



DESIGN OF HOUSEHOLD FAUCET CONNECTION WITH WATER SAVING NOZZLE AND FILTER

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Abstract: Water is the basic need for all living beings. Sufficient, clean and safe water is needed by everyone. Due to the rapid urbanization and industrialization water conservation is becoming a necessity. India is a tropical country where rainfall is irregular which makes water management crucial. The problem isn't because of less supply it is out of careless manner of using water. Water scarcity has been progressively increased over the period of time due to increase in population density in both rural and urban areas. Water when used in a unplanned manner may lead to scarcity in future and severe droughts. some of the areas in our country has already faced this problem as we know. Identification of the losses and reducing them with the help of various methods available around is a better way for a safe future. We all are concerned about future so why not start working for it. The project is regarding how we can take a step towards managing this natural resource for our better future and method available for everyone at best. One of the way is with the use of nozzle. There are several studies done on water conservation and saving but all come with its respective cons. Here on this project we are trying to overcome the cons. So it could be efficient, accessible and enduring.

Keywords – Faucet Connection, Water Saving Nozzle, Filter

1. INTRODUCTION

1.1 Information about Project

Water is the natural source which we get from nature. It's the most basic need of human being. Though water is non-renewable source but life to mankind, plants, animals and all living creature. Since its non-renewable source it's our responsibility to makes the management and storage of water in an appropriate manner.

Water and energy conservation are so intimately intertwined that they are practically synonymous. Any reduction in the usage of water will automatically result in a reduction of the use of energy. The urban water users have been reported in per capita growth in water consumption of urban resident which leads substantial increase in water demand.

According to last 10 years survey it was estimated that around 40% of the world population suffered water shortage problem. Most of the cities around the world were seeking a more efficient management of water resources. Fortunately, it has been proved that we can conserve water dramatically and, in a manner, which will not seriously affect the lifestyle we are used too. As water being the one of the basic need it becomes our responsibility to conserve the sources by means of less consumption rather optimum consumption.

One of the efficient ways to save water from waste is using nozzles. Water saving nozzles have become a vast market in today's society. Water if used in an unplanned manner may lead to scarcity in future and severe drought. So, the water saving nozzles play an important role by preventing the wastage of household water. Identifying losses and minimizing them as well as cutting down the water consumption may serve us from the catastrophe to come. While there are many development taking places and some are availed in the market. Though the question still arises about its durability and efficiency. Many designs are available in market but many of them still lacks the accessibility for common people.

Our project is on providing a effective design for effective household nozzle connection. The study recommends that low-income households use water saving and filtering device which will gradually increase the less use of water for house hold purpose and universal to all types of faucet and taps. Its accessibility being inbuilt with universal connector makes it more convenient and reliable for common people. It requires less than 1/3 of income for common people to install the water saving nozzles. Our research and study focus on ideal nozzle on the same budget as of others that are available in market. Nozzle which saves 70-80% of water and prevent water wastage.

1.1.1 Aims of Study

The aim of this project is to develop a design on water saving and filtering nozzle for ruler areas.

The objective of this project is as follows:

- To provide filter water.
- To provide nozzle connection in reasonable cost.
- To reduce the use of water to the optimum level.

1.2 Statement of Problem

India is a tropical country where rainfall is irregular. Rapid urbanization, industrialization is taking place which puts load in requirement of water. We all are facing the problem of water crises. But crisis is not about having scarcity water to satisfy needs. It is a crisis of managing water so badly, that billions of people suffer every day. The supply of water and energy is one of our most critical national problems. If we cannot increase our supply, then it is imperative to reduce our consumption. Available water for ruler areas contains sediments which can lead them to diseases. Improper system and lack of economic access leads to health issues.

1.3 Motivation of Study

For billions of people worldwide, the poor availability of drinking water restricts consumption patterns and affects quality of life. At present, globally, at least one billion people experience an interruption to their supply throughout a 24 h period and around 3.1 billion individuals depend on unreliable, non-piped water supplies that are located off-premises. Currently there is insufficient data in India to estimate the population using a water source that is "available when needed", suggesting a need for evidence to fill this gap. The World Health Organization (WHO) outline a global drinking water availability benchmark which recommends that between 50 and 100 L/capita/day (LPCD) is required to meet domestic needs, including washing, personal hygiene and cleaning.

Therefore, we intend to design and implement Water saving and filtering nozzle for common people. Drinkable water which is used optimistically is our motive.

1.4 Significance of Study

From extensive research we have carried out way to save water using nozzle. This study tells about conservation methods as ways of optimizing access to clean water. A review of comprehensive literature was carried out to draw a variety of important conclusions as well as field studies, focusing on the middle-income households living in ruler area within the study area. The principal water conservation factors focused on the use of water efficient technologies (nozzle).

2. Problem Analysis and objective

2.1 Problem Analysis

- Water wastage

In many parts of not only our country but of the world, there is a tremendous need of water which is usable mainly drinkable. The problem is caused due to enormous use of water in the areas where its available easily. People tend to use it as much as its available which generates the shortage for serving it to the areas with shortage. This needs to reduce.

- Quality of water

Low quality are often as big problem as the lack of available water because people often get seriously sick from drinking contaminated or unclean water. This is a major problem in rural areas where water availability is also a serious question. People who live there have no choice but to drink however and whichever water they get.

- Cost of proper nozzle

Now a days price for getting a good quality of water is very high. It comes with a whole setup of filters which sometimes can't be afforded as well as not needed in some areas. Specifically speaking about the rural areas where there is no place for setting the filter setup.

2.2 Objectives

- To reduce water wastage.

Water is an very important factor which is why it is indeed to be used consciously, water waste is to be reduced.

- To get filtered water

There are various nozzles available in the market but few of them work efficiently. Our objective is to get Sufficient water saving and filtering nozzle that serves the purpose.

- To get a cost-effective nozzle

Our main objective is to provide everyone with a low-cost nozzle that serves every objective given properly. A water saving aerator and also a filtered water provider connection.

3. METHDOLOGY

3.1 Working principle

The method is for discharging two different ways. A nozzle with aerator is attached to a faucet on left side to give out tap water with a reduced flow and on the other hand we have a filter setup before nozzle attachment which is for getting filtered water. Therefore, it is a faucet connection is switchable between for a regular tap water and filtered tap water.

In our project here, we're proposing a design for a nozzle and filter arrangement which helps in giving out two types of water as per usage as. First, regular tap water but with reduced flow for household works and secondly, filtered water for drinking through the same tap connection. The nozzle connection that we are proposing has a aerator nozzle installed on both sides and has a filter installed (on the right) before the nozzle for drinking water.

3.2 Processes

1. Regular tap water
2. Filtered tap water

1. Regular tap water

The flow chart above gives a idea about the process that will happen through water pipe and nozzle and its output. The water will come through the tap connection that is been already fixed in houses for faucet connections. Then the water will go inside the tap connections which is designed with a diversion from inside.

A diversion is provided in design after faucet connection for regular tap water on the left side and filtered water to the right side. For this specific process the valve given on right side will remain closed and only the valve on left side will be opened for tap water to pass through and flow through the aerated nozzle that is attached.

The nozzle that is attached here has a aerator inside with two mesh filters for removing impurities and a plastic connector. The plastic connector is given for keeping the mesh filters aligned. The water flows through this nozzle and then comes out through nozzle with a reduced flowrate.

2. Filtered tap water

The flow chart above gives a idea about the process that will happen through water pipe and nozzle and its output. The water will come through the tap connection that is been already fixed in houses for faucet connections. Then the water will go inside the tap connections which is designed with a diversion from inside.

For this specific process after the diversion the valve of left side will remain closed and only right side valve shall be opened.

The water will flow through the filter provided which here is polypropylene (PP) filter which will clean the water containments which will make the water drinkable.

After the filter the water will pass through the nozzle containing mesh filters for more filtration and at end drinkable water will be out.

- Flowrate:

This is the volume of water that flows through a nozzle in a given time at a given pressure. This is commonly measured in gallons per minute. If the nozzle is greater than 10% of its rated flow it is considered worn and should be replaced. There are several ways to perform this test. If more than 10% of the nozzles tested show wear of 10% or more the entire set should be changed.

Almost all nozzles are ISO color coded and named for what their flow rate is in gpm at 40psi. A red nozzle or a 04 will flow 0.4 gallons in one minute at 40psi. This applies across most major brands and different types of nozzles. Most manufacturers work this into their part numbers FC-GA110-04

Most nozzles manufacture have a tolerance of +or- 3% on the output of a new nozzle.

- Pattern Distribution

It is also important to check nozzle pattern distribution. This can be done with a visible inspection. Sometimes it is easier to spot irregular patterns in low light or dark conditions when using a nozzle lights or a bright light source on the pattern. During the day parking the sprayer so that the sun shines through the pattern will assist in highlighting any pattern irregularities.

Hand held alternators are also available for checking nozzle distribution on a per nozzle basis or for testing entire booms. Using the economical hand-held model is simple with the most difficult part being lining up the center of the device to the center of the pattern. After collection from the spray pattern at a recommended height a good nozzle should show symmetrical distribution without being overly heavy in the center.

- Filtration

Low quality of water is very important problem with the lack of availability of water because of which people at times get seriously sick by drinking contaminated or unclean water. The filtration is a important process that should be provided with every nozzle as well as water connection system. We here are proposing a nozzle connection which also has a filter attached for the filtration process within. The filter that we are using in our design is polypropylene filter also called as PP filter. These are made in various sizes; the typical honeycomb structure of the filter body gives it a considerable capacity for accumulating impurities present in the fluid being filtered. These filters can be produced in different yarns, according to the application they are designed for polypropylene, rayon, cotton, nylon, and glass fiber.

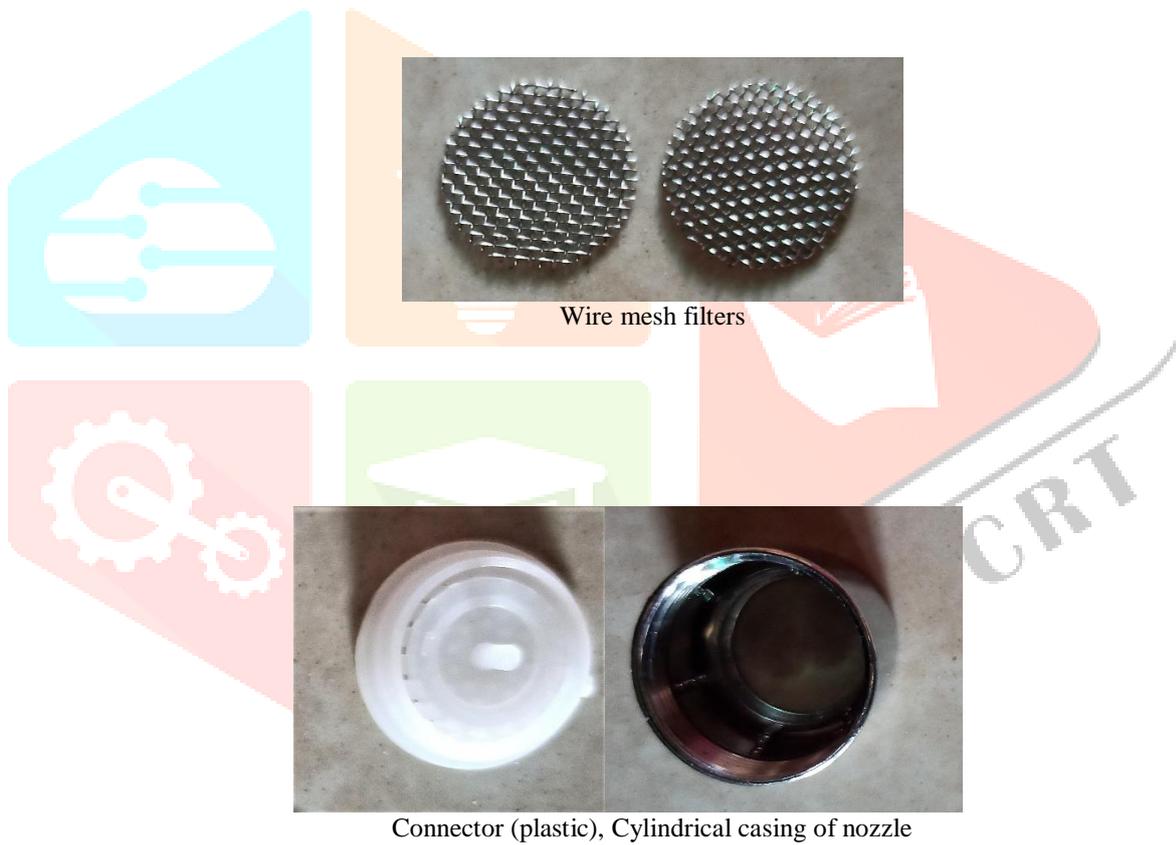
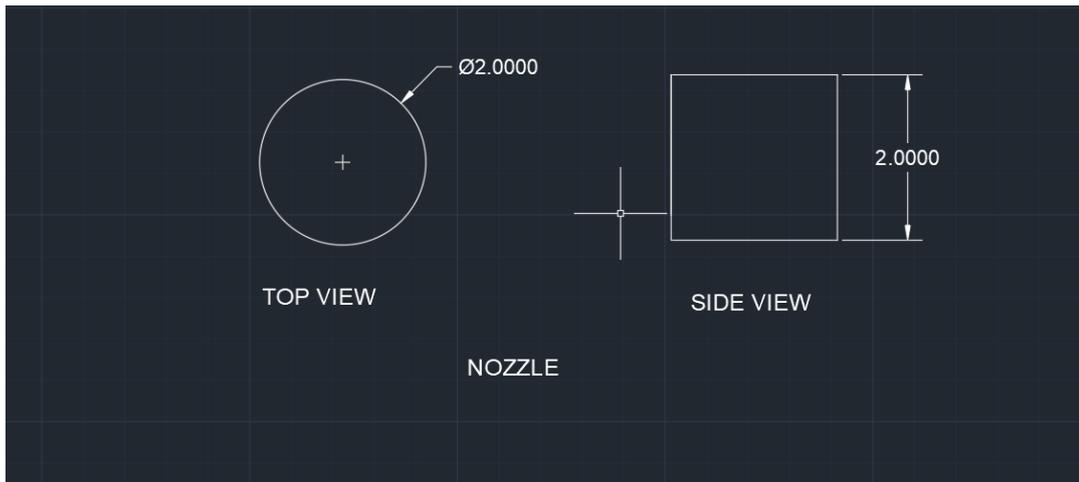
- Ball Valves

Quarter-turn 2-way ball valves are by far the most common type of process control valve. They are 2-way (inlet and outlet), 2-position (open and closed) valves that are used for shut-off or isolation of a system, or a loop or component within a system. The basic construction of a ball valve includes a ball as the obstructer which is sandwiched between two cup shaped seals referred to as "seats". Typically, the ball has a bore straight through it. Media flows through this bore when the valve is open. When the ball is rotated 90°, the flow of media is stopped by the sides of the ball which now completely fill the opening in the seats.

The ball valve is an inexpensive alternative to other valves. Ball valves use a metal ball with a hole bored through the center, sandwiched between two seats to control flow. Used in many hydrocarbon process applications, ball valves are capable of throttling gases and vapors and are especially useful for low-flow situations. These valves are quick opening and provide a very tight closure on hard-to-hold fluids

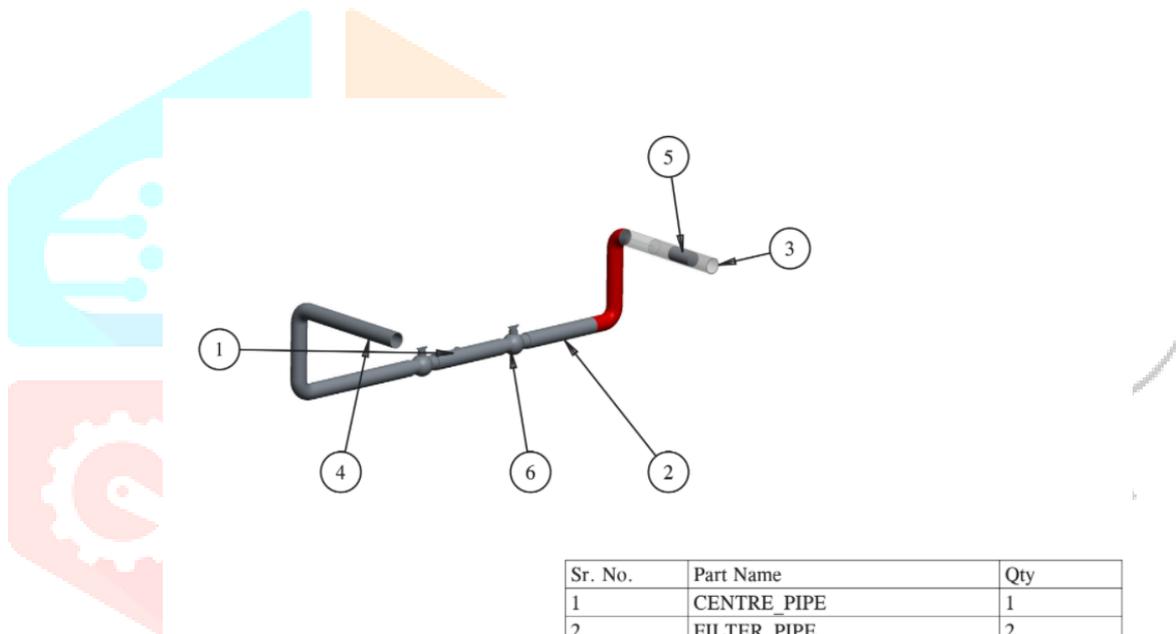
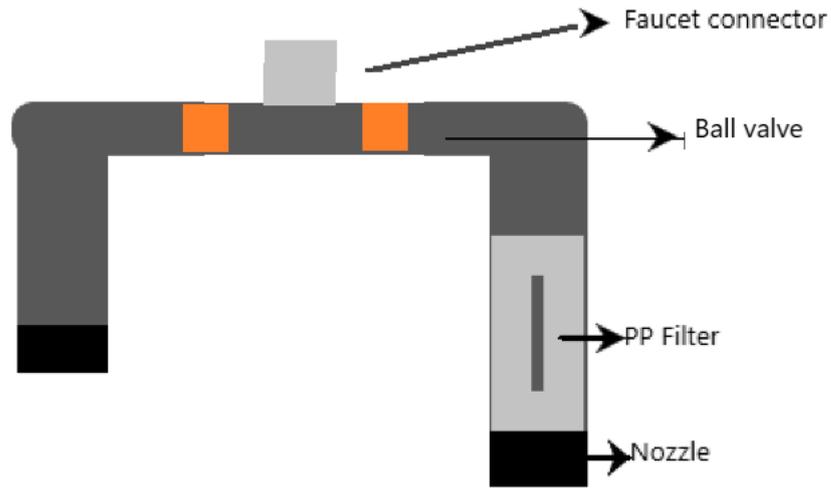
Ball valves do not use a handwheel but instead use a wrench to control the flow. A 90° turn of the wrench opens or closes the valve. This simple design yields a non-sticking operation that produces minimal pressure drop when the valve is in its full-open position.

3.3 Components and constructional details



4. DESIGN

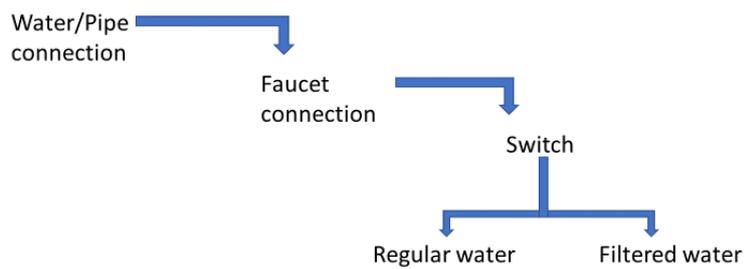
4.1 PROPOSED DESIGN



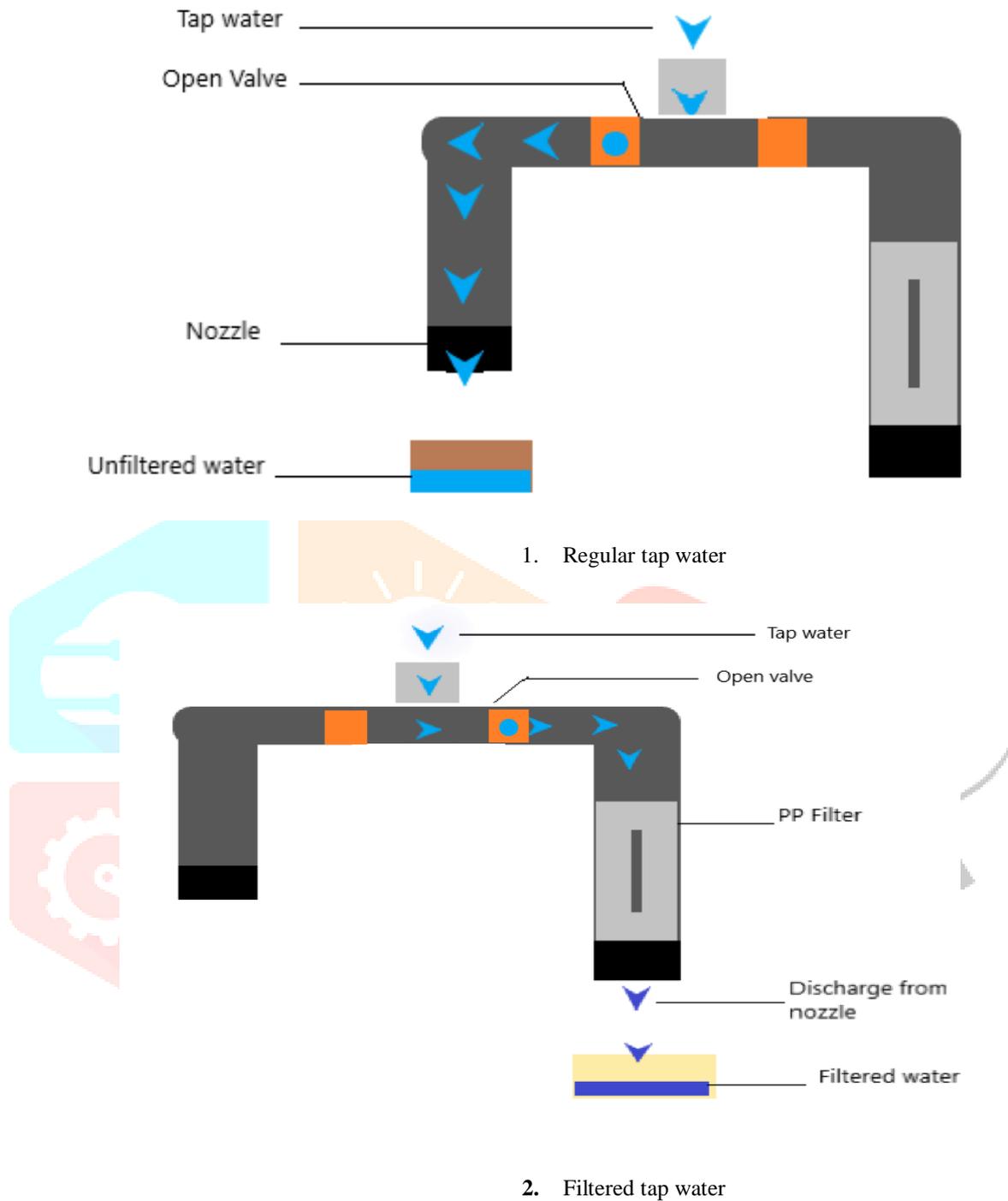
Sr. No.	Part Name	Qty
1	CENTRE_PIPE	1
2	FILTER_PIPE	2
3	NOZZEL_CONNECTION	1
4	NOZZEL_CONNECTION_PIPE_2	1
5	PP_FILTER	1
6	VALVE	2

CAD Model

FLOW CHART (WORKING)



WORKING



5. CALCULATIONS

- Flow rate

It is the amount of liquid sprayed from a orifice of a nozzle per hour. The flowrate depends on the application or the purpose of which liquid is to be sprayed. Flow rate is actually calculated from the orifice diameter (cross section area) and pressure. So, a bigger orifice and lower pressure (theoretically) produces the same flow rate as a smaller orifice and higher pressure.

Flow rate formula:

$$Q = CA\sqrt{2gh}$$

- Q = flow rate, m³ /s
- C = flow rate coefficient,
- A = orifice cross sectional area, m²
- g = gravity acceleration, 9.8 m/s
- h = potential head, m

According to the above formula the flow rate of the spray nozzle is proportional to the square root of pressure.

$$Q1:Q2 = \sqrt{P1}: \sqrt{P2}$$

P = Pressure

- Pressure

In various manufacturing companies the word pressure represents fluid pressure. The pressure calculations are done with help of pressure gauges connected to the flow points. The numbers can be obtained from the catalogues that different companies provide for the selection of the required type of nozzle. The pressure is measured in MPa or PSL bar.

- CAPACITY – fluid capacity varies with spraying pressure

The relationship of pressure and flow with a given orifice is:

$$Q_1 / Q_2 \sim (P_1)^n / (P_2)^n$$

Q = Flow Rate (in gpm or lpm)

P = Liquid pressure (in psi or bar)

n = Flow exponent

To approximate any unknown flow or pressure, use this formula when the other variables are known. The "n" exponent is used to approximate the ratio of pressure to flow based on the type of spray pattern.

- IMPACT

Impact, is the measure of force imparted on a surface by a spray pattern at a given distance. It can be expressed in several ways. All definitions are derived from the most basic equation of total impact force. This is the force that any flow, at any pressure, is capable of making on a surface. This does not account for orifice shape, nozzle type, fluid properties and other factors.

$$I = K \times Q \times \sqrt{P}$$

Total theoretical impact = constant (based on units) x flow (at pressure P) x square root of pressure (P)

I = total theoretical spray impact

K = constant

Q = flow rate

P = liquid pressure

- Nozzle wear

Nozzle wear is typically characterized by an increase in nozzle capacity, followed by a general deterioration of the spray pattern. Flat fan spray nozzles with elliptical orifices experience a narrowing of the spray pattern. In other spray pattern types, the distribution within the spray pattern deteriorates without substantially changing the coverage area. Materials having harder surfaces generally provide longer wear life. Materials that offer better corrosion resistance are also available. However, the rate of chemical corrosion on specific nozzle materials is dependent on the solution being sprayed. The corrosive properties of the liquid being sprayed, its percent concentration and temperature, as well as the corrosion resistance of the nozzle material to the chemical must all be considered.

- Ball Valve

Ball valves consist of a spherical obturator with a cylindrical hole, usually of the same diameter as the pipe, although it can be smaller. Operation is by rotation (1/4 turn) of a shaft mounted, often horizontally, with its axis at right angles to the cylindrical hole. Seals are usually resilient and can provide drop tight shut off. Ball valves are commonly used in small diameters (up to DN 300) although at least one manufacturer can make ball valves up to DN 1200. Ball valves are manufactured in one-piece, top entry, two-piece and three-piece bodies. A top entry body allows access to the ball and seats for maintenance without the need to remove the valve and is preferred for larger sizes.

- REGULAR TAP (without nozzle)

Ideal pressure for regular tap is 50PSI which is equal to 3.44bar.

Now, by using Bernoulli's equation

$$P = \frac{1}{2} \rho V^2$$

$$V = \sqrt{2 / \rho P}$$

$$V = \sqrt{2 / 997} * 3.44$$

$$V = 0.083 \text{m/s} \quad (\text{by taking values from design data book})$$

Now, Flowrate of regular nozzle

$$Q = AV$$

$$A = \pi d^2 / 4 = 0.00025 \text{m}^2 \quad (d = 1.8 \text{ cm})$$

$$Q = 0.0083 * 0.00025$$

$$Q = 0.020 \text{ m}^3/\text{s}$$

$$Q = 317.006 \text{ gpm}$$

- FAUCET CONNECTION (with nozzle)

As the household water connection remains the same the values of P, ρ and V will remain same.

$$A = \pi d^2 / 4 = 0.0022 \text{m}^2 \quad (d = 5.1 \text{ cm})$$

$$\rho / \rho g + V^2 / 2g + h = C (\text{constant})$$

$$0.0045 + h = 1$$

$$h = 0.995\text{m}$$

Therefore,

$$Q = A \sqrt{2gh}$$

$$Q = 0.0022\sqrt{2*9.81*0.995}$$

$$Q = 9.7 \text{ m}^3/\text{min}$$

$$Q = 6.81 \text{ gpm}$$

PROPOSED FILTER

Polypropylene (PP) Filter

Material of filter element components:

Filter material : Asymmetric gradual aperture polypropylene (PP) plated filter

Supports/Diversion : PP

Core/Cover/End cover/End caps : PP

Sealed leads/Fins : PP, Built in stainless steel

O-Ring : 222,226 silicon rubber etc.

Sealing technology : Hot melt without adhesives

Characteristics and features

- All polypropylene structural materials, professional hot-melt sealing technology, no adhesive, no secondary pollution
- Excellent high-term resistance and extensive chemical compatibility
- All the compositions reach up to the requirement of the biological testing characteristics of USP Class 6 plastic products at 121°C and the food contact materials listed in the relevant regulations of Chapter 21 of the Federal Regulations of the United States (CFR). They also conform to the requirements of China's "Standard for Hygienic Safety Evaluation of Equipment and Protective Materials in Drinking Water" (2001) for drinking water transport and distribution equipment.
- It is manufactured under ISO 9001 and ISO 14001 systems and Class 100 environment.
- The filter membrane has a gradient aperture structure for pre-filtration with large flow rate ,low pressure difference and long service life .



Fig-String wound polypropylene filter cartridge

6.RESULT

NOZZLE RESULTS

About 9-27 gallons of water is used for household purpose.

Discharge by regular tap without nozzle , Q1 = 315.006 gpm

Discharge by nozzle tap , Q2 = 6.81 gpm

Therefore,

$$\text{water saved} = Q1 - Q2$$

$$\begin{aligned} &= 315.006 - 6.81 \\ \text{water saved} &= 308.166 \text{ gpm} \end{aligned}$$

ACKNOWLEDGEMENT

It gives us immense pleasure to express our gratitude to **Mr. S.M. Kavishwar**, who provided us constructive criticism and a positive feedback during this project work.

We are indebted to **Dr. N. K. Mandavgade**, Head, Department of **Mechanical Engineering** who were always there whenever we needed any help. Without him and his co-operation, completion of this project work would have been inevitable and his presence behind us is totally indispensable.

We also express our sincere gratitude to our respected Principal, **Dr. Amol Deshmukh** for providing us necessary facilities.

Our sincere thanks to the teaching and supporting staff of "**Mechanical Engineering**", without their help, we could not have even conceived the accomplishment of this report. This work is virtually the result of their inspiration and guidance.

We would also like to thank the entire Library Staff and all those who directly or indirectly were the part of this work. We are also thankful to our parents whose best wishes are always with us.

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