Role of Gray Water in Power Generation

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Abstract- The current era demands non-conventional energy that should be produced with no harms to nature. Furthermore to it, scarcity of water will have to be faced by present and upcoming generation. Water management should be done in the such a manner that the potential energy of water must be utilized as well as discharge must go in recharge of water resources. This paper emphasis on a simple proposal that "If certain area is taken under gray water collection from residential houses with a population of more than 1,00,000 and after physical purification, it is collected in intake structure situated at low-lying area of city where with energy is generated; and after to this, same water is used for ground water recharge." This paper also introduces new type of Sedimentation tank called as 'Circumferential sedimentation tank' for treating to gray water, which will be effective in water treatment within comparatively less timings and less usable space. While dealing with graywater, it must be viewed that it is also a waste and it implies a tremendous load on waste water treatment plant and this proposal will be helpful for proper management.

Keywords- *Treatment methodology, basic idea, scenario of proposal, power calculation, turbine recommendation.*

1. Introduction

Conventional sanitary engineering has maintained that "sewage is sewage" whether it be graywater alone or total Sewage. But graywater is specifically wash water, that is, bath, dish, and laundry water excluding toilet wastes and free of garbage-grinder residues. When properly managed, graywater can be a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It is, after all, the same phosphorous, potassium and nitrogen making graywater a source of pollution for lakes, rivers but might be proved to be excellent nutrient sources for vegetation when this are made available for irrigation.

2. Physical Treatment for Raw Graywater

If any significant quantity of food waste enters the system from dishwashers and kitchen sinks received from either cooking or any other domestic activities can be removed in first stage treatment and thereafter it is being sent to the further treatment for more physical purification.

Treatment is being done in two stages;

A. With circumferential sedimentation tank
B. With Charcoal and sand filter

2.1 Circumferential Sedimentation Tank

This tank is based on principle that as the length of flow of water is increased then simultaneously detention time of water is also increased, resulting to more settlement of sedimentary or food particles. In this raw graywater is firstly entered in Ist inlet tank and as water level goes up it enters to IInd tank and goes circumferentially and it thereafter it enters to final tank and after overall settlement of particles, water comes out of tank. The total working of the system depends upon rate of flow of water.
(Refer fig. 1.)

2.2 Sand and Charcoal Filter

This is provided with Geotextile cloth, fine sand, coarser sand, charcoal and pea gravel. This type of filter will be effective in removing small particles and also effective to treat water biologically. This results to pure and clear quality of water which will be deserving for further process. (Refer fig. 2.)

3. Basic Idea behind the Proposal

Approximately, as per UNESCO Standards with Indian scenario, quantum of graywater being produced from residential houses will be 30 to 40 litres/cap/day. As we are undertaking whole city under project with approx more than 1,00,000 population then quantum of graywater produced will be as much sufficient to generate power to glow street lights or community floor mill or community level consumption. For this total area is to be laid with common collecting pipe lines leading discharge to central location which might be located at low lying area of city so that water will come by gravity. Raw graywater will be allowed to collect in inlet tank throught day for 24 hrs. and at particular time this collected water is permitted to fall down on turbine blades which set up is installed at

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sufficient deep pit to get required head of water. Now, after rotating turbine blades, this water will be enough clear to be used as rechargeable water to ground water resources. (Ground infiltration)

4. Complete Scenario of Project with Example of Raipur City, Chhattisgarh

As shown in adjoining map of Raipur city, and reference to map produced by 'Survey of India Department', topography of Raipur city is approx. plane i,e not covered with hills and more undulation. You will find the level difference between place at 'Mowa' and other places of Raipur city is 8 to 9 M will be sufficient for pipe lines to take flow of water. (Refer fig. 3.)

4.1 Layout Depicting about Project

As from given it will be clear that preselected low lying area (For example: Mowa in Raipur) where main conduit lines are taken and finally collected in tank. As the raw graywater is produced from planned area is flowed, it will be continuously collected in tank throughout a day. Now, at particular specified time when there will be least possibility of production of graywater (after 8 to 9Pm) this water will be released at particular flow rate to get match with 'Circumferential sedimentation tank' and thereafter it will be sent to 'Sand and Charcoal Filter' where further water quality will be improved. Now this water will be allowed to fall down through penstock with sufficient head provided with specified depth of pit where turbine with alternator is installed. Now this produced electricity will be saved in batteries for their further uses. After rotating turbine blades, this water will be imposed to pass for ground water resources which will be further useful for rising water levels in wells of suburban area.
(Refer fig. 4.)

4.2 Sample Calculation for Generation of Electricity from High Head and Low Discharge Turbines

The two vital factors to be considered are the flow (volume / unit time) and the head of the water. The flow is the volume of water which can be captured and re-directed to turn the turbine generator, and the head is the distance the water will fall on its way to the generator. The larger the flow - i.e. the more water there is, and the higher the head - i.e. the higher the distance the water falls - the more energy is available for conversion to electricity. Double the flow and double the power, double the head and double the power again. A low head site has a head of below 10 metres. In this case you need to have a good volume of water flow if you are to generate much electricity. A high head site has a head of above 20 metres. In this case you can get away with not having a large flow of water, because gravity will give what you have an energy boost. The key equation to remember is the following:

Power = Efficiency X Head x Flow x Gravity X water density

Where, power is measured in Watts, head in meters, flow in liters per second, and acceleration due to gravity in meters per second per second. The acceleration due to gravity is approximately 9.81 meters per second per second - i.e. each second an object is falling, its speed increases by 9.81 meters per second (until it hits its terminal velocity). Therefore it is very simple to calculate how much hydro power you can generate.

Example for approximate data of Raipur city:-

Approx. qty. per capita per day =30 Litres.
Approx. population=12,75,000 Nos.
Quantity of water per day=12,75,000*30=38250000litres
Assuming 6 hrs. running time
Flow rate available =1.77 m^3/Sec
Head provided=15M

Power= 15*0.85*9.81*1000*1.77=2.21KWatts/sec

5. About Micro Hydropower Turbines

Turbine is a device which converts kinematic energy of falling water to mechanical energy and thereafter this energy is converted to electrical energy through alternator. Selection of type of turbine depends upon head and flow availability and site topographical condition. So, turbine are classified according to high head, medium head and low head. As shown in adjoining graph, for different type of turbine with varying head and discharge, energy generation is depicted. (Refer fig. 5.)

6. Tables, Figures

Table 1: Characteristics of Raw Graywater

	Shower	Bath	Hand basin	Combined	Shower repeat	Bath repeat
BOD_5 (ppm)	146 (55)	129 (57)	155 (49)	146 (54.3)	90 (26.1)	185 (31)
COD (ppm)	420 (245)	367 (246)	587 (379)	451 (289)	181 (63.4)	651 (112)
TOC (ppm)	65.3 (44.6)	59.8 (43)	99 (142)	72.6 (79.3)	–	–
Turbidity (NTU)	84.8 (70.5)	59.8 (43)	164 (171)	100.6 (109)	17.9 (3.8)	51.7 (11)
SS (ppm)	89 (113)	58 (46)	153 (226)	100 (145)	25.8 (8.5)	49 (10.6)
TC (cfu/100 ml)	6,800 (9,740)	6,350 (9,710)	9,420 (10,100)	7,387 (9,759)	17,000 (11,000)	23,900 (20,000)
E. coli (cfu/100 ml)	1,490 (4,940)	82.7 (120)	10 (8,750)	2,022 (5,956)	590 (1,630)	21,800 (22,100)
FS (cfu/100 ml)	2,050 (4,440)	40.1 (48.6)	1,710 (5,510)	1,740 (4,488)	31.5 (40.6)	10.2 (0.48)
TN (ppm)	8.7 (4.8)	6.6 (3.4)	10.4 (4.80	8.73 (4.73)	–	–
PO_4^- (ppm)	0.3 (0.1)	0.4 (0.4)	0.4 (0.3)	0.35 (0.23)	–	–
NH_3 (ppm)	–	–	–	–	–	–
NO_3 (ppm)	–	–	–	–	–	–
pH	7.52 (0.28)	7.57 (0.29)	7.32 (0.27)	7.47 (0.29)	7.74 (0.26)	7.74 (0.02)

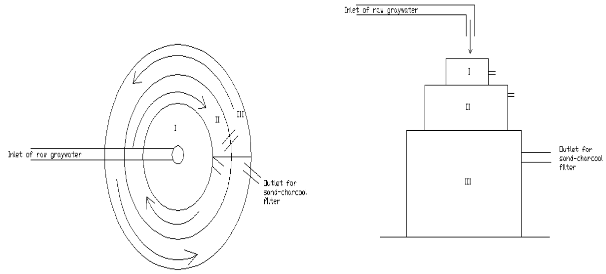

Fig. 1. Plan and Elevation showing 'Circumferential sedimentation tank'

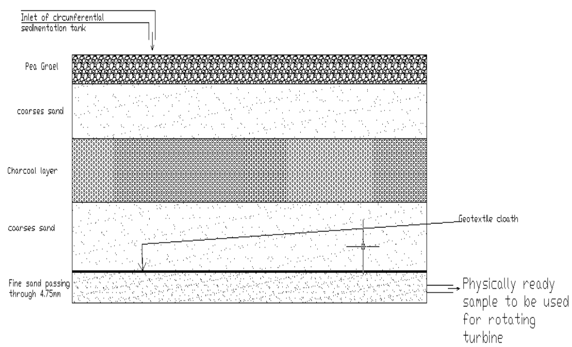

Fig. 2. Sectional elevation showing 'Sand + Charcoal filter'

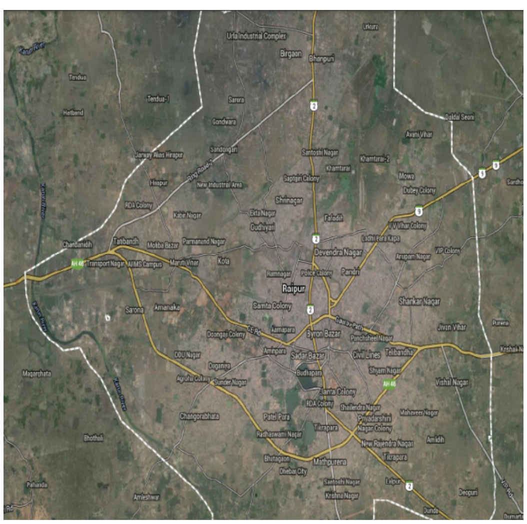

Fig. 3. Map of Raipur City

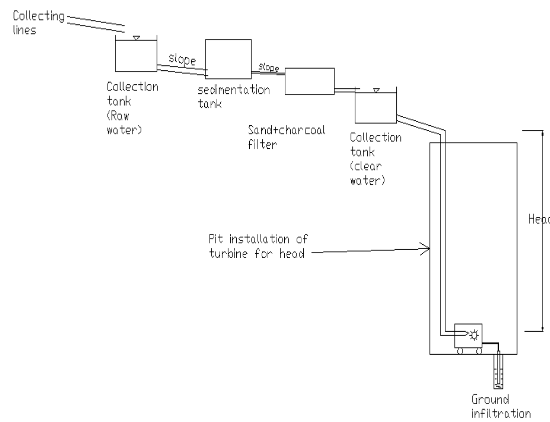

Fig. 4. Flow of water from source to ground infiltration.

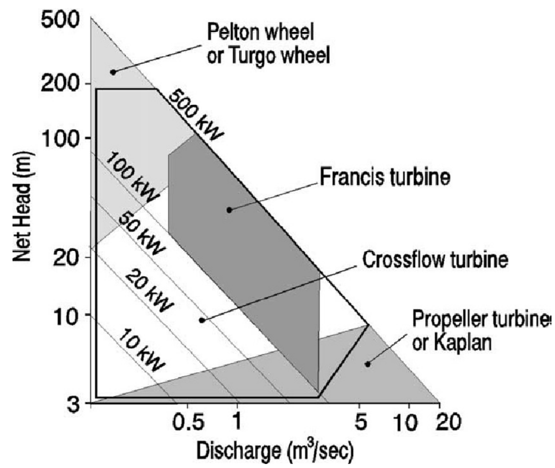

Fig. 5. Head-flow ranges of small hydro turbines

6. Discussion

Future threats to the water management for fulfillment of human requirement is main challenge in front of contemporary techniques. By the way of this paper, it will be good attempt to bring in notice of society and government the issue regarding water uses and 'Non-conventional uses' for well being of this planet. The world hit cities where the gap between demand and supply is yawning 70% and crisis is acute in those cities like Mexico, New delhi, Kanpur, Asanso, Dhanbad, Meerut, Faridabad, Vishakapatnam, Madurai, Hyderabad, etc. In such cities, it goes hard to fulfill demand upto 30 %. At the same time our conventional energy resources are getting vanished day by day. If this technique is being supported with runoff from streets after rainfall , it will be the economical and effective for implementation since the output of power will be much more. One thing must be kept in noticed that this might be affected by seasonal variation. Though this attempt cannot fulfill the whole requirement of society, still it will proved to be as a helpful support for water management. As double benefit of power generation and simultaneously ground recharge is possible, environmental ecology will be maintained.

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