When dried,

dispersed soil forms crusts which are hard to till and interfere with germination and seedling emergence.

The most reliable index of the sodium hazard of irrigation water is the sodium adsorption ration, SAR. The sodium adsorption ratio is defined by the formula:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

Where the ionic concentrations are expressed in mg/l.

Toxic ions and heavy metals

Many plants are susceptible to toxic elements and it normally results in impaired growth, reduced yield, changes in the morphology of the plant and even its death. The degree of damage depends on the crop, its stage of growth, the concentration of the toxic ion, climate and soil conditions.

The most common phytotoxic ions that may be present in municipal sewage are: boron (B), chloride (Cl) and sodium (Na). Hence, it is necessary to know the concentration of these ions for further utilization for plants.

pH

The pH is an indicator of the acidity or basicity of water but is seldom a problem by itself. The normal pH range for irrigation water is from 6.5 to 8.4; pH values beyond this range can be considered abnormal. Basically, pH is a routine measurement in irrigation water quality assessment.

STUDY AREA

The study was conducted in Pudukottai district, Arimalam block. Pudukkottai district was carved out of Tiruchirappalli and Thanjavur districts in January 1974.The district has an area of 4663 Sq. Km. The predominant soil is RED LOAM. Though agriculture is the main source of sustenance for a majority of the population, the scenario is not quite encouraging. There is no perennial river, however AgniarVellar, Koraiyar, Gundar, etc. are some of the seasonal rivers that drain the district. Since the river flows are copious in this district, there are no reservoirs. The sewage waste from each household flows into a pond located near the area.

Figure No 1: "Improper Sewage into Water Body"

COLLECTION OF SAMPLE

As said earlier the tests were conducted in the Arimalam block of Pudukottai. The following images will clearly envision the problem and the cause of the production of waste water. The sewage or the waste water sample was collected from this area and suitable tests were conducted.

Figure No 2: "Waste Disposal" **Figure No 3: "Eutrophification"**

The figure 1&2 shows that the locality is affected by pollution due to improper disposal of sewage waste into the water body. At the same time the solid waste including plastic covers, bags and daily households are disposed into the stagnant water. This leads to breeding of mosquitoes, Eutrophication, and water pollution.

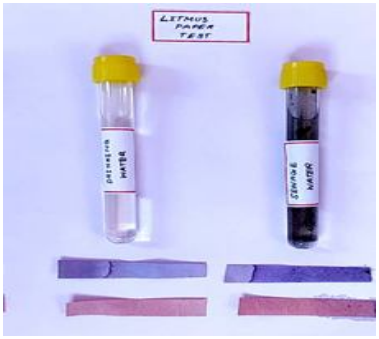
TESTS PERFORMED WITH THE SAMPLE

Various simple tests were performed on the collected sample from the local area. The tests conducted are as follows-

Litmus paper test

The inference that we achieve from this test is that if the sample is acidic, the blue litmus paper turns to red colour. Similarly, if the sample is basic in nature then the red litmus paper turns blue in color. This test was performed on all the four test samples. The test was conducted and the result was that the sewage sample from locality was found to be slightly basic.

Figure No 4: "Litmus paper test"



pH Test:

The pH refers to the negative logarithmic of hydrogen ion concentration in the particular sample. The test was conducted by simply inserting the pH meter into the test samples and the value was noted for each sample. According to this test, Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7 (25 °C), being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively.

Figure No 5: "pH TEST"

TDS test

TDS refers to total dissolved solids and is the measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular (colloidal sol) suspended form. This test was conducted on the samples and the results were tabulated.

Figure No 6: "TDS test"

Total hardness test

Total hardness is a measurement of the mineral content in a water sample that is irreversible by boiling. Therefore, total hardness can be equivalent to the total calcium and magnesium hardness. By using the total hardness testing kit, the sample was classified as hard or soft water. The test was conducted by using a series of reagents like RTH 1, RTH 2, and RTH 3 etc.

For hard water the inference is got by observing the color change as to from pink to blue and vice versa for soft water.

Figure No 7:"Hardness testing kit"

INFERENCE FOR THE TESTS UNDERTAKEN

The appropriate tests were conducted from the sample taken the wastewater samples. The wastewater (sewage) is compared with the other fluid samples from Arimalam and are tabulated in Table 1.

The test results show that the values of the sewage sample are slightly higher than that of the other samples. This shows that the sewage sample has biological contents which alter the characteristics and in turn it increases the temperature as well as other parameters.

Table No 2: "Comparison of Distilled Water, Water Sample and Sewage Sample"

Test Type	Distilled Water	Water Sample	Sewage Sample
Colour	Crystal clear	Muddy yellow	Dark grey
Odor	Odorless	Odorless	Pungent
Litmus test	No change	Slight change from blue to red	Red turns blue
Brisk Effervescence	none	none	Presence of bubbles
pH	7	6.7	7.4
TDS meter(X 10)	-	35	1200
Temperature	25^0C	29.2^0C	30.5^0C
Hardness(X 5)	-	8	86

PROCEDURE FOR COMPOST ANALYSIS[7,8,9]

Determination of pH

The pH of the compost sample was determined as per the procedure described by Chandrabose*et al.,* (1988). The pH is defined as the negative log to the base 10 of the H+ ion concentration. The pH of the bedding materials was determined Potentiometric method using a digital pH meter.

Thirty gm of air-dried sample passed through a 2mm sieve was transferred to a clean 100ml beaker to in which 60ml of distilled water was added. The contents were stirred intermittently and the sample suspension was again stirred just before taking the reading. The electrodes were immersed into the beaker containing sample water suspension and meter readings both in the supernatant solution and suspension were recorded.

Determination of Electrical Conductivity (EC)

The electrical conductivity of the test samples was determined as per the procedure outlined by Chandrabose*et al.,* (1988). Electrical conductivity is the measurement of total amount of soluble salts present in the sample and is expressed as millisimens/cm (mS/cm). To five gm of the experimental sample, 50 ml of distilled water was added, stirred well and the suspension was allowed to settle for eight hrs. The electrode of the conductivity cell was immersed into the sample solution and the EC was read and expressed in millisimens/cm (mS/cm).

Estimation of Organic Carbon by Empirical method[10]

The determination of organic carbon was carried out as per the procedure of Empirical Method. Exactly one g of finely ground oven dried sample (at 105°C) was placed in a constant mass silica crucible and heated in a muffle furnace at 550°C for 2h. The crucible was allowed to cool down in a desiccator and again weighed.

$$\text{Organic matter (\%)} = \frac{\text{Initial mass - Final mass}}{\text{Initial mass}} \times 100$$

The ratio of carbon content to volatile substance content remains to some extent for a particular type of organic waste. The volatile substance in the sample was determined as for organic matter estimation.

$$\text{Organic Carbon (\%)} = \frac{VS}{A} = \frac{\text{Organic matter (\%)}}{1.724}$$

Where, A = a constant 1.724 (Walkley and Black, 1934)

VS = Volatile substance percent (organic matter percentage)

Estimation of Total Nitrogen (N) The total nitrogen of the sample was estimated by Kjeldahl method. This method involved two steps

(i) Digestion of the sample to convert the N compound in the sample to the NH_4^+ form:

To a 100 ml Kjeldahl flask 0.5gm of dried sample was transferred. Twenty ml of the sulphuric salicylic acid mixture was added and swirled gently so as to bring the dry sample in contact with the reagents. It was allowed to stand overnight. About 5gm of sodium thiosulphate was added the next day and heated gently for about 5 min. Care was taken to avoid frothing. The contents were cooled to which 10gm of sulphate mixture was added and digested in the Kjeldahl apparatus for 1hr. Bumping during the digestion can be avoided by adding glass beads. When the digestion was completed, the digest was cooled, diluted and distilled as follows.

(ii) Distillation and determination of NH_4^+ in the digest: To a vacuum jacket of micro- Kjeldahl distillation apparatus, 10ml of the digest was transferred. In a conical flask, 10ml of 4% boric acid solution was taken containing bromocresol green and methyl red indicators, to which the condenser outlet of the flask was dipped. After adding the aliquot digest, the funnel of the apparatus was washed with 2-3 ml of deionized water and 10ml of boric acid. After completion of distillation, boric acid was titrated against N/200 H_2SO_4. Blank was also carried out to the same end point as has been followed in the case of the sample.

Weight of the sample = 0.5gm Normality of H_2SO_4 = N/200

Volume of digestion = 100ml; Aliquot taken = 5ml

Titrant Value (TV) = Sample TV-Blank TV

N (%)=TVx0.00007 x100x100 (1ml of N/10 H2So4 + = 0.000014gm N)

0.5 X 0.5

Estimation of Phosphorus[11,12]

I) Diacid digestion

Using a 9:4 mixture of HNO3 carried out Diacid digestion: HClO4. One gm of ground sample was placed in a 1000ml volumetric flask. To this, 10 ml of acid mixture was added and the contents of the flask were mixed by swirling. The flask was placed on a hot plate at low heat in a digestion chamber. The flask was subsequently heated at higher temperature until the production of red NO2 fumes ceases. The contents were further evaporated until the volume was reduced to about 3-5 ml but not to dryness. The completion of digestion was confirmed when the liquid becomes colourless. After cooling the flask, 20ml of deionized or glass distilled water was added and the solution was made up to the mark with deionized water. Then it was through Whatman No.1 filter paper.

II) Determination of Phosphorus (P)

Total phosphorus content of the sample was estimated by colorimetric method. The aliquot from sample digestion was pipetted out to 50ml volumetric flask. Then 10ml of vanadomolybdate reagent was added to each flask. The volume was made up with deionized water and mixed thoroughly (by shaking). Yellow colour was developed in about 30 minutes (The colour is stable for 2-3 weeks). The absorbance /transmittance of the solution was read at 420nm with a spectrophotometer. The phosphorus concentration was determined using the prepared standard curve.

P (%)= Sample concentration (ppm) X 1 X 100 X Final volume(ml)

Weight of Aliquot sample(ml) 1000

Estimation of Potassium

Total potassium content of the manure sample was determined as per Tandon (1993) by flame photometric method. The unknown sample was atomized in the flame photometric and the readings were recorded. The potassium concentration was determined using the prepared standard curve and multi with dilution factor.

Determination of Calcium (Ca)

The calcium and Magnesium contents of the sample were determined as per procedure of Tandon (1993). An aliquot of the sample solution containing upto 3mg calcium was pipetted out into a china dish and diluted to 10ml. About 10 droops of each of potassium cyanide, hydroxylamine hydrochloride, potassium hexacyofarrate and triethanolamine solution were added. Also 2.5 ml NaOH solution and one

ml of calcon solution were added. Then, the contents were titrated against 0.01N EDTA until the colour changed from wine red to blue using EBT indicator.

Estimation of Magnesium (Mg)

Magnesium content was calculated from the difference between the contents Ca+ Mg and the calcium content.

$$\text{Ca or (Ca + Mg) meq/gm} = \frac{\text{(ml of EDTA consumed X Normality of EDTA) X Volume made}}{\text{Aliquot taken}}$$

For calculation of percentage of calcium and magnesium, the milliequalants of Ca or Mg are to be multiplied by their respective equivalent weights (Meq X Eq. wt/mg). Then 10 to get Ca or Mg percent per gm of sample divided the value.

Determination of Ca and Mg

An aliquot of sample solution containing upto 3.0mg of Ca and Mg was pipetted out into a China dish and diluted to 10ml. to this 15ml of ammonium chloride, ammonium hydroxide buffer solution, about 10 drops of each of potassium cyanide, hydroxylamine hydrochloride, potassium hexacyofarrate and triethanolamine solution were added. After adding all these reagents, the solution was warmed for 3 min., cooled and 10 drops of Erichrome Black-T (EBT) indicator solution was added. The contents were titrated with EDTA.

Estimation of Iron and Zinc

Principle: The technique involves determination of concentration of a substance by the measurement of absorption of the characteristic radiation by the atomic vapour of an element. When radiation characteristic to a particular element passes through the atomic vapour of the same element, absorption of radiation occurs in proportion to the concentration of the atoms in the light path.

Reagent: Triple acid: 9:2:1 concentrated nitric acid, concentrated sulphuric acid and concentrated per chloric acid.

Procedure: 1. 1.0 ml of vermicompost was taken into micro kjeldahl flasks and added 12ml of triple acid, digested the samples over heated sand bath, made up to 100 ml with distilled water. 2. The contents were directly fed in to the atomic absorption spectrophotometer with the nm of 248.3, 213.9, 279.5 and 324.8; the corresponding iron, manganese, zinc and copper were respectively estimated. 3. The corresponding ppm was read from the standard curve drawn.

INFERENCE FOR THE COMPOST

Table No 3: "Physico -Chemical Parameters of Biocompost Prepared from wastewater sludge"

S.No	Parameter	SAMPLE A					
		Sludge resource	Vermin compost	Azolla Compost	Sludge + Azolla Compost	Sludge + Vermicompost	Sludge + Vermicomp + Azolla Compost
1	pH	6.9±0.1	7.5±0.1	7.2±0.1	6.9±0.1	7.4±0.1	7.9±0.1
2	Potassium (K%)	0.65%	0.72%	0.70%	0.68%	0.77%	0.88%
3	Electricalconductivity(EC)	3.74Mmhos/cm	4.23Mmhos/cm	4.20 Mmhos/cm	3.74Mmhos/cm	4.67Mmhos/cm	4.69Mmhos/cm
4	Magnesium(Mg%)	0.97%	1.12%	0.97%	0.95%	1.17%	2.12%
5	Zinc (mg)	312.3mg/kg	320.9mg/kg	310.0mg/kg	315.7mg/kg	378.7mg/kg	389.9mg/kg
6	Iron (Fe%)	0.6%	0.7%	0.7%	0.9%	0.7%	0.9%
7	Phosphorous(P %)	1.01%	1.17%	0.17%	1.17%	1.29%	1.35%
8	Total Nitrogen (N)	1.57%	1.62%	1.45%	1.65%	1.78%	1.87%
9	Total Carbon %	13.0%	15.79%	16.0%	16.4%	17.9%	19.2%
10	Calcium (Ca%)	3.96%	3.99%	4.15%	4.32%	4.84%	4.92%
11	Organic matter %	22.6%	25.7%	27.5%	26.5%	30.3%	36.7%

From the table sludge compost shows desirable prop as that of conventional manure. The test was further carried out by combing Sludge, Azzola and Vermicompost in the ratio of 1:1. We can compare the results that are tabulated as when vermicompost is added along with the sludge the result is quite desirable than vermicompost alone. There is minor variation when sludge in addition to Azzola is compared to Azzola alone. By the combination of the three the results appear to be desirable. This shows an advantage to the plants growth as well as in recovering resource from waste water.

BIOSOLID MANURE

Evolution involves also a new generation of wastewater treatment plants, where energy, organics, and other resources are recovered[13] as valuable byproducts instead of being wastefully dissipated or destroyed. This is being driven not only by a need for reduced cost and resource, particularly energy consumption, but is also motivated by worldwide depletion of non-renewable macronutrients such as easliy-accesible phosphorous, and the need to reduce anthropogenic effects

on terrestrial nitrogen cycles. Domestic wastewater by itself cannot completely fulfill fertilizer requirements, as there is substantial dissipation to both domestic animal production (not normally captured in urban treatment systems), as well as the environment. Globally, approximately 20% of *manufactured* nitrogen and phosphorous is contained in domestic wastewater, of which the majority is potentially recoverable due to urban concentration. The situation is more attenuated for energy. Bio solids, mainly composed by inert organics, non-recoverable nutrients and excess metals. This is the byproduct from the "release" stage. It seems to be critical to achieve almost complete AD, otherwise much of the benefits are lost in excess sludge production. However, Bio solids can be also used as organic fertilizers[14] if they fulfill the requirements.

Further detailed studies and researches with the sample may reveal the feasibility of Bio solids recovery from waste water sample for manure and deeper knowledge on its characteristics.

CONCLUSION

This paper has focused on the comparative study of conventional manure and that obtained from the waste water from Pudukottai. The drivers are clear, and are to translate technologies which would normally remove contaminants into a liquid or waste concentrate stream (or reactively dissipate them) into products that feed into the circular economy. This is not a massive shift from current practices, but instead of focusing the process on removal, it focuses on recovery of the manure for agricultural utility.

The idea of recovering manure based products from wastewater may once have seemed fanciful, but it's a prize that many in the water quality community are working towards. It not only helps to reduce the disposal of waste water but also increases the economy of the district and also the desire to bring a major change in the community. Of the wide variety of innovative projects underway not all will succeed, but those that do may just hold the key to plugging the funding gap for India's wastewater treatment plants.

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