Alternative sewage treatment gives fuel and manure

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THE WORLD'S POPULATION is increasing at an accelerated rate. The population growth rate is very high in developing countries. Migration of rural population to urban area is universal phenomena. The rapid growth of cities in India is a phenomena observed in the post independence period due to rapid stride of industrial growth. If the present trend of growth of urban population continue it is estimated that 60 per cent of world's population will live in urban areas by 2000AD. The city of Bangalore is one of the fastest growing metropolitan cities in India. Due to various socio-economic factors the process of urbanisation not only continues but becomes faster with the passage of time. Such and similar reasons aggravate the stress on civic amenities like water supply, sanitation, dwelling, transport and health care facilities. This results in creation of slum dwellings without basic civic amenities. For economic reasons it is extremely difficult to provide proper water supply and sewerage facilities for all. Even most developed countries have not been able to achieve 100 per cent results. Such facilities are not only costly in terms of capital outlay but beyond the affordability of smaller communities in meeting operation and maintenance costs. But if no facility is provided, health hazards will overtake communities with various communicable diseases.

Community toilet concept has been popularised in India by Sulabh International, Safai Vidyalaya, and NASA Foundation of Ahmedabad and are effective in providing community sanitation to communities in many cities in India. In localities like slums, suburban settlements, or villages where sewerage facilities are not available or space is a constraint, community toilets, having pour flush latrines are a viable alternative. They can dispose of excreta into leaching pits/septic tanks/biogas plants where it is converted into safe, odourless organic manure besides generating energy in the form of biogas to be used for lighting, heating and electricity production.

The Centre for Environment Education, Southern Regional Cell at Bangalore has constructed two community toilet blocks in two slums, one near Banashankari Temple and another near Maruthi Seva Nagar in Bangalore.

At Ambedkar Nagar Slum near Banashankari Temple, a Community Toilet Block comprising 12 toilets, 6 for men and 6 for women separately, with water supply arrangement and bathroom facilities on pay and use pattern as popularised by NASA Foundation and Sulabh International has been constructed and commissioned. This community toilet block was commissioned in December, 1995 and is presently being maintained by NASA Foundation. The spent water and sewage is connected to the municipal sewer system available in the slum.

At Sathyanagar Slum near Maruthi Seva Nagar, the Community Toilet complex comprising 20 toilets, 10 each for men and women separately, with water supply arrangements, has been constructed with pour flush latrines, to restrict water usage and collect human night soil through a network of PVC pipes to a biogas plant. The spent slurry is fed to solar sludge drying beds with soak pits. Biogas generated is planned to be utilized for power generation through a dual fuel engine. On the roof of the toilet block, class rooms have been constructed for imparting health education, literacy, craft classes and other income generating programmes for slum dwellers. Details of this venture are beyond the scope of this paper.

Community toilet block at Sathyanagar

The arrangements of toilets' 10 each for men and women are shown in Fig.1. Pour flush water seal latrines having a squatting pan sloping to the horizontal by 20 to 30 degrees, a water seal depth of 20mm, and needing 1.5 to 2 litres of flush water have been designed and constructed by CEE South. The rural pattern squatting pan designed by Safai Vidyalaya, Ahmedabad has been adopted for this. In order to restrict usage of water, an ablution tap is not provided in the water closet room. A ground level tank is provided on each side for men and women to take water in 1000 to 1500 ml containers. The pan is proposed to be cleaned after use by each person. In all, water use of 2.5 to 3 litres per person is anticipated so that human night soil can easily be transported to the digester for biogas production. Slurry from the digester will be applied on a solar sludge drying bed. Dried sludge can be used as organic manure, after testing for the presence of human pathogenic micro-organisms.

Biogas plant

Biogas plants here are constructed in masonry work and in cases where floating domes are used, they may be of mild steel, fibreglass or HDPE. Cattle dung is often the only substrate used for biogas production in India. However, the principles of anaerobic digestion also apply to the digestion of human night soil. This application has social relevance in providing adequate sanitation and simultaneously obtaining gas for cooking, power generation, and lighting besides organic manure from dried sludge. Hence it was proposed to construct a biogas plant and to use human

Figure 1. Toilet complex, Biogas Plant at Sathyanagar Slum

night soil as the feed material. Moreover within the city limits, it makes more sense to treat night soil rather than look for cow dung as a method of generating biogas.

Design and construction

It is estimated that each toilet would be used by 50 persons over a period of 6 - 8 hours in a day. Specific production of human excreta is 150 - 300 ml per capita per day and urine is 1000 - 1500 ml with 20 - 30 grams Biochemical Oxygen Demand (BOD) per capita per day. Waste water flow is 1 to 1.5 litres each for flushing and cleaning per person for each usage. For calculating the appropriate size of digester, 2.5 litres of waste water per person is considered along with 250 ml faeces and 250 grams BOD per capita. The solid content in waste water will work out to be 10 per cent. Hydraulic detention time of 10 days is considered appropriate for the volume of digester constructed here which is to 25 m^3. Two digesters each of 12.5 m^3 capacity have been constructed in series.

The gas plant consists of two parts i.e. digester and gas holder. Digester is a strong well of RCC 1:l.5:3 constructed below ground level, its size 2.5m X 2.5m with liquid depth of 2.5m.The well has a partition wall in the middle, of 2.5m height. Two standing pipes reach the bottom of the well from either side of the partition wall and have their openings on the surface by the side of the wall, at partition wall level. One pipe serves as inlet and other as outlet. The mixture of human night soil and water from closets is let down through the inlet pipe and as the digester gets filled up, the mixture undergoes anaerobic digestion and the spent slurry overflows to next compartment. The slurry then enters the second digester after which the overflows are applied to the sludge drying beds (see Fig.l). The upper position of the digester serves as a gas holder. Accumulated biogas drawn from top through pipes and a pressure regulator, will be utilized for power generation. Considering the BOD per capita contribution of 25 grams per day for 1000 persons, biogas of $25m^3$ is anticipated to be generated. Electricial power of 1.25 KW per m^3 of gas can be generated. Thus with 25 m^3 gas, 31.25 KW power is expected to be generated every day by duel fuel engine to run a pumping set. If surplus gas is generated, the same will be utilised for heating water or lighting the toilet complex and classrooms.

Slurry disposal on solar sludge drying beds

The spent slurry from the biogas plant is fed to solar sludge drying beds constructed adjacent to it. Spent slurry of 2.5 m^3 per day is expected and would be conveyed through PVC pipes to a depth of 0.50 m. Five solar sludge drying beds of size 2^m X 7.6^m have been constructed to provide 10 days drying period. The solar sludge drying beds constructed resemble solar stills with tops covered with FRP translucent glass and base of coarse sand filter media on a graded granite stone metal to act as supporting media. This arrangement will help to dry the slurry by evaporation from top through a gap, de-watering from bottom, and sun light entering the beds will act as a disinfectant to destroy pathogens. The covering of solar sludge drying beds will minimise the smell nuisance, prevent accidental entry by children and animals and prevent flooding by rain water. Dried sludge can be used as organic manure which will be rich in nutrients.

Benefits

Community toilets with biogas plant constructed to use human night soil as substrate provides hygienic disposal of human waste and improve health conditions of communities, help promote personal hygiene, interruption of water related diseases, increase human well being and working capacities which may help improve economic development and productivity. The system provides fuel for energy production and rich organic manure.

Conclusion

Providing community toilets in urban slums and rural areas will provide indirect, but long lasting health care benefits of sanitation programme. This helps in reaching the slum dwellers without much cost and least recurring maintenance expenditure and provides an alternative to costly conventional sewerage, sewage treatment and disposal methods.

References

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