

Design of Harvestine Filter Unit

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Abstract: The rapid growth of population which also lead to access use of water and also wastage of water. In this research we are designing Filter Unit for Reusing The Rain Water for our Daily using purposes. As we all Know the percentage of water day by day decreasing so this point is to keep in mind so this is our research for making such Filter Unit which helps to increase the ground water percolations also. As the Cost for Rain Water Harvesting Process is also more costly but, in our Research, we are trying to minimise the total cost by implementing filter unit on Roof Surface so that we can reduce the cost of Rain Water Harvesting Process. Our main moto is to make Model Cheap, Model should be easily Installed, it should Sustain of Type of Discharge, it should produce less amount of waste, system should give a good quality of water from the outlet. We are going to install our model in nearby region and make a survey on it how our model can be utilizing. Water supplies can become polluted either through industrial or human wastes or by intrusion of minerals such as arsenic, salt (coastal area) Rainwater is ultimate fresh water. Rainwater is generally of good quality.

KEYWORDS: Filter Unit, Rain Water Harvesting, Model, Ground Water, planning.

I. INTRODUCTION

“JAL HI JEEVAN HAI” we all have heard this phrase but very few have understood and implemented it. The result of its ignorance is now evident. Today we are facing acute shortage of fresh water even for drinking in most parts of the country. The main reasons are, high rate of population growth, modern life style and urbanisation with excessive extraction of ground water etc.

HARVESTINE: Word Harvestine has been derived from the word harvest which means to collect. With a vision and mission to save water Harvestine filters used for rainwater harvesting. Harvestine filter named over the name of the filter is the signature product of the company. With most water filtering capacity, lightweight nature, ease of use and cost effectiveness makes it our signature product. High quality material is used to achieve durability and resistance against damage. Cleaning of the filter is hassle free because of the cleaning vent placed down the earth. All these traits make it our most popular and preferable product.

Rainfall occurring on the continental regions (23% of total global rainfall), partially get stored in the surface water bodies, and as ground water through natural percolation, remaining over flows through the continental regions in the form of streams/rivers before merging in oceans i.e. saline water.

This supply of fresh water is available during a limited monsoon period during the year, that too non-uniform in spatial distribution and magnitude. Though the fresh supply is available for a limited period but the water is required for the survival of living beings throughout the year. This imbalance of availability and requirement is met by extracting the water stored in the surface bodies i.e. ponds, lakes etc. or from ground water storage.

Rain water harvesting is the accumulation/ deposition of rainwater for reuse before it reaches the aquifer. Around third century BC, the farming communities in Baluchistan and Kutch used rainwater harvesting for irrigation. In Tamilnadu, rainwater harvesting was made compulsory. Rain water harvesting means collecting rain water from the top of roof or building, open spaces surrounding the buildings, farm-areas, etc. And then storing it for a later use or diverting it to an existing well for recharging. Generally, two type of water tanks are utilized- underground water tank and above ground water tank. Individual rainwater harvesting systems are one of the many tools to meeting the growing water demand. Rainwater harvesting is an environmentally sound solution to address issues brought forth by large projects utilizing centralized water management approaches. Population growth all over the world is causing similar problems and concerns of how to supply quality water to all.

II. LITERATURE SURVEY

Boers, Th.M. and Ben-Asher, J., 1982. A review of rainwater harvesting. Agric. Water Manage. This article reviews recent literature on rainwater harvesting and its potential application for crop production. Some 170 articles published between 1970 and 1980 were found, all of them revealing an awareness of the increasing need for rainwater harvesting and a recognition of its potential. A definition of rainwater harvesting is presented on the basis of three characteristics common to it: arid to semi-arid climate, local water, and small-scale operation.

Anant D. Patel, Asst. Prof. Pratima K. Shah, Rainwater harvesting is an old practice that is being adopted by many nations as a viable decentralized water source. North Gujarat is water scarce region. The rainfall is irregular in nature. Ground water is major source of water and that's why ground water is declining day by day. It has resulted in the alarming depletion of water level & drastic deterioration in ground water quality. In Gandhinagar average rainfall is below normal rainfall. This research paper describes a collaborative & development of affordable technologies for capturing & retaining runoff including that from roof tops and roads using this as a valuable source of water and artificially recharge the percolation well and ultimately increase the ground water level. This can be helpful as a valuable water source in future.

International Water Management Institute Anand Program Office, Elecon Campus, Anand Sojitra Road, VVNagar Anand, Gujrat India This paper identifies six critical issues in rain water harvesting efforts in water scarce region of India. First there is no emphasis on potential local supplies and the demand they have to cater for local supply potential is low in most water scarce regions, a fact compounded by poor reliability, and demand far exceeds the supply potential. Second there are complexities in the economic evolution of RWH, Due to lack of scientific data on inflows, runoff collection and storage efficiency, beneficiaries, value of the incremental benefits generated and scale consideration.

J.R. Julius¹, et.al., Rainwater harvesting is an old practice that is being adopted by many nations as a viable decentralized water source. This paper reviews the methods, design of rainwater harvesting systems, and its impacts adopted in all parts of the world.

Liaw, et.al., Thirdly, the collected rainwater around the House can be used for many different purposes. These include the washing clothes, dishes and much more. This would prevent groundwater depletion and groundwater table supplement.

Fourth harvest rainwater systems are inexpensive, offer high-quality water, reduce the dependence on fountain. The excess rain water can be used also to recharge groundwater aquifer through artificial recharge technique.

III. METHODOLOGY

We are using a unique way of roof top rain water harvesting. We are using our designed setup as a rain water filter. It is easy to collect rain water from the building, roofs and numerous other sources.

As long as you are ready and you have everything with a few different items, what it needs, harvest rain water and enjoy naturally delicious, clean and useful water start? Method is as follow:

3.1 DATA SURVEY

The Chandrapur Municipal Corporation (CMC) and Chandrapur Super Thermal Power Station (CSTPS) are headed for a face-off as a water crisis looms at Irai dam. If the current rain shortfall continues, and there is no rise in water level in Irai dam, then the biggest power plant in the state might have to shut down at least some generation units in the coming months. The lack of water could force the administration to reserve remaining water for drinking purposes only.

3.2 SELECTION OF METHOD OF HARVESTING

As the Chandrapur rainfall was not suitable for storing it and further direct using it. So, we decided to work on the method of increasing ground water table. Due to urbanization there was very less space for water digging pit or for making a large filter unit. As standard filter was too costly to construct and they all were having their various disadvantages so we decided to design a new filter unit.

3.3 DESIGN OF FILTER UNIT

While designing the system, we are mostly focused on the following points

- System should be cheap
- System should be easy to install
- System should be sustaining of type of discharge
- System should produce less waste

- System should be easy to clean and install
- The most important i.e system should give a good quality of water from the outlet.

The design is done on considering the urban area with less space.

3.4 TESTING OF FILTER UNIT

Testing of the water collected from the outlet of the filter is to be done to define the quality of water after passing through the filter unit. The testing which we are going to be perform are PH value test & total dissolved solid test.

3.5 LAYOUT PLAN FOR S.S.C.E.T

We are going to make a well define layout plan of rainwater harvesting for Shri Sai College of Engineering & Technology

The software that we are going to use is AUTOCAD.

3.6 INSTALLATION OF FILTER UNIT

After designing the filter unit, is to be installed at S.S.C.E.T and various building at Chandrapur. The building should be located at three different coordinates of Chandrapur i.e.Pathanpura, Bangali Camp, Wadgao.

IV. FILTERS

Filters are used in rainwater harvesting system when the water is stored in tanks for direct consumption, to remove suspended pollutants from collected rainwater. Filtration and disinfection of water are necessary before human consumption.

A filter unit is a chamber filled with filtering media such as fibre, coarse sand, gravel layers. Charcoal can be added for additional filtration. It consists of three parts:

- Container: Made of concrete, brick masonry, PVC, galvanised iron sheet or ferro-cement etc.
- Perforated plate: Made from a non-corroding material i.e. steel, PVC etc., with 1 cm diameter holes.
- Filter Media: It normally comprises of following layers:

Layer 1: Layer of sand-fine to medium

Layer 2: Layer of gravel (4 to 16 mm)

Layer 3: Layer of gravel/pebbles bed (16 to 50 mm)

4.1 Type of filters

Depending upon the filter media used and its arrangements, filters commonly used in rain water harvesting system are as under:

(i) Charcoal water filter

A simple charcoal filter can be made in a drum or an earthen pot. The filter media comprises of gravel, sand and charcoal.

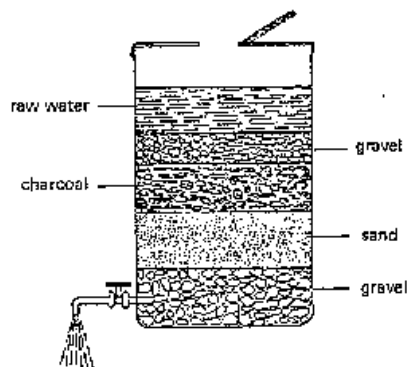


Fig no 1: Composition of a charcoal filter

(ii) Sand filters

In these filters commonly available sand is used as filter media. Sand filters are easy and less expensive to construct. These filters are quite effective for removal of micro-organisms and turbidity (suspended particles like silt and clay)

In these filters, filter media are placed as shown in figure below:

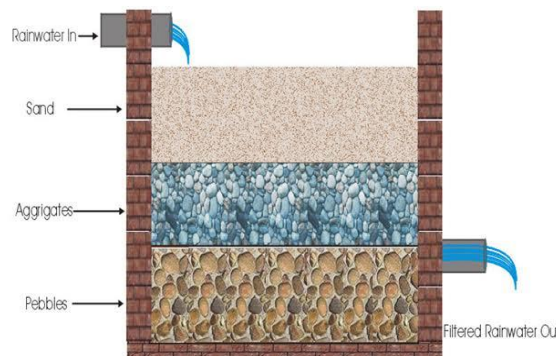


Fig no 2: Sand filter

The container of sand filters can be either PVC, concrete, ferro-cement tanks or it can be provided underground in a pit lined with masonry. The design of filter bed and the specification of gravel and sand has been explained in para 4.2. □ These filters are commonly used for recharging ground water. Sand filters are also used for removing silt from the harvested water for recharging functional tube well/hand pump/ dug well.

(iii) Dewas filters

These are the filters design and widely used for filtering roof top rain water in the Dewas area of Madhya Pradesh for recharging service wells.

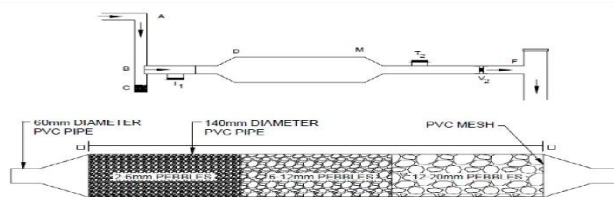


Fig no 3: Dewas filter

The filter consists of a PVC pipe 140 mm dia and 1.2 m long. There are three chambers, the 1st purification chamber has pebbles varying between 2 to 6 mm, the second chamber has slightly larger pebbles between 6 to 12 mm, and the third chamber has the largest 12 to 20 mm pebbles. There is a mesh at the out-flow site through which clean water flows out after passing through the three chambers.

(iv) Filter for large rooftops

When the rainwater is harvested from a large rooftop area for direct storage, filtering unit with high filtration rate is required particularly for high intensity rainfall. A system is designed with three concentric circular chambers in which the outer chamber is filled with sand, the middle one with coarse aggregate the inner-most layer with pebbles. This way the area of filtration is increased for sand, in relation to coarse aggregate and pebbles to achieve overall higher rate of filtration. Rainwater reaches the centre core and is collected in the storage tank/sump.

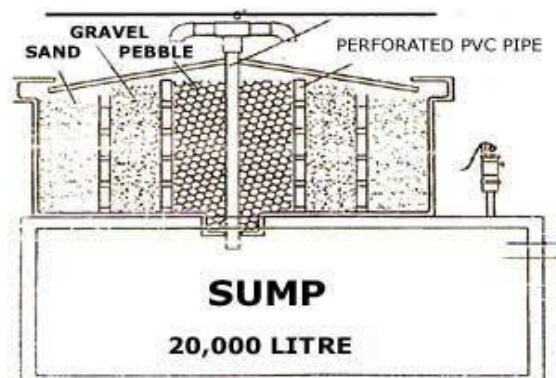


Fig no 4: Details of filter for large rooftops



4.2 Filter media specification for sand filters

The filter media of inverted sand filter basically consists of a gravel bed overlain by a sand layer. The specifications for gravel bed and the sand layer are as under:

(i) Gravel bed

Table no 1: Showing size and thickness

Layer number from top	Size of gravel (mm)	Thickness of layer (cms)
1	2-5	7.5-10.0
2	5-12	7.5-10.0
3	15-20	10.0
4	20-38	10.0
5	38-65	10.0

- Characteristics of gravel:
 - Gravel shall be non-flaky free from clay, organic impurities, shells etc.
 - Naturally available rounded gravels are more preferred.
 - Specific gravity shall be more than 2.5.

(ii) Sand layer

Over a gravel bed a coarse sand layer of 50 to 75 cms thick is provided.

- Characteristics of sand:
 - Sand should be hard free from clay, dust, roots, organic materials etc.
 - Effective size = 0.45 to 0.70 mm
 - Silica content > 90%
 - Lime content < 2%
 - Specific gravity – 2.55 to 2.65

4.3 Design of sand filter

(i) Filter bed area

Area of sand filter bed is designed to cater the critical runoff flow rate. Normally the rate of filtration of filter bed is considered 4 to 5 m³/m²/hour. The typical design of filter is enumerated as under

Suppose filter is to be designed for a catchment area of 200 sq.m. Peak rainfall intensity of area is 80 mm/hour. Runoff coefficient of the catchment is 1.0.

First calculate the peak runoff rate from the catchment

Peak runoff rate = peak intensity of rainfall x catchment area x runoff coefficient Therefore, Peak runoff rate = 200 x 0.08 x 1.0 = 16 m³/hour

Assuming, Rate of filtration = 5 m³/hour

Area of filter bed required = Peak runoff / Rate of filtration = 16 / 5 = 3.2 m²

Provide filter bed of 2 m x 1.6 m size

Normally, ratio of length to width of filter bed is kept as 1.25.

(ii) Height/Depth of filter unit

The depth of the container is normally kept at least one foot above the top of the filter media to provide the required hydro-static head for filtration.

4.4 FILTER MEDIA

4.4.1 SILICA SAND

Silica sand has long been used to clean and purify water. The earliest recorded use of a sand filter dates back to 1804 when John Gibb designed and installed an experimental filter. This method of filtration was refined during the following two decades, culminating with the installation of the world’s first treated public water supply by James Simpson for the Chelsea Waterworks Company in 1829. The practice of water treatment became mainstream after the physician, John Snow, made a connection between the quality of water and incidences of Cholera in 1845/55. The Metropolis Water Act was introduced and for the first time there were minimum standards for water quality, requiring

that water be 'effectually filtered' from 31st December 1855. Today, the provision of good quality potable water is taken for granted in much of the developed world.



Fig no 5: silica sand

➤ **HOW IT WORK?**

The natural silica filtration grade sands have a sub-angular to rounded shape, making them an ideal filtration media to capture suspended solids in water. Due to the high silica content, the sand is extremely durable and hard-wearing, allowing it to be precisely graded to facilitate efficient filtering. Four grades of silica sand are used for water filtration in the UK today, these are 6/14, 8/16, 14/25 and 16/30. The silica sand is usually laid on top of a supporting layer of gravel within the filter vessel.

4.4.2 ACTIVATED CARBON

Activated carbon filters are generally employed in the process of removing organic compounds and/or extracting free chlorine from water, thereby making the water suitable for discharge or use in manufacturing processes. Eliminating organics in potable water, such as humic and fulvic acid, prevents chlorine in the water from chemically reacting with the acids and forming trihalomethanes, a class of known carcinogens.

Activated Carbon (AC) filtration, as with any water treatment method, is not capable of removing every possible type of contaminant. For example, sodium, microbes, fluoride, and nitrates cannot be removed with AC filtration. Water softening also cannot be achieved with AC filters. In addition, heavy metals, such as lead, can only be removed with a very specific kind of activated carbon water treatment, which is typically used only in residential point-of-use filters.



Fig no 6: Activated carbon

➤ **HOW IT WORK?**

Activated carbon water treatment is basically used for two water treatment purposes and each work in totally different ways.

1. Chlorine Removal: Activated carbon may be used to remove chlorine with little degradation or damage to the carbon. De-chlorination occurs rapidly and flow rates are typically high. However, this process requires an extensive amount of surface area, and organics in the water will eventually fill up and block the pores of the carbon. Ultimately, the activated carbon filter will need to be replaced as its ability to dechlorinate the water will slowly decline. Spent carbon can be re-activated; however, re-activated filters should only be used in waste-water treatment applications. One advantage to using AC is its low operating cost and virtual "fail safe" operation once installed. One disadvantage is that as the chlorine is removed from the topmost layer of the media, the AC provides a damp environment ideal for the growth and proliferation of bacteria. Bacteria can cause problems in medical applications, or when using carbon as a pre-treatment to reverse osmosis.

2. Removal of Organic Matter: As water passes through an activated carbon filter, organic particles and chemicals are trapped inside through a process known "adsorption". The adsorption process depends upon 5 key factors: 1) physical properties of the activated carbon (surface area and pore size distribution); 2) the chemical makeup of the carbon source (amount of hydrogen and oxygen); 3) the chemical makeup and concentration of the contaminant; 4)

water pH and temperature; and 5) the length of time the water is exposed to the activated carbon filter (called empty bed contact time or EBCT).

4.4.3 CALCITE

The Calcite pH Neutralizer is a crushed and screened white marble media which can inexpensively be used to neutralize acidic or low pH waters to a neutral, less corrosive effluent. Calcite is a naturally occurring calcium carbonate media. One of the advantages of Calcite is its self-limiting property.



Fig no 7: Calcite

Table No 2: Tools & Equipment’s used

Tools	No of requirement
PVC Tee	3
PVC End Cap	1
Reducer	2
valve	2
screen	3
Nylon bags	3

Table No 3: Filter media in gms

Filter media	Weight in grams
Silica sand	1700
Activated carbon	900
calcite	1100

V. HARVESTINE FILTER UNIT

After designing the various numbers of design, we had finally designed a filter unit which was standing at the peak of all the required conditions. And we had named it as HARVESTINE FILTER UNIT

5.1 Installation of harvestine filter unit

Harvest lane filter unit is easy to install procedure as follows: -

- Connect all the outlet of terrace at one point using PVC pipe.
- Cover the terrace outlet using screen.
- Connect that point to harvestine filter unit inlet.
- Fit the harvestine filter unit using clam, etc.
- Then connect the outlet of Harvestine filter unit to bore well, tube well, well, etc.

5.2 Working of Harvestine filter unit

- Condition 1: Considering the first rainfall of the rainy season.

Let the flush valve to be open so that terrace area gets clean automatically.

The rain will bring all the impurities with it and will get out through flush valve and pipe from flush valve can be directly connected to drain system. And as we know the first rain contain dissolve gases in it and make it acidic know as acidic rain which is harmful. Acidic of water will change depending upon the region. Hence the opening of flush valve loads to 0% of change that the rain water will enter in to filter media. And gives a direct way to remove terrace waste and the acidic rain. After one or two heavy rainfall the flush valve can be closed.

Closing of flush valve leads to processing of filter unit.

- Condition 2: Now considering that the two heavy rainfall are over and the flush valve is closed.

Due to two heavy rainfall the terrace had already got clean up. Now the rain water flow through PVC pipe and get enter into harvestine filter unit. The rain water flow through pipe due to gravity and strike the closed valve as the valve is closed the rain water get trapped there. Now the water level rises to the tee section and water start entering in the second portion of filter. Due to the 5-micron screen fitted in tee section which avoid the micro impurities to enter in the second portion of filter unit. Now again in the second portion the clear water hit the second valve and some of the get trapped over there. Again the rain water goes against the gravity and lead to the settlement of heavier particles due to gravity. The water level raises and pass through the filter media section.

The filter media consist of four part.

1. Screen
2. Silica sand
3. Activated carbon
4. Calcite (calcium carbonate).

The screen consists of foam or 5-micron mesh which leads to 0% of suspended impurities to enter in other filters media. After passing from screen the rain water passes through the silica sand bed which also helps to trap the suspended impurities.

Now after passing from silica sand the rain water passes through the activated carbon bed which help in removal of organic matter. After passing through the activated carbon bed the now the rain water passes through the calcite bed. Which reduces the acidic of water and neutralize it. This bed is used only where there is high percentage of acidic rain. The region with neutral rain does not required this bed. After passing through calcite bed the water flow through the screen towards the outlet of the filter. At this point the filtration process of water completed. At the outlet of filter unit, the PVC door elbow is given to check the quality of water. Then the filter water is directly flow towards bore well, tube well, or well etc. Through PVC pipe setup. As the percolation speed of soil is high at greater depth leads to the increase in ground water table.

This how the overall unit is going to work. And the unit is versatile unit. ie the volume and the size of unit can be design according to rainfall discharge.

5.3 Back Flush of Harvestine Filter Unit

As the water flow against the gravity through filter unit resulting of this there is certain level of water remain in filter unit. After rainfall is over when the both value of filter is open. The water with high velocity gets out from the filter unit. Which forced the trapped impurities to get out of the filter unit. The process of trapped impurities form filter screen, bed etc. by opening flush value is called back flush of Harvestine filter unit. This gives the filter ability to get automatically clean.

5.4 Cleaning of Harvestine Filter Unit

Cleaning of Harvestine filter unit consist of sample 5 steps.

- 1) Opening of cap: End cap of filter can be easily open from the top of second portion of filter.
- 2) Remaining of filter lead: After opening of end cap the filter beds are packed in nylon bag which can be easily removed by putting hand into filter body from end cap.
- 3) Washing of filter bed: After taking out beds from filter to be wash with force which removes the impurities from the beds.
- 4) Setting back filter beds: after washing filter beds the washed filter beds to put back to filter body as it was earlier.
- 5) Closing of end cap: lost and the final step to close the filter body with end cap.

In this way the cleaning of filter is done.

Cleaning of filter should be done once in a week. And beds should be changed after every two year.

5.5 Precaution to Be Taken While Using the Harvestine Filter Unit

- Terrace area should be kept clean.
- Avoid keeping material which can get rust on terrace.
- Avoid keeping pets on terrace.
- Do back flush of filter after every rain fall.
- Clean the filter once in the week for better performance.

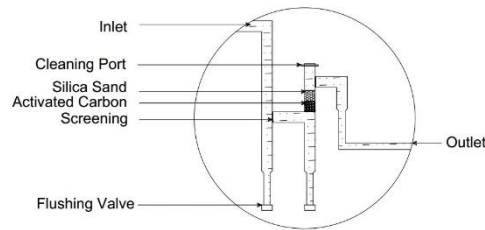


Fig no 8: Harvestine Filter Unit

VI. RESULTS AND CONCLUSION

1. Rain water harvesting is one of the best ways to solve the world burning facing issue: water scarcity
 2. Most useful for large scale application saving of energy per lifting of well and saving of water bills
 3. Harvested water can be used for daily household needs the more the business and industries involved leads to greater environmental and economic benefits.
 4. Rainwater harvesting saves water, money and the environment.
 5. Rain water harvesting helps to increase the ground water table.
- Harvestine filter unit can be the best way of a portable harvesting filter with excellent quality of water and at an economical rate.

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