MODIFICATION OF RAIN WATER HARVESTING PIT TO NEUTRALIZE ACIDIC pH OF RAIN WATER

Upendra Verma[1] and Vaishali Sahu[2]

Department of Civil& Environmental Engineering, ITM University, Gurgaon, Haryana, India

ABSTRACT

Acidification of rain water in urban cities is playing major environmental issues. Acid rain is generally caused by the formation of sulphuric acid and nitric acid. These sulphur and nitrogen emission are resulted from different sources like industries, vehicles etc. Rain water is a major source for ground water recharge in urban and rural India, Government of India has already provided water policies in 1987 and 2002 for conservation of water with different technology of harvesting. Roof top rain water harvesting is a good practice to collect rain water and inject it directly in the ground without much contamination. Ministry of Environment and Forest (MoEF) suggested different design and material selection for rain water harvesting pits to remove the suspended particles and other impurities, however no provision of controlling the pH is provided for the acidic rain water. Hence the present study proposes modification in the existing rain water harvesting pit to neutralize the acidic pH from rain water.

KEYWORDS

Acid rain, rain water harvesting, ministry of environment and forest

1. INTRODUCTION

Rainfall is very important natural mechanism for purification of atmospheric air. Many studies have reported that the release of nitrates and sulphates from industrial activities is responsible for contamination of our atmosphere. The concentration of the major air pollutant is more in urban and industrial area as compared to non-urban areas. The concentration is increasing with fast growing population, transportation, energy demand and industrialization. These pollutants are responsible for acid rain [1]. Many studies have shown that Europe and North America have experienced the adverse effects of acidic deposition in form of rain **[2] [3],** and many Asian country **[1] [4]** and China **[2]** are also facing this problem at initial level.

Rain water is always considered as good quality water for any purpose but due to anthropogenic activity against ecology, it is now considered as polluted water for some initial duration [5]. Industrialization is a basic need for rapid growth of economic activity, industrial development, energy use but simultaneously energy demand, transportation, land use practices and most important open burning has been leading to changes of atmospheric chemistry **[6] [7].** All these activities directly or indirectly contaminate rain water and results into an acid rain which is very harmful for soil, ecology system, surface water and human being etc. Also the fresh water is becoming scarce with increased

demand and consumption. To meet the water demand the Government of India through gazette notification issued by Ministry of Urban Development and Poverty alleviation vide No. N-11011/9/98-DDV (Pt)/DDIB dated 28 July, 2001 regarding modification/addition to the building bye law 1983, made it necessary to have water harvesting techniques by collecting the runoff water including rain water in all new buildings on plots of 100 sq.m and above [8]. Roof top rain water harvesting is one of the most suitable technologies for recharging the ground water and as per water policy 1987 & 2002.

Roof top rain water harvesting is basically use for direct augmentation of ground water from roof top catchment without having any major loses and contamination. Rain water directly falls on building roof top catchment area and with help of pipe lines can be directly inserted into the ground after passing through suitable filtration unit **[9].** Roof top rainwater harvesting system have various components like catchment area, coarse mesh, drain pipes, gutter, flush pipes, filter unit, storage tank, collection sump, pump unit etc. Filtration is generally used to remove the impurities from the runoff. Many filtration techniques were studied and rapid sand filtration was recommended as an efficient filtration for a roof top rain water harvesting unit [5, 9]. However if the rain is acidic (lower pH) then the provided material will not be suitable for neutralization of pH. If the same acid rainwater directly recharges into the ground water, it will have direct impact on the ground water quality and also does not fulfill the source water quality standard. Hence the provision is made to flush out the initial phase of the rain water from the harvesting pit. But flushing of the rain water will result in loss of huge quantity of water which can be used for harvesting if the pH is neutralized. Hence it is required to modify the existing rain water harvesting pit design so as to neutralize the pH of acidic rain and the acidic rain need not to be flushed but can be used for recharge of ground water.

2. OBJECTIVE OF THE WORK

The objective of the present work is to modify the existing rain water harvesting pit so that the pH of acid rain can be neutralized and the acid rain can be collected and can be used to recharge the ground water. The modification is made in the coarse sand layer of the pit. It is suggested to replace the conventional sand layer by the natural (Ganga and Yamuna) sand to neutralize the pH.

3. MATERIALS

Studies show that Uttar Pradesh, Bihar, Jharkand, West Bengal Uttarakhand and Haryana are the highly sediment basin of Ganga and its tributaries. As the formation of these soils is caused by the climatic condition and topography of the Himalayan region, these soils are classified as alluvial soil in Ganga river plane. Yamuna and Ganga alluvial soil are Gangetic alluvium (calcareous) and coastal alluvium [14, 15]. Ganga and Yamuna sand are type of alluvial soil which is basically composed of lime & potassium. The presence of lime is responsible for the alkaline nature of soil. Studies on Ganga tributaries reported the major elements of alluvial plane as alumina, mica, kaolinite, chlorite, silica, ferrous, calcium, sodium and potassium [16]. Therefore Ganga sand from Kanpur, Uttar Pradesh and Yamuna sand from Greater Noida were collected for replacing the conventional sand layer of the harvesting pit.

4. RESULTS AND DISCUSSION

4.1 pH :- pH value is logarithmic value of reciprocal hydrogen ion activity in moles per liter. pH value variation in water is due to hydrolysis of salts of strong bases and weak acid or vice versa. Dissolved gases like carbon dioxide, ammonia and hydrogen sulphide also affect pH value **[17]**. pH value range generally defined through Indian standard on

the basis of acceptable limit or tolerance limit. Different characteristic and uses of water having different pH value range as per Indian standard. Artificial ground water recharge system through roof top rain water harvesting requires water quality similar to drinking water and as per IS 10500, 1991the recommended pH is 6.5 to 8.5 **[18].**
The sand samples were kept in flask filled with distilled water of known pH for 24 hours. After 24 hours the pH variation in both the samples were checked. Three samples were tested for each sand and the average value is being reported in table 1. It shows the alkaline pH of Ganga and Yamuna sand, which will be adequate for controlling or neutralizing pH of acidic water till saturation point.

Table1:- pH value of Ganga and Yamuna sand with repetition value

S.NO.	GANGA SAND	YAMUNA SAND
1.	8.90	8.71

4.2. Permeability/ Hydraulic conductivity: - Artificial recharge planning and design basic criteria are permeability and infiltration rate of soil. Permeability/hydraulic conductivity calculations of soil are very important at time of constructing recharge system because permeability is property of soil to transmit water and air. Ministry of Environment, Forest & Climate change (MoEF) suggest permeability of different soil for artificial recharge system, where coarse sand permeability suggested 20-100 m/day **[19].** Table 2 described Ganga and Yamuna sand permeability and comparison with MOEF& CC suggested coarse sand.

Table 2:- Permeability of Coarse, Ganga &Yamuna sand

S.NO.	Coarse sand m/day (as per MoEF)	Ganga sand (m/day)	Yamuna sand (m/day)
1.	20-100	49.25	38.88

The results shows that the permeability rate of Ganga and Yamuna sand falls in the range prescribed by MoEF for coarse sand to be used in the harvesting pit. It is also noted that the permeability of both the sand is an appreciable value and hence will help in proper discharge rate also.

4.3. Infiltration rate: - Infiltration rate depends on the different soil texture and shows movement of water in soil. Water movement contains in soil due to gravitational force and capillary attraction, first water wets the soil particle than extra water move towards ground from surface due to gravitational force. The rate at which water absorbed in soil particles in known time is called infiltration rate and depend on the texture , hydraulic conductivity, vegetation and structure of soil **[20].** Infiltration rate plays very important role at time of designing capacity of rain water harvesting pit and the proposed numbers. Table 3 shows that the Ganga and Yamuna sand is having infiltration rate within the range as suggested by MoEF. Figure 1 is shows the comparison of infiltration rate of Ganga and Yamuna sand with the coarse sand for the pit as per MoEF.

Table 3:- Infiltration rate of Ganga, Yamuna & coarse sand

S NO.	Coarse sand cm/hour	Ganga sand cm/hour	Yamuna sand cm/hour
1.	2.00-2.50	2.35	2.47

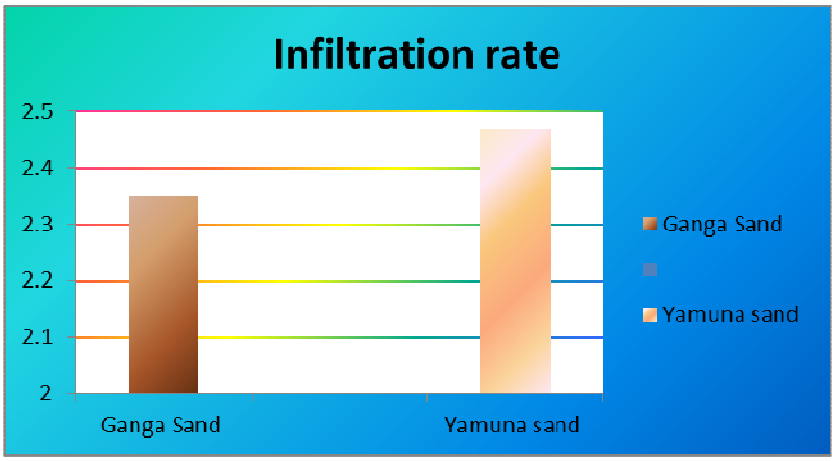

Figure 1: Infiltration rate of Ganga and Yamuna sand

4.4. Saturation point: Saturation point for any soil can be defined as the point where any soil or sand loss the characteristics and no chemical reactions occurs.

4.4.1 Ganga sand Saturation point: -The known volume of acidic water was passed through the known quantity of sand and the pH variation in outlet water was checked. The process was continued up to the point when the pH of the inlet and outlet water was same. Table 4 shows the pH variation with volume of acidic water. Figure 2 shows the saturation point for Ganga sand.

Table 4:- Saturation readings for Ganga sand

Weight of ganga sand - 25 gm		
Volume of acidic Water (ml)	**pH of Inlet water**	**pH of outlet water**
25	5.41	7.60
50	5.41	7.23
75	5.41	6.91
100	5.41	6.78
125	5.41	6.61
150	5.41	6.48
175	5.41	6.15
200	5.41	5.81
225	5.41	5.72
250	5.41	5.65
275	5.41	5.54
300	5.41	5.48
325	5.41	5.41
350	5.41	5.41

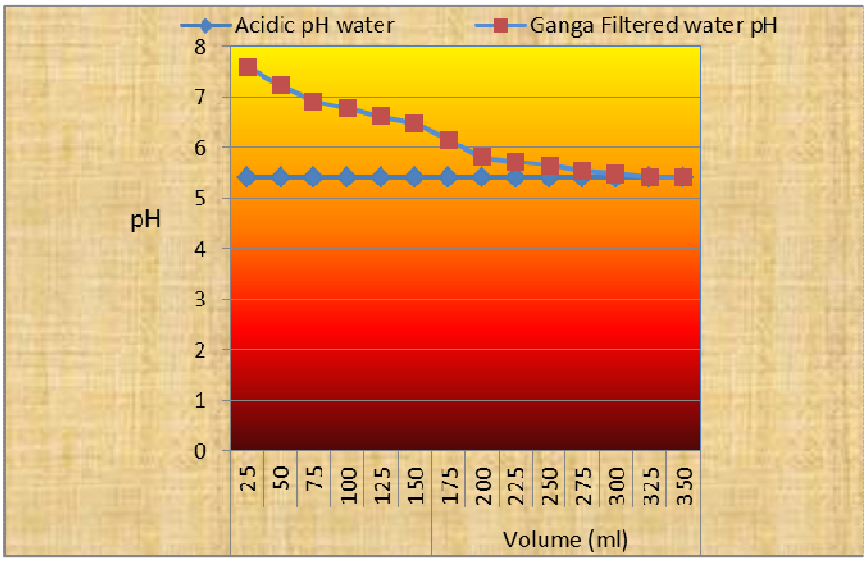

Figure 2: Saturation point of Ganga sand

4.4.2 Yamuna Sand Saturation point:- Same process was continued to find the saturation point for Yamuna sand. Table 5 shows the pH variation with volume of acidic water. Figure 3 shows the saturation point for Yamuna sand.

Table 5:- Saturation readings for Yamuna sand

Weight of Yamuna sand - 25 gm		
Volume of acidic Water (ml)	**pH of Inlet water**	**pH of outlet water**
25	5.41	7.35
50	5.41	7.21
75	5.41	6.93
100	5.41	6.70
125	5.41	6.63
150	5.41	6.50
175	5.41	6.12
200	5.41	5.85
225	5.41	5.53
250	5.41	5.50
275	5.41	5.42
300	5.41	5.41
325	5.41	5.41

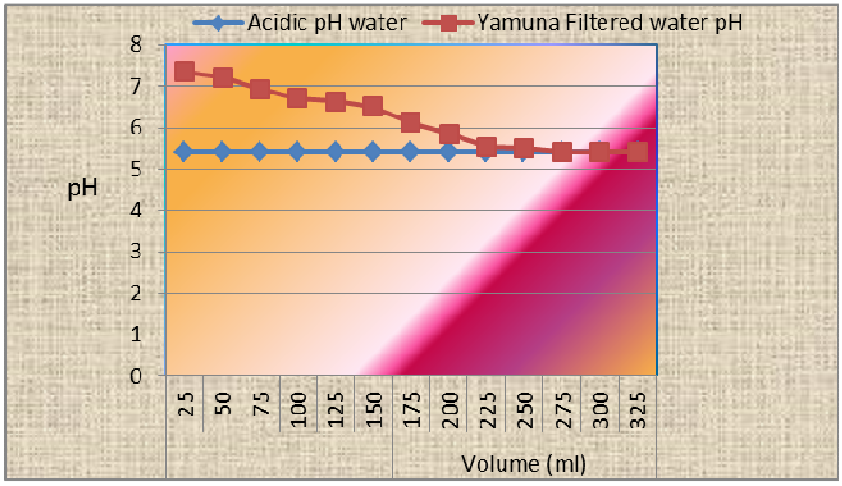

Figure 3: Saturation point of Yamua sand

CONCLUSIONS

After complete study on Yamuna and Ganga River sands we can predict that both sands are adequate to neutralize acidic water from rain water without effecting natural characteristic of rain water. We can conserve lots of water in large construction project roof top rain water harvesting because of sometime diversion factor from roof top rain water calls a lots of water wastage. Basis of laboratory test on controlled quantity of Ganaga and Yamuna sand, assumed quantity of sand matter for saturation point of sand characteristic's and directly impact on neutralizing capacity of sands. Government/proponent should take initiative for conserving of rain water through modification of rain water harvesting pits because of rain water consideration is like a Distilled water but due to atmospheric/ground pollutant its carrying lots of unwanted pollutants.

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AUTHORS

Mr. Upendra Verma is a certified professional having 6 Years of combined experience of construction industry and industrial research organizations. Presently working as a Sr. Environmental Engineer in Unitech Ltd. He is pursuing M.Tech in Energy and Environmental Management from IT University Gurgaon.

Ms. Vaishali Sahu has done her M.Tech from IIT Roorkee in 2005 and is pursuing Ph.D. She has 8 years of teaching experience and is an Assistant Professor in the Department of Civil & Environmental Engineering, ITM University, Gurgaon, India. Her research areas are Water, Waste Water Management, and Environmental Pollution & Waste Management. She has published 24 papers in the journal and conferences of national and international repute. She has guided two students from Kassel University Germany for the summer project and also guided three M.Tech students.