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DESIGN OF SEWAGE TREATMENT SYSTEM FOR PUTTAPARTHY URBAN DEVELOPMENT AUTHORITY AND ALTERNATE USAGE OF TREATED WASTEWATER FOR SEWAGE FARMING

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ABSTRACT

The primary objective of this study is to design a sewage treatment system for PUDA (Puttaparthy Urban Development Authority) in A.P and usage of treated wastewater for irrigation. The treatability studies help us to design further treatment prior to disposal or reuse. The study area, Puttaparthy, being a pilgrim centre, attracts people all over the world. In the present study, design of the various sewage treatment units like screens, grit chambers, primary settling tanks, trickling filters, secondary settling tanks, sludge digestion tanks and sludge drying beds were carried out for the estimated peak population. Puttaparthy and its surrounding areas come under drought prone areas of Anantapur district. Hence, the treated wastewater of PUDA can be used effectively for raising some suitable crops in that area. The National Water Policy of India also emphasizes the need for recycling and reuse of wastewater. Earlier studies on sewage farming reveal that disposal of sewage effluent by applying on land increases crop yield by 33%, as sewage contains a lot of fertilizing minerals. Since the quantity of effluent from PUDA is considerably high, usage of treated sewage for irrigation is a good alternative.

INTRODUCTION

The characteristics and composition of sewage mainly depends on its source. Sewage contains organic and inorganic matters, which may be in dissolved, suspension or in colloidal and settleable state. Usually large proportion of the waste matter is organic in nature, which is attacked by saprophytic organisms, which are organisms that feed upon dead organic matter. Sewage also contains various types of bacteria, viruses, protozoa, algae and fungi etc. many of which are pathogens and harmful to the human and animal life. Treatment of the sewage is required to remove all the contaminants from it before the same is disposed off to a natural water body or on to the land.

Sewage, if allowed to accumulate without treatment, leads to production of malodorous gases due to decomposition of organic matter, resulting in epidemics due to presence of disease causing microorganisms and pathogens. It also stimulates aquatic growth due to presence of nutrients, and ground water pollution due to percolation of polluting and toxic compounds.

If the quantity of sewage is more, the receiving water will become polluted or the land will become sewage sick. Under such circumstances, it becomes essential to perform some treatment to the sewage, so that the land or receiving water without any objection can accept it. To avoid such type of nuisance, treatment of sewage before disposing off the same into natural water body or onto land has been made mandatory by most governing bodies worldwide. When the sewage is disposed off by these methods on the land or into the water, the natural purification processes will immediately start and the sewage treatment will be done in due course of time. In case of small towns and when the quantity of sewage is not very high, it can be directly disposed off without any treatment.

The land on which excessive sewage will be applied will become sewage sick and it will create dirty scenes as well as nuisance and unhygienic smells. If the excessive quantity of sewage is mixed with natural water body course, the water will become septic and totally unfit for any other use. Strength of sewage is its potentiality for producing nuisance, caused by the offensive odour and the oxidisable organic matter content. Therefore, it becomes necessary to reduce the quantity of sewage strength and make it such that it can be applied safely to the land or discharged into the natural water body courses. This objective is obtained by the treatment of sewage and by reducing its strength. The main objective of the treatment units is to reduce the sewage contents (solids) from the sewage and remove all the nuisance causing elements and change the character of the sewage in such a way that it can be discharged safely in the natural water course or applied on to the land. The degree of treatment will mostly be decided by the regulatory agencies and the extent to which the final products of treatment are to be utilized. The regulatory bodies might have laid down standards for the effluent or might specify that conditions under which the effluent could be discharged into a natural stream, sea or disposed off on to the land. The method of treatment adopted should not only meet the requirements of these regulatory agencies, but also result in the maximum use of end products to economy.

STUDY AREA

Puttaparthy town is a major Gram Panchayat of Anantapur district in Andhra Pradesh. It is an important pilgrim centre of Sri Sathya Sai Baba's Prashanthi Nilayam and situated about 80 km from district headquarters. It is located at the point of intersection of 14° 08' north latitude and 77° 50' east longitude. Puttaparthy town showed considerable vertical and horizontal growth including its vicinity area of Yenumullapalli Gram Panchayath. Puttaparthy has witnessed high growth of population due to influx of devotees to Prashanthi Nilayam and due to migration of people for supporting activities. Special occasions such as festivals also see quite a large number of devotees, visiting this place.

The Puttaparthy town is mostly covered with underground drainage system. The collected sewage, is let out directly on to the ground by the side of Anjaneya Swami temple without any treatment. The Prashanthi Nilayam area partly has a separate drainage system and letting out its sewage near N.G.O. colony, i.e., Harizanawada without any treatment of sewage. This is creating a great nuisance and giving raise to many water-borne diseases. The town comprising of existing areas and other developing colonies are not covered with any drainage system. The sewage and sullage from the residential areas, institutions and septic tanks is being let out into earthen drains, which frequently resulted in pools of stagnated water at several places, which is obviously not an aesthetic scene. During the festival seasons, where the pilgrims and devotees become abnormal in number, too much of sewage and sullage is generated, creating a great menace to the town and also to the people. To avoid this, a proposal was made to set-up a sewage treatment system near Chitravathi river in Yenumulapally village. The duly treated sewage can be applied for irrigation purpose. The objectives of the study include:

- To design suitable sewage treatment system for Puttaparthy Urban Development Authority.
- To study the possibilities of usage of treated wastewater for irrigation, i.e, sewage farming in surrounding areas of PUDA.

SEWAGE TREATMENT PROCESS

In modern treatment works, sewage undergoes several stages of treatment. Preliminary treatment deals with large solids, which are removed by screening and returned to the sewage flow. At this stage grit is removed in special tanks. The sewage then undergoes primary treatment, which consists of allowing the sewage into primary sedimentation tanks where solids settle out in the form of sludge. The next stage is secondary treatment or biological treatment in which microorganisms are utilized to make organic matter out of solution so as to form a sludge which can be settled out in a secondary settling tank (or) final clarifier. Tertiary treatment can reduce the organic matter content still further. Nutrient removal consists of reducing the phosphorus and nitrogen in the sewage so as to prevent plant growth in the receiving waters. The various methods of treatment of sewage are shown in the flow chart (Fig. 1).

Metcalf & Eddy (1992) states that, biological treatment of wastewater basically reduces the pollutant concentration through microbial coagulation and removal of non-settleable organic colloidal solids. Organic matter is biologically stabilized so that no further oxygen demand is exerted by it.

SEWAGE FARMING/WASTEWATER IRRIGATION

The recycling and reuse of wastewater has been given due importance in our national water policy. The population pressure and the urgent need for water conservation have urged us to look for alternate source of irrigation water to enhance the agricultural production. In the wastewater irrigation practices, two important aspects namely the health aspects and effects on soil and crops were studied. Currently, the principal consumptive use of water is for irrigation. The area that could be potentially irrigated has increased form 19.5 million ha (just after independence) to 78 million ha at present in the 10th 5-year plan. Out of the estimated ultimate irrigation potential of 113.5 million ha, further development of a substantial order is necessary to meet the food and fibre needs of the growing population. Hence, recycling and reuse of water should be an integral part of our water resources development. Reuse of domestic and industrial wastewater could be considered as an alternate water resource under these circumstances. In utilizing wastewater for irrigation, it is not only water that is reused but also the valuable nutrients, which are present in wastewaters. The practice of fertilizing the fields and fishponds with human wastes is an age-old practice, which is in vogue throughout the country. The utilization of human wastes appears to be rooted in the Society's concept of economic use of valuable nutrient resources to sustain production. But the use of wastewater in agriculture came into existence only after the advent of water carriage sewage system. So with the encouragement from the government and the willingness of the people to reuse wastewater for agriculture, an alternate resource of water is available at the periphery of the urban areas to increase the food, feed, fibre and fuel production, where the demands is concentrated. The water quality of the treated water should be evaluated cautiously and the crop selection should be done based on the guidelines and recommendations given by World Health Organization (1989) given in Table 1. The appropriate treatment technology for reuse of effluent for irrigation should be able to meet the quality guidelines for agriculture. Removal of pathogens is the prime objective in treating wastewater for reuse. Conventional methods of wastewater treatment emphasize the reduction or removal of BOD and suspended solids, where removal of high-risk pathogens such as helminths is ineffective. The simplest and cheapest technology that will have the greatest chance of success is by waste stabilization ponds. BIS (1965) (ISI) standards of wastewater effluents to be discharged on land for irrigation are given in Table 2. It is suggested that, the public should take preventive measures by keeping the raw vegetables submerged for at least 10 minutes in 1 in 400 water solution of bleaching powder, and then thoroughly wash them with water before use. The health of the farmers, working in the fields, is also an important factor. They should also take adequate precautions by wearing gum boots and gloves, otherwise, the larvae present in sewage effluent may get into their body, through direct contact, causing disease, most commonly the intestinal worms.

Jairam (1987) showed that the soil physical and chemical properties change remarkably under wastewater irrigation. A study was conducted at the sewage farm at Coimbatore. Soil profiles were dug and the study was conducted at the fields irrigated with sewage water for 25 years and 15 years and it was compared with non sewage irrigated soils. The results of the study showed that there was significant decrease in bulk density of farm soil after 25 years of irrigation, water-holding capacity was also high. The micro nutrient-content and accumulation of some of the heavy metals in the soil showed that due to sewage irrigation zinc, iron and manganese were more in soil irrigated for 25 years with sewage water.

DESIGN OF SEWAGE TREATMENT UNITS

Base Details		
Anticipated population	=	2.75 Lakhs
Capacity of the plant	=	55 MLD
Influent Characteristics		
pH	=	7.45
Total Suspended Solids	=	1600 mg/L
Total Dissolved Solids	=	143 mg/L
COD	=	780 mg/L
BOD	=	360 mg/L
Required Quality Of Effluent After Treatment		
BOD	=	50 mg/L
Total Suspended Solids	=	50 mg/L

Prediction of population is done by using Annual rate of increase method and expected population at the end of year 2016 is 2,75,000. Ultimate peak discharge is taken as 55×10^6 litres/day.

Various treatment units like screens, grit chambers, primary settling tanks, trickling filters, secondary settling tanks, sludge digestion tanks and sludge drying beds were designed as per specifications. The sewage treatment system proposed is mentioned in flow chart (Fig. 2). Effluent after passing through sludge drying beds will have BOD, COD and total solids meet the standards set for sewage farming. The dried sludge from the beds can be used as manure or for filling up low-lying areas.

The favourable conditions for adopting sewage irrigation in PUDA include scanty irrigation water; low rainfall, therefore, good absorption capacity of the soil; availability of large area of open barren land; presence of sandy loam so no problem of clogging of soil and developing insanitary conditions; low water table in Puttaparthy, hence high rate of percolation; and severe unemployment problem and migration of farmers for work due to scarcity of water and drought.

Considering the warm climate, the negligible flow in the streams during the summer season and the need to grow more food for our teeming population, entire India should also make use of wastewater an alternate resource for irrigating crops similar to other developed countries. Besides, the ever-increasing demand for commercial fertilizer can also be met from the nutrients and organic matter present in domestic and industrial wastewaters. It would be beneficial if the practice of sewage farming is developed on the concept of wastewater reuse as an alternate resource rather than as a method of disposal of sewage water.

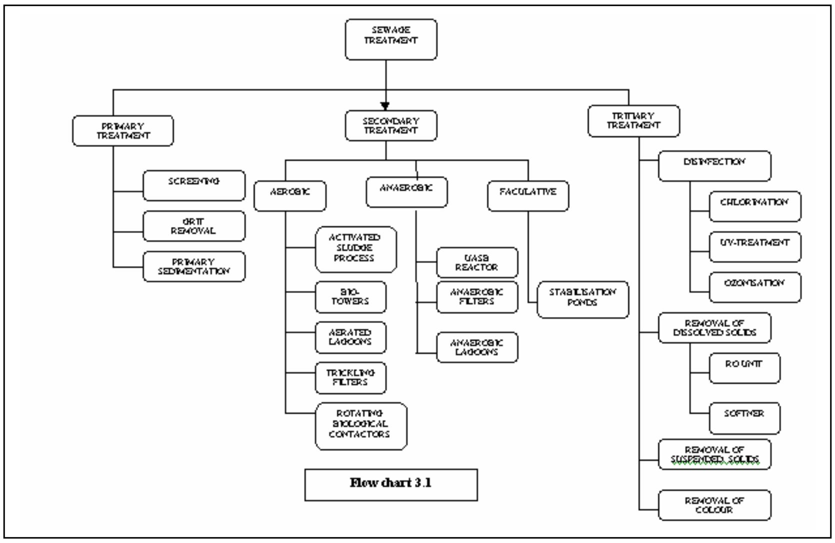

Fig. 1: Various methods of treatment of sewage.

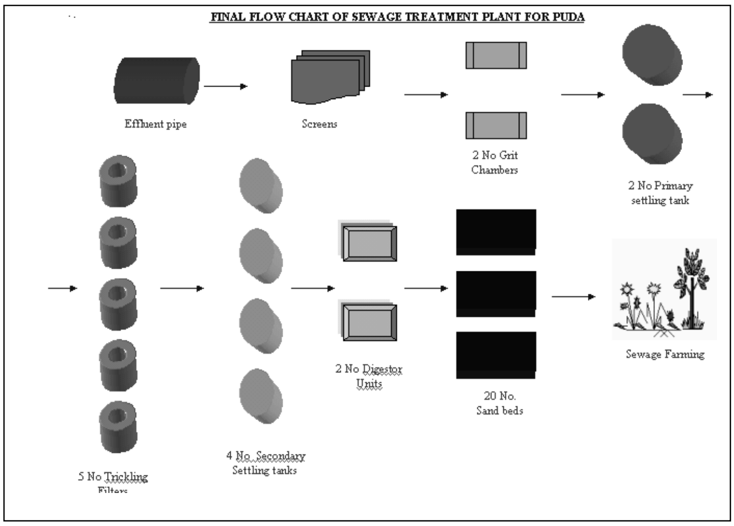

Fig 2: Proposed sewage treatment system for PUDA..

CONCLUSIONS

Disposal of sewage effluent (treated/diluted) by applying on land increases crop yield by 33% as sewage contains a lot of fertilising minerals. Fertilising elements like nitrogen, phosphorus and potash help in increasing the yield of cash crops like cotton and sugarcane etc. As Ananthapur district is drought prone area, large number of people are migrating for work due to lack of irrigation water for growing crops. As the quantity of effluent from PUDA is considerably high, use of treated sewage for irrigation is a good alternative. Following recommendations are made for sewage farming.

1. Rotation of crops should be practiced.

Table 1: WHO (1989) suggested cropping pattern for irrigation with sewage effluent.

Types of Sewage Effluents	Recommended Crops
A. Raw sewage (Preferably diluted)	a. Commercial non-edible crops. e.g., cotton, jute, milling type cane, cigarette tobacco b. Essential oil bearing crops e.g., citronella, mentha, and lemongrass. c. Fodder grasses d. Cereals and pulses e.g., paddy, moong, etc. e. Oil seeds f. Fruits crops e.g., banana, citrus, etc.
B. Primary treated sewage	As indicated above and a. Vegetables, which are cooked before eating e.g., brinjal, beans, cucurbits. b. Fruits not coming in contact with soil or water e.g., grapes, papaya, apples. c. Green fodder grasses. d. Ornamental plants.
C. Secondary treated	As above and all types of crops including vegetables eaten after cooking.
D. Secondary treated and disinfected	As above and all crops without restriction.

Table 2: BIS (1965) (ISI) standards of wastewater effluents to be discharged on land for irrigation.

S.No	Characteristic/constituent of effluent wastewater	Tolerance Limit as per IS: 3307-1965
1.	BOD_5	500 mg/L
2.	pH value	5.5 to 9.0
3.	Total dissolved solids (TDS)	2100 mg/L
4.	Oil and Grease	30 mg/L
5.	Chlorides	600 mg/L
6.	Boron	2 mg/L
7.	Sulphates	1000 mg/L
8.	Percent of sodium with respect to total content of sodium, calcium, magnesium and potassium	60%
9.	Radioactive Materials	
	(i) α-Emitters	10 μC/mL
	(ii) β-Emitters	10 μC/mL

2. Proper drainage should be maintained.
3. Care should be taken to avoid spreading of diseases like typhoid and dysentery by proper treatment of sewage and by adopting proper preventive measures.
4. Crops to be eaten raw or which do not have any skin to be removed before eating, should not be grown in sewage farms.

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