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A STUDY ON ANALYSIS OF ENVIRONMENTAL SLUDE WASTE

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ABSTRACT

Swami Vivekanand University Sagar is one of the largest academic institutions in India with lots of people residing in its campus. Such large number of people will lead to large amount of sewage from hostels and academic areas. A sewage treatment plant has setup near SVNU, of Residence for the treatment of all municipal wastes from the hostels and academic areas. As a result a considerable amount of municipal sewage sludge is generated in the plant which has no use. Chemical characterization has been performed on the municipal sewage sludge so that it can be used as a domestic fertilizer. The present study involves the analysis of heavy metals such as mercury, arsenic, iron, nickel, copper, zinc, calcium, lead, chromium, magnesium, aluminum, sodium, potassium, phosphorus, silicon by using the Atomic Absorption Spectrometer. The physical and chemical parameters like TOC, hardness, colour, pH, total nitrogen, fluoride has also been determined for the sewage sludge sample. Six number of samples are collected from the Sewage Treatment Plant at different times of the day to have an average data of the measured parameters. The average values of all the parameters are found out. The samplings are also dried in different methods to have a comparative study.

INTRODUCTION

1.1 SLUDGE

The solid byproducts left out after the purification and filtration process of waste water is called sludge. Sludge is composed of pollutants that have been removed by sedimentation and filtration. It comprises of solid waste, heavy metals, pathogens and disease causing organisms. Since sludge is a biodegradable element and is rich in organic content it has various uses in the field of environmental engineering. Sludge is the end product of the waste water treatment process. There are many physical and chemical processes involved in the treatment process which results in the concentration of heavy metals and many pathogens present in the waste water. But sludge contains valuable nutrients like phosphorus and nitrogen and also abundant organic matter that is very useful when the soil is subjected to erosion. The nutrients and organic matter are the two main reasons why sludge being a waste is used as a fertilizer on lands.

Advantages of using sludge

- **Land filling:** It is the simplest solution for the dumping of sewage sludge. It prevents the spreading of pathogens/pollutants by concentrating the sludge into a single location.
- **Incineration:** In this method sludge is dried and then burned to recover the energy from the sludge. Heat from sludge incineration can also be used for heating buildings. Heat produced can also be used to produce steam and electricity generation. This method destroys pathogens and decomposes organic chemicals.
- **Biofuels production:** municipal sewage sludge can be used for production of methane gas which is rich in energy. It is produced by anaerobic digestion in sludge digesters. Methane gas is used to generate power via turbines. The gas can also be used for household utilization instead of conventional CNG gas.
- **Mine reclamation/landscaping/forestry:** Extensive heat dried sewage sludge can be used on landscapes where organic matter has been depleted through continuous irrigation and cropping/ mining. Here sewage sludge are put in layer in places where soil has no organic value. This result in the increase in the organic content in soil resulting in increase in vegetation cover.
- **Use in Agriculture:** In many developed countries this process has been used for obtaining the nutrients from sludge for plant growth. Sludge is a valuable source of organic matter and are nutrient rich fertilizers. It can contain even more nutrients present in inorganic fertilizers.
- **Other Potential uses include:** Use in cement production, as herbicides, as fish food and also production of bricks.

1.2 Sludge Stabilization

For uses in the above processes sludge has to be properly stabilized and must be free from the toxic organics, heavy metals and disease causing pathogens. It is needed to reduce the harmful content of the sludge so that it can be used in above said processes. Stabilization helps in reducing pathogens, eliminating odors and inhibit the potential for putrefaction. Sludge stabilization is done in following processes.

1.3 Objectives of the Study

The principal objective of the study is to use the unused sludge generated from the sewage treatment plant as a domestic fertilizer. The sludge includes household waste solids from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sludge contains a lot of organic matter which if stabilized can be used as manuring agent which can restore the fertility of the soil.

The objectives of the study are:
1. Physical and chemical characterization of the sewage sludge from the Sewage Treatment Plant svnu sagar
2. Comparison of the N: P: K ratio of the municipal sludge samples with other synthetic fertilizers and bio solids.

2. Methodology for determination of metals

To determine the metals in the digested sludge sample Atomic Absorption spectrometer is used. The underlying principle of this instrument is that a light beam is passed through a flame containing atomized particles into a monochromator which then leads to a detector which detects the presence of those atomized particles by measuring the light absorbed by the atomized elements in the flame. For determination of each metal a different source lamp is used with the wavelength identical to the

wavelength of the metal which is to be found. This makes it free from spectral interference. The concentration of the element in the sample is directly proportional to the amount of energy of characteristic wavelength absorbed in the flame. The presence of metals in the sludge can be beneficial or troublesome or toxic to the soil or to the plants or to animals which eat those plants depending upon the concentration. Flame and electro-thermal methods are generally applicable at low as well as moderate concentrations. The concentrations of all the metals are determined using Atomic Absorption spectrometer. [16]

Atomic Absorption Spectrometer consists of
- A light emitting source
- Burner : To atomize the digested sample
- A display unit
- Hollow Cathode ray lamps

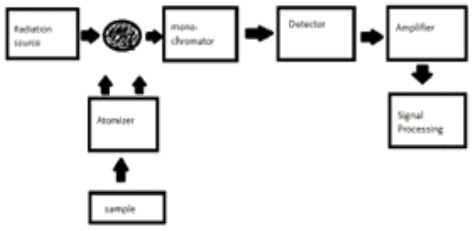

Fig 1 showing the schematic diagram of an AAS

The Atomic Absorption Spectrometer consists of an atomizer which converts the sample in to atoms. Many atomizers convert sample into atoms through flames. Some example of atomizers are flame atomizers, electro thermal atomizers, etc. radiation source of most of the AAS is hollow cathode lamps. These lamps are available in different wavelengths as per the requirement of the element. The hollow cathode lamps provide a constant supply of radiation so that the atomized elements can absorb the wavelength of the source and get detected. When the atoms absorbs the particular wavelength then it is passed through a monochromator which passes only the element of required wavelength through it. After the element is passed through the monochromator it gets detected on a detector and gets amplified. Then by signal processing the concentration of the required element is determined.

2.1 Methodology for determination of chemical characteristics

All the chemical characteristics of the digested sewage sludge sample was found with the help of a colorimeter (DRB 200 model) thermostat. The following chemical characteristics were studied:

- pH
- Total Nitrogen
- Sulphates
- Total organic carbon, Flourides

Fig 2. A colorimeter (DRB 200 model)

3. RESULTS AND DISCUSSION

3.1 Tabulations

The samples are tested in the AAS and the concentrations of various metals and Chemical characteristics are tabulated in Table 1 and Table 2.

Metals	Sample 1 oven dried (ppm)	Sample dried with magnesium sulphate (ppm)	Sundried sample (ppm)
Mercury	0.001	0.001	0.001
Copper	0.341	0.325	0.320
Zinc	3.733	3.210	2.986
Calcium	15.839	15.102	14.863
Lead	0.129	0.121	0.102
Chromium	0.479	0.423	0.399
Iron	16.308	15.962	14.214
Nickel	0.208	0.196	0.152
Magnesium	4.551	4.217	3.986
Aluminum	70.266	65.244	68.378
Silicon	105.54	50.201	109.245
Potassium	9.868	9.547	9.154
Phosphorus	5.324	5.109	4.214
Sodium	4.424	4.271	3.841

Table 1 showing the concentrations of metals in the three samples.

Chemical characteristics	Sample 1 oven dried	Sample dried with magnesium sulphate	Sun dried sample
pH	5.9	6.6	6.9
Fluoride (mg/g)	0.07	0.07	0.07
Total Nitrogen (mg/g)	11.00	10.21	9.24
Sulphate (mg/g)	0.40	0.68	0.32
TOC (mg/g)	6.24	5.21	8.20

Table 2 showing the chemical characteristics of all the three digested sludge sample.

Table 1 shows the concentration of metals in the three samples obtained from the Sewage Treatment Plant behind the V.S. Hall of Residence, NIT Rourkela. It is observed that the concentration of all the metals vary very little with the method of drying. The sun dried sample has the least concentrations of metals among all three. Therefore the sun dried method should be adopted if the sludge is to be used as a fertilizer. The same is true for Table 4 where the concentration of metals is low around 12 noon to 3 p.m. All the metals in Table 1 and 4 are in within prescribed limits of the IS codes and are therefore safe to be used as a fertilizer. Table 2 shows the concentration of fluorides, sulphates, etc of all the three samples. All the values are very less for the sundried sample. As it is stable and dried in sun all the harmful characteristics of the sludge is destroyed in the heating process. In Table 3 the concentration of various chemical characteristics is displayed with respect of the time. Again in the time between 12 noon to 3 p.m. the values are at all-time low and are therefore can be used as a fertilizer. Table 5 shows the concentration of nonmetals namely Carbon, Nitrogen, Hydrogen, Sulphur are determined as a percentage to the total weight volume of the sample. The nitrogen content of the oven dried sample is better than the other counterparts. All the concentrations of the non-metals are found in the C.H.N.S laboratory of NIT Rourkela. The concentration of nonmetals is converted from percentage to mg/g in Table 7. In Table 8 the N: P: K ratios of all three digested sewage sludge samples are calculated. It is calculated by dividing ppm concentration of the specific element. N: P: K ratio is the percentage of Nitrogen, Phosphorus and Potassium to the total weight. A fertilizer with a N: P: K ratio of 1:5:7 will have 1% of the total weight of the fertilizer as nitrogen and 5% as phosphorus and 7% as potassium. Potassium and phosphorus are present as K2O5 and P2O5. So to find the percentages of N P K we have to find the total solution weight. The empirical formulas are: Percentage of Nitrogen = ((concentration of Nitrogen in ppm) / Total solution weight) * 100 Percentage of K as K2O5 = (((conc. of Potassium in ppm) / Total solution weight)*1.2046) *100 Where 1.2046 is the K to K2O conversion factor. Percentage of P as P2O5 = (((conc. of Phosphorus in ppm) / Total solution weight)*2.2914) *100 Where 2.2914 is the P to P2O conversion factor. After tabulating the N: P: K ratios of the digested sludge sample, the N: P: K ratios of other various synthetic fertilizers as well as bio solids are compared with the digested sludge sample and are tabulated in Tables 9, 10, 11.

CONCLUSIONS

Chemical characterization of all the sludge samples was performed. The pH value was found to be slightly acidic, ranging from 5-7. Concentrations of all the metals are found to be within the permissible limit prescribed by WHO. The concentrations of fluoride, TOC, sulphates, total nitrogen are within the permissible value according to the guidelines of WHO. The concentrations of Mercury (0.001 mg/l), Iron (15.962 mg/l), Lead (0.129 mg/l) was found to be within the permissible value suggested by WHO.

The average N: P: K ratio of the sludge sample taken from Sewage Treatment Plant was found out to be 1: 3.2: 10.6. The N: P: K ratios of the sludge sample are compared with other synthetic fertilizers and bio solids. The sludge of the Sewage Treatment Plant has all the characteristics to be a good domestic fertilizer but its strong and pungent odor creates a problem in its land application.

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