

**DESIGN OF RAINWATER HARVESTING AND FILTRATION SYSTEM FOR
DOMESTIC USE**

MUHAMMAD FAISAL BIN M.M.AKRAM

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DECLARATION.

I declare that this report entitled “Design of Rainwater Harvesting and Filtration System for Domestic Use” is the result of my own work except for quotes as cited in the references.

Signature :

Author :

Date :

APPROVAL.

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Mechanical Engineering with Honors.

Signature :

Supervisor Name : PROF. MADYA Ir. Dr. Ts. ABDUL TALIB BIN DIN.

Date :

DEDICATION.

I dedicate this thesis to my supervisor, Prof. Madya Ir. Dr. Ts. Abdul Talib bin Din who have guided me throughout this project. This thesis is also dedicated to my parents who have been a great source of support mentally and physically.

ABSTRACT.

This project offers a method of harvesting and filtering rainwater for domestic use. The project purpose is to help meet the increasing demands of water due to the increase of human populations. This can also help household areas or farms that experience high level of rainwater to reduce the run-off that chokes the drain as well as reduce soil erosion. The project also helps reduce the billed water usage for daily use such as by using rainwater to water the plants and to feed the livestock at the farm for farmers. By doing so, the water collected can supplement the domestic water needs and alternatively reduce the water usage. The design is made using CAD software (Fusion 360), and the design is refined based on the previous researchers compiled from the internet and also from the survey handed out to determine the needs of the consumers. The water is collected from the roof, filtered using a specific filtration system and then stored in a tank for later use. The process takes place during raining time and easy to be used or installed.

ABSTRAK.

Projek ini menawarkan kaedah penuaian dan penapisan air hujan untuk kegunaan domestik. Tujuan projek ini adalah untuk membantu memenuhi permintaan air yang semakin meningkat diikuti dengan peningkatan populasi manusia. Ini dapat membantu kawasan ladang atau isi rumah yang mengalami taburan air hujan yang tinggi untuk mengurangkan air hujan berlebihan yang boleh menyebabkan longkang tersumbat dan juga dapat mengurangkan hakisan tanah. Projek itu juga membantu mengurangkan penggunaan air untuk kegunaan harian seperti menggunakan air hujan untuk menyiram tumbuhan dan memberi makan ternakan di ladang untuk penternak haiwan atau petani. Dengan berbuat demikian, air yang dikumpul dapat menambah keperluan air domestik dan secara alternatif mengurangkan penggunaan air. Reka bentuk dibuat menggunakan perisian CAD (Fusion 360), dan reka bentuk dibuat berdasarkan penyelidikan terdahulu yang dikumpulkan dari internet dan juga dari tinjauan yang disampaikan untuk menentukan keperluan pengguna. Air dikumpulkan dari bumbung, ditapis menggunakan sistem reka bentuk penapisan tertentu dan kemudian disimpan dalam tangki untuk digunakan kemudian. Proses ini berlaku semasa masa hujan dan mudah digunakan serta dipasang.

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List of symbols and abbreviations.

DN- Diameter Nominal

PVC- Polyvinyl chloride

HOQ- House of Quality

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Chapter 1

INTRODUCTION.

This chapter is about the introduction of this thesis project which includes the project overview, problem statement, objectives and scope of work.

1.1 Project Background.

Water is known as one of the most important elements in our daily life. It dominates the surface of Earth and is vital to life on our planet. We all know that as the populations of humans on Earth increases, so does the demands of clean drinkable and useable water.

Studies shown that rainwater can be used as a substitute to be used in helping out on our daily use. Rainwater can be used to help us accomplish various daily task such as washing, cleaning, watering the plants, feeding it to the livestock and many more. Rainwater is said to be useful but not recommended to be drank as drinking water unless it has gone through filtration and treatment process that eliminates the foreign substance or bacteria. By filtering and treating the rainwater, it will be a clean and drinkable water.

Most people are still not convinced that treated rainwater can be used in our daily life. Most people still stick to the water supply that is supplied by the water supply company. By collecting rainwater, it can help reducing the billed water usage in a household, helps from wasting drinkable water to be used on daily things such as washing, cleaning and many more. This can also help reducing the water bills at home and ensure that our homes always have water to spare even when our normal household water supply is having problem.

1.2 Problem Statement.

Water demands rises each day as the populations on Earth increases. The useable and drinkable water availability is going to be a major health issue around the globe, as the world population increases. The need for safe clean water is likely to double in the next decade, where the world population is expected to exceed nine billion. The water supply that is currently in use to supply the Earth's population is decreasing each day. The need of finding a new alternative are researched every day to help fight this current issue. Rainwater is said to be an excellent substitute to replace normal treated water to be used for washing, cleaning, watering the plants, feeding it to the livestock and many other use besides drinking as rainwater are not meant to be drank unless they are filtered and treated properly.

1.3 Objectives.

The objectives of the project are as follows:

- i. To design and fabricate a rainwater harvesting and filtration system for domestic use.
- ii. To meet the increasing demand of water following the increase of human population on Earth.
- iii. To gather the unused water streaming to reduce soil erosion and reduce the run-off which chokes the drains.
- iv. Supplement domestic water needs.

1.4 Scope of Project.

The scopes of this project are:

- 1) Farmers or any other agricultural business owner.
- 2) Household areas that frequently experience water shortage.
- 3) Areas that experience a high level of rainfall distribution.

1.5 General Methodology.

The actions that need to be carried out to achieve the objectives in this project are listed below:

- 1) Literature Review.

Journals, articles, or any materials regarding the project will be reviewed.

- 2) Research on Weather Forecast.

Research on the weather forecast is done by using the data from the internet to identify the type of rain and the total rainfall for each year to determine the total water that can be collected.

- 3) Report Writing.

A report on this study will be written at the end of this project.

Chapter 2

LITERATURE REVIEW.

This chapter contains the literature review that based on the objectives and scope of the project. This chapter is conducted in order to complete this research done by reading some journals that have a connection to the project title of “Design of Rainwater Harvesting for Domestic Use”. This chapter contains rainwater harvesting collection process, filtration process, water management process, gutter and water catchment design, piping system and design optimization.

2.1 Rainwater Harvesting Process.

Water is an essential element that we used in our daily life. It is one of the most important needs to human being. Rainwater harvesting process is a water collection process mainly used to harvest rainwater by collecting rain water from the roofs or other high surfaces to be stored for later use. It is mainly used to meet the increasing demand of water. The process of rainwater harvesting requires a large area to collect a large amount of rainwater to be filtered and stored for future use especially during rainy seasons to help recover during drought or water shortage [1].

As the population increases, the world will be facing the scarcity of water and will be trying to find other alternatives to help them in recovering for the shortage of water. Factors that contribute to the water scarcity problem are the high population growth, the huge influxes of refugees from neighboring countries, and the impacts of climate change [2].

In conclusion, based from the journal reviewed for the rainwater harvesting process, the main factor that affects the water shortage is the because of the rapid population growth. The matter is currently one of the main factors that contributes to the scarcity of water.

2.2 Filtration Process.

The water filtration process is the single most important aspects in the system. Filtration is important because it holds the key to ensuring the water harvested is safe or unsafe to be used. Filtration are used to remove impurities by lowering contamination level of water. The filtration process for rainwater harvesting system is simple yet important because the water collected needs to go through filtration process before it can be used as water for livestock, plants, cleaning, washing and many more. The most important aspect that needs extra attention to is the filter type [3].

2.2.1 Filter Type.

There are many types of filter that can be used to filter the rainwater collected. The type of filter determines the quality of water on the outcome. The finer the mesh size of the filter, the better the quality of the water will be. There are many types of filter that can be used for rain water harvesting but the most suitable one is the DN 100 filter which is suitable for inline compact filtration system and it is used for a $150m^2$ size roof water collection which is the roof size of a normal-sized house [4].

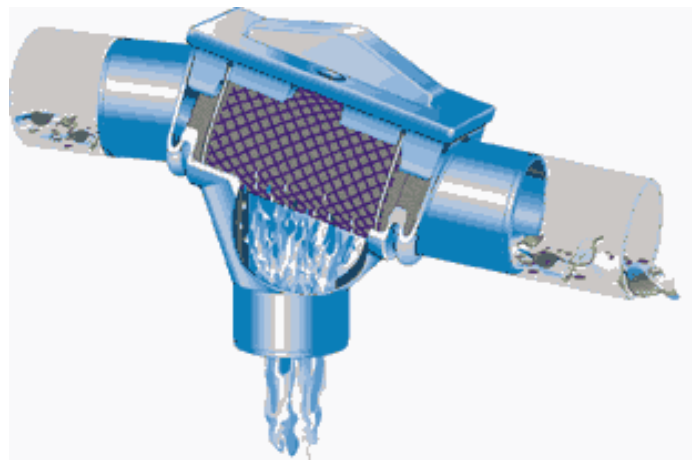


Figure 2.1: Illustration of DN 100 function.

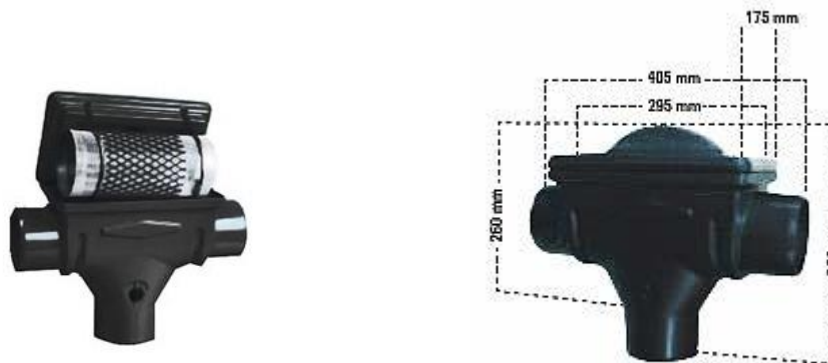


Figure 2.2: DN 100 filter.

Figure 2.3: DN 100 filter measurements.

The example of the filter is as shown in the figure above. The mesh size of the filter cartridge is $0.7mm \times 1.7mm$ which is suitable for filtering rainwater. The

placement of the filter will make it easy for the water to be filtered and to push the excess dirt or unwanted material out of the pipe as shown in Figure 1 above of the illustration on the placement and functions of the filter [5].

In conclusion, on the journal reviewed, it can be confirmed that the use of the DN 100 filter is the most suitable filter that can be used for this system.

2.3 Water Management Process.

Water management process is important in managing the water harvested. The main parameters need to be taken seriously are the water tank and the excess water.

2.3.1 Water Tank.

A water tank is a well-built container with many shapes and sizes for storing water. Water tanks are made to provide storage space for water to be used in many applications such as, drinking, irrigation agriculture, suppressing fire, agricultural farming, for both plants and livestock, chemical manufacturing, preparing foods as well as many other uses. The water tank needed for this rainwater harvesting process is a medium-sized water tank enough to hold a minimum of 200 liter of water that can be used for agriculture, livestock and many other purposes. The most suitable water tank is an opaque tank that blocks sun light from passing through it to prevent algae growth [6].

2.3.2 Excess Water.

Excess water is one of the things that needs extra attention to when harvesting rainwater. The excess water that is collected needs to be disposed of properly to prevent the tank from cracking or damaged by taking in excess water weight. The excess water needs to be measured to be within an optimum level with the capacity of the tank and needs to have an overflow valve that will allow excess water to flow and exit the tank. The excess water flowing out needs to be disposed of into the ground instead of on the ground to prevent stagnant that attract mosquitoes and soil corrosion in the ground near the water tank [7].

2.4 Gutter and Water Catchment Design.

For over two millennia, it was proven that humans have attempted to collect rainwater for domestic and agricultural use with many ways that they can think of. The gutter is one of the devices used to catch and flow the collected rainwater that falls on the roof into a pipe and goes straight to the tank to be stored. The gutter and water catchment is the main body that assists the water collection that is used in the project. The normal domestic roof-based rainwater harvesting systems consists of 4 main components that needs to be considered [8].

Four Main Components.

- A catchment surface (roof)
- A mean of intercepting runoff from the catchment surface (gutters)
- A means to transport water to the reservoir (downspout)
- A reservoir to collect the water

The main components used are to ensure that the water collected from the roof is safely and efficiently gathered. There are many types of gutters used for the process of collecting rainwater, the types vary with shapes and sizes. The gutter efficiency and productivity rely on its ability to capture and transfer runoff from a roof into a storage tank. The most important parameter that needs to be considered when choosing a gutter design is to find the one with the right and suitable cross-section. The focus is the gutter cross-section as the cross section plays the biggest role when catching rainwater because it can help by intercepting the runoff flowing from the roof [9].

There are many different shapes and cross-section of gutter used for buildings and houses these days, the common ones used these days are the V-shaped gutter, Square gutter, Trapezoidal gutter and a Wrap gutter design as shown in Figure 4 below.



Figure 2.4: Cross-section of gutter (from left to right), V-shaped gutter, Square gutter, Trapezoidal gutter and a Wrap gutter design.

The gutter design is unique and have their own benefits and constraints. But the most suitable gutter that were chosen for this project are the Trapezoidal gutter design because it can hold the greatest amount of water flowing due to its big upper cross-section that helps and allows for catchment of both roof runoff and direct rainfall [10].

In conclusion, the gutter and water catchment design need to be chosen properly as it determines the efficiency of the watch that will be collected during rain time.