DEVELOPMENT AND EVALUATION OF AN ALTERNATE MEDIA FILTER FOR DRIP IRRIGATION SYSTEM

By

ANUSREE C K (2018-02-009)

RESHMA JACOB (2018-02-032)

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ARCHANA DAS N (2018-02-048)

PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

AGRICULTURAL ENGINEERING

Faculty of Agricultural Engineering and Technology

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

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DECLARATION

We hereby declare that this project entitled "**DEVELOPMENT AND EVALUATION OF AN ALTERNATE MEDIA FILTER FOR DRIP IRRIGATION SYSTEM"** is a bonafide record of project work done by us during the course of study and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of another university or society.

Place: Tavanur

Date : 10-06-2022

ANUSREE C K (2018-02-009)

RESHMA JACOB (2018-02-032)

SHANA SHERIN V (2018-02-037)

ARCHANA DAS N (2018-02-048)

CERTIFICATE

Certified that the project entitled **"DEVELOPMENT AND EVALUATION OF AN ALTERNATE MEDIA FILTER FOR DRIP IRRIGATION SYSTEM"** is a record of project work done jointly by **Ms. Anusree C K (2018-02-009) Ms. Reshma Jacob (2018-02-032) Ms. Shana Sherin V (2018-02-037) and Ms.Archana Das N (2018-02-048)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to them.1

Place: Tavanur

Date: 10-06-2022

Guide : **Dr. Asha Joseph**

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

SYMBOLS AND ABBREVATIONS

Mm	Millimetre
Cm	Centimetre
M	Metre
L	Litre
mL	Millilitre
G	Gram
g/l	Gram per litre
ºC	Degree Celsius
Lph	Litre per Hour
Hr	Hour
S	Second
Min	Minute
dS/m	Deci Siemens per metre
µS/cm	Micro Siemens per centimetre
pH	Potential of Hydrogen
EC	Electrical Conductivity
Vs	Versus
Fig	Figure
l/hr	Litre per hour
m^3/hr	Metre cube per hour
Kg/cm^2	Kilogram per centimetre square
Kg/m^2	Kilogram per metre square
Kg/m^3	Kilogram per metre cube
m^3/min/m^2	Metre cube per minute per metre square
m^3/m^2/hr	Metre cube per metre square per hour
t/ha	Tonnes per Hectare
kPa	Kilopascal
et al	And Others
PVC	Poly Vinyl Chloride
LDPE	Low Density Poly Ethylene

Ca	Calcium
Mg	Magnesium
Fe	Iron
Mn	Manganese
TSS	Total Suspended Solids
JTU	Jackson Turbidity Unit
Ppm	parts per million
RRWH	Rooftop Rain Water Harvesting
KCAET	Kelappaji College of Agricultural Engineering and Technology
MIS	Micro Irrigation System
RCC	Reinforced Cement Concrete
M Tech	Master of Technology
&	And
%	Percentage
2^{nd}	Second
1^{st}	First
i.e.	That is
/	Per
etc.	Et cetera
viz,	Namely
No.	Number

CHAPTER I

INTRODUCTION

Drip irrigation is used worldwide to save water and energy in irrigated crops by applying water at a low rate over a long period of time at frequent intervals with low pressure delivery systems. Drip irrigation in the mid-1960 to mid-1970's was considered an emerging technology with its application limited only to high-priced, specialty crops. Today it is used for a wide variety of crops, even those crops that were initially considered unprofitable for management under drip irrigation. Through careful nurturing, drip irrigation has grown into a stable and economically significant part. The nutrient uptake efficiency is also high in case of drip irrigation system.

Despite its success, a frequent problem can be found in these systems related to drip clogging, caused either by poor water quality or wrong specification of filters. The clogging of drip emitters is the largest maintenance problem with drip systems (Keller and Bliesner, 1990). It is difficult to detect and expensive to clean, or replace, clogged emitters. Partial or complete clogging reduces emission uniformity and, as a consequence, decreases irrigation efficiency. Water supplied from different sources contain dissolved and suspended impurities which can lead to physical chemical biological restrictions in the emitter resulting in uneven application rate of water. The clogging problem, if not properly solved, it may results in complete rejection or severe restriction of a promising efficient, method of irrigation and water conservation. The phenomenon of emitters clogging is one of the biggest problems facing the use of drip irrigation system, because water is conveyed in small quantities and low pressure through the small orifices of the water dispensers and thus it is easy to get clogged with the mineral particles (sand, clay), organic matter (insects, animals, algae, etc.) or chemical deposits. To find out the reasons of clogging, should be open the end of one of the sub-irrigation pipe or open the emitters, and collect the samples of the sediments to determine the type of these materials (Feng *et al*., 2018).

To ensure good water use efficiency and to improve the life time of drip irrigation system, periodical maintenance of drip irrigation system is required. Periodic maintenance includes repairing and replacing drip system parts, washing of filters, cleaning of laterals to prevent salt accumulation and blockage of emitters (Lamm *et al*., 1995). The farming community also had great impact on the irrigation and associated industries. So, proper and adequate water filtration is an essential requirement to prevent clogging in drip irrigation system for consistent emitter operation, thereby aiding in less maintenance of the irrigation system.

The filters commonly used in drip irrigation system are gravel filter (media or sand), screen filters, hydro cyclone filter or centrifugal separator and disc filters (Kannan *et al*., 2020). Gravel filter provides deep three-dimensional filtering with back flush cleaning, as one of the most effective filtration methods for all water types. They are mainly used for primary filtration of water contaminated with organic impurities, waste like vegetative materials and algae. Media filters consist of layered beds of graded sand and gravel placed in one or more cylindrical tanks. Sand media filter is used widely in drip irrigation where water contains organic impurities such as algae and fungi or inorganic suspended impurities such as sand, silt or clay. When too much foreign materials have accumulated within the sand bed, it becomes difficult to force the water though the filter, and the head loss across the filter is increased.

Hence an appropriate filtration can help to extend the life and improve the maintenance of the irrigation system. Filtration is a basic need to avoid clogging of emitters in drip irrigation (Kannan *et al*., 2020). Currently there are different kinds of filters used in drip irrigation system such as Screen filters, Disc filters, Hydro cyclone filters, etc. Even though these factory made filters are readily available in market, farmers in rural areas can't afford their price. Also, market may be at a faraway place. Hence, the study focussed on development of low cost alternative media filter for drip system. In this study an alternative media filter with locally available natural materials like gravel, red clay roof tile, charcoal, metal chips, metal stone, fine sand and silex sand were used as filter media in a vertical flow column to treat the waste water for drip irrigation. Hence a study entitled "Design and Development of an alternate media filter for drip irrigation system" was undertaken with the following specific objectives.

i. Design and development of an alternate media filter for drip system
ii. Evaluation of the developed filter
iii. Comparison of filter units using different media
iv. Testing of filter for emitter flow variation

CHAPTER II

REVIEW OF LITERATURE

2.1 DRIP IRRIGATION AND ITS IMPORTANCE

Drip irrigation system is also called as trickle irrigation system where water is applied drop by drop directly to the root zone of the crop at very low rates 2-20 lph (litres per hour), through small diameter pipes called laterals fitted with outlets called drippers or emitters. In other irrigation systems, the whole soil profile is wetted, unlike in drip irrigation only root zone is wetted (Plusquellec, 2009). In common irrigation systems such as flooding, water is lost through evaporation but in case of drip irrigation system the water loss through irrigation is eliminated (Ahadi *et al*., 2013).

Gulomov and Sherov (2020) conducted a field experiment at the Tashkent Institute of Irrigation and Mechanization Engineers during 2015 to 2017 to analyse the current research on drip irrigation for the efficient use of water resources caused by increasing global warming. They examined various designs, advantages, disadvantages, and low-pressure drops. Irrigation method was applied to the apple orchard, in the sandy loam soil of Tashkent region according to the mechanical composition of that particular type of soil . With the use of local low pressure drip irrigation technology, they achieved the highest apple tree yield of 19.8 t/ha.

Deshmukh and Sen (2000) reported that adoption of drip system of irrigation proved quite beneficial for saving in irrigation water (50 per cent) which would help increase area of guava in semi-arid climate of Rajasthan with the available water resources in the state of Rajasthan.

Shareef and Zhongming (2019) conducted a study on essentials of drip Irrigation system for saving water and nutrients to plant roots as a guide for growers. Their study pointed out many factors that the farmers need to care about them when used drip irrigation system. On the other hand, emitter clogging is considered as a big problem with importance of cost consequences and production. Therefore, technical guidelines for system managements should be adopted and followed. Finally, water is very important and necessary and must be placed in the priorities of our economic plans. So by using drip irrigation because of its advantage, rationalization in the behaviour of water consumption and reducing the loss of water use, training and technical rehabilitation of farmers on the use of modern technologies in irrigation in terms of operation, maintenance and management were concluded.

Sathyapriya *et al*. (2019) conducted an empirical study on drip irrigation system. Drip irrigation system is regarded as solution for many of the problems in dry land agriculture and improving the efficiency in irrigated agriculture. Keeping all these in view, they studied the extent of benefits derived from drip irrigation in horticultural crops and identify the constraints encountered by farmers in adopting the drip irrigation for horticultural crops. The results revealed that majority of drip irrigation farmers had expressed the advantages like saving of water, saving in labour cost for irrigation, increased yield, water saving, labour saving, increased quality of produce, reduced weed growth, extended shelf-life of produce and uniform application of water.

2.2 WATER QUALITY AND DRIPPER CLOGGING

The main problem concerning the performance of drip-irrigation systems utilizing wastewater effluents is clogging of the drippers. Each emitter has a certain design flow rate ranging from 1-8 L/hr, which is affected by the operation pressure (between 100-200 k Pa), water temperature, and by clogging. Emitter flow paths usually have widths of only 0.5-1.0 mm and vulnerable to clogging (Gilbert *et al*., 1979)

Adin and Sacks (1991) conducted a study in the fields of Kibbutz Naan by a drip irrigation experimental setup. Their study defined the clogging factors and mechanisms of blockage within three types of drippers as a basis for developing technical measures to overcome the problem. The physical and chemical properties of the deposits in hundreds of emitters were examined, using both field and laboratory experiments. The sediment build-up begins with the deposition of amorphous slimes, to which other particles adhere. The clogging rate is more affected by particle size than by particle-number density. The chemical composition of the deposits in the dripper changes with the season. Filtration prevents immediate clogging of large particles. Clogging potential may be decreased by modifying the emitter structure and by chemical pre-treatment.

Based on the findings on emitter clogging and experience gained in controlling it, Nakayama and Bucks(1991) have derived a classification scheme that include the major factors involved in emitter clogging. Main approach to control clogging was proper water management. The type of treatment was based quality of irrigation water and they classified in terms of its physical, chemical and biological composition. Physical parameters involved in emitter clogging is inorganic materials (sand, silt, clay), organic materials, plastic cutting and lubricant residue. Chemical factors involved are heavy metal cations (Ca, Mg, Fe, Mn), anions (carbonate, hydroxide, silicate, sulphate), fertilizer sources etc. Biological factors involved are microbes, algae, bacteria etc. Based on these parameters they identified major clogging factors and control measures to prevent emitter clogging.

Capra and Scicolone (2004) conducted a study on emitter and filter tests for wastewater reuse by drip irrigation. The tests involved five trials conducted in Sicily (Italy) using five kinds of municipal wastewater and different kinds of emitters and filters. Their test confirms the great influence of the water quality on the performance of drip irrigation systems for the same kind of emitter and filter, when the total suspended solids and organic matter content increased, the percentage of totally clogged emitters also increased, whereas the mean emitted discharge, the emission uniformity coefficient, and the operating time of the filters between cleaning operations decreased.

Gilbert *et al.* (1981) conducted a study on emitter clogging and flow problems in drip irrigation. His experiments develop water treatment methods for preventing emitter clogging and maintaining long-term operation of the system under actual field conditions. Eight trickle emitter systems in combination with six water treatments were evaluated during a comprehensive 4-year study. Emitter clogging was related to emitter design and to degree of filtration treatments of Colorado River water. Emitters with flexible membranes failed after a few months of use with chemically conditioned water or showed serious deterioration and decomposition after 4 years. Five of the eight emitter systems required sand and screen (200 mesh) filtration plus chemically conditioned water to keep suspended materials from physically clogging the emitter. However, two emitter systems with the same design but different flow rates have continued to operate with only screen (50 mesh) filtration. For emitters unaffected by material deterioration, the water conditioned continuously with acid alone was just as effective as a combination of continuous or intermittent chlorine and acid treatments in reducing emitter clogging.

2.3 USE OF DIFFERENT TYPES OF MEDIA FILTERS FOR WATER PURIFICATION

2.3.1 Rain water filter

The filters are generally used to remove suspended pollutants from the water. Filter units consists of a chamber filled with filtering media such as fibre, coarse sand and gravel layers to remove debris and dirt from water (John, 2011**.** Filters are used for treatment of water to effectively remove turbidity, colour and microorganisms. After first flushing of rainfall, water should pass through filters. There are different types of filters in practice, but basic function is to purify water.

2.3.2 Charcoal water filter

Mohammed *et al.* (2020) evaluated the contaminant removal efficiency of an improvised charcoal filter in the study. Research showed that charcoal has the potential ability to remove dissolved iron, turbidity, and pathogenic organism from drinking water. They collected water sample from River Challawa and was poured through four layers of charcoal filter. The physicochemical and bacteriological characteristics of the water sample before and after filtration were determined and evaluated. Although testing for coliform bacteria in the samples before and after filtration read positive, the charcoal filter showed very high turbidity removal efficiency (i.e. up to 98%) after a seven-number of repeated filtration runs. It also showed high odour, hardness, and chloride removal efficiencies. Also, pH value of the sample before filtration was acidic (5.7) but increased to 7.7 after filtration which is suitable for drinking water. Hence, it was recommended that charcoal filters can be used to produce high-quality water.

2.3.3 Sand filter

Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and microorganisms. In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm effective size gravel layer followed by another layer of gravel and boulder (John, 2011).

2.4 MEDIA FILTERS BY DIFFERENT COMBINATIONS

Kannan *et al*. (2020) conducted a study on development and evaluation of low cost filters for micro irrigation system improving water productivity under Consortia Research Platform on Farm Mechanization and Precision Farming during 2018 to 2020. This study developed a low cost filter and tested the developed system in the field for efficiency in terms of pressure drop vs discharge and quality of output water. It was observed that the discharge from the filter increases as the time increases. Pressure drop and head loss in the filter system increases with flow rate. Efficiency of the filter increased from 25% to 64% when it acting as double chamber filter and 23% to 62% when it acting as single chamber filter with flow range of 5 m^3 /h to 30 m^3 /h. As flow rate increases, soil particles retained and efficiency of the filter increased with increase in head loss. Filter materials and screen filter removed the sand particles effectively. Uniformity coefficient of 0.95 was observed in single chamber filter which was found suitable for small farm applications.

Kiran *et al*. (2009) conducted a study on the feasibility of a low cost filter for roof rain water harvesting (RRWH) in KCAET Tavanur, Malappuram. The filter was able to remove about 87% of the impurities. The study concluded that the system can be strongly recommended for households facing problems of water scarcity and water quality.

Harishankar *et al*. (2010) developed an improved design of roof top rainwater harvesting (RRWH) filter at KCAET Tavanur, Malappuram, Kerala. An upward flow type filter, having alternate layers of coir fibre and activated charcoal filled in a PVC pipe to a density of 83.65 kg/m^3 was installed as the filter. The filtration rate and efficiency of the filter were found to be 3.83 $m^3/min/m^2$ and 90% respectively. The study concluded that the improved design was more efficient.

An iron hydroxide coated sand medium for removing bacteria and heavy metals from roof harvested rainwater was developed by Ahammed and Meera (2006) at Cochin, Kerala. The study showed the potential of iron hydroxide coated sand as a sorptive filter medium for use in simple home water purification devices for treatment of roof harvested rainwater.

Asha *et al*. (2016) mentioned theme rapid sand filter for water purification. According to them, rapid sand filters are very common in all conventional water treatment plants. Most of the rapid sand filter beds are suffering by problems like stratification, mud ball formation and unsatisfactory effluent and high backwash water requirement. Dual media and multimedia filters can overcome the limitations of rapid sand filters. Alternatively, higher filtration rates even can be achieved. An attempt was made to the study of dual media filter using anthracite coal as a filter media along with conventional sand media. Comparative study showed that higher rate of filtration is possible along with higher filter run and less backwash requirement.

A research work on water purification using magnetic assistance was reported by Ritu and Mika (2010). Magnetic separation is one purification technique that has been adopted from ore mining industries to anti-scale treatment of pipe lines to seeding magnetic flocculent. This research explained a series of information on this water purification technique and explains different aspects of magnetism and magnetic materials for water purification.

Setyowati *et al*. (2021) conducted a study on optimization of local materials in the water purification system as an effort to reduce iron content in water sources "Sumber Lestari" in the Manduro Village, Jombang District . Their study developed a cheap and easy technology to reduce the presence of excess iron in groundwater. The iron removal system was developed by slow sand filter and selecting coconut husk fibre as the substrate material of filter media. The filter media was made from coconut husk fibre 15 cm, plain sand 15 cm, coconut husk fibre 20 cm, plain sand 20 cm, charcoal 15 cm, gravel 10 cm and mineral stones 15 cm. The developed technique seemed to be very effective in reducing the iron concentration below 0.3 ppm as required. This research result showed that filter media could reduce iron content. The efficiency of the filter media in reducing the iron content was about 71 - 96%. They also concluded that media filters are effective for reducing iron content in groundwater up to 96%.

Shijila and Praveena (2020) conducted a study on evaluation of existing micromesh filter in KCAET campus, Tavanur for actual rainfall conditions. Two additional filters of sand and charcoal were also developed as secondary filters and connected to the outlet of the mesh filter to improve the purification efficiency. They also tested roof water quality from different roofs such as clay tiled, RCC paved with terracotta tiles, clay tiled, old RCC and new RCC. The results showed that pH values of the roof water were not varying with respect to roof materials and their values were very close to 7. EC was varying with respect to roofs and rainfall events. Turbidity and suspended solids were also showed variation with respect to roof and rainfall events, their concentration was higher than the permissible limit. After the filtration, the turbidity and suspended solids concentration reduced by 81% for mesh filter alone and 85% when secondary filter combinations of sand or charcoal were used. The study has proved that the micro mesh filter and the filter combinations with sand and charcoal are very effective in the purification of roof rain water.

Jaksirinont (1972) conducted a study on development of a series filtration water treatment method for small communities of Asia. A series filtration water treatment system using local materials was developed for treating surface water in small communities of Asia. Design criteria were developed using coconut husk fibre as roughing filter medium and burnt rice husk as polishing filter medium. The optimum filtration rate was 1.25 $m^3/m^2/hr$ for both filters. The optimum depth of media using series filtration units was at 100 cm for coconut husk fibre and 80 cm for burnt rice husk. A dual media filter, comprising coconut husk fibre of 80 cm depth followed by burnt rice husk of 20 cm depth, fed at a filtration rate of 1.25 $m^3/m^2/hr$, and had efficiencies for turbidity and coliform removal greater than 997 when treating surface waters. Duration of the filter run, using the dual media, would approximate one month's operating time based on current village water use habits in Thailand. The dual media filter appears promising as a tertiary waste treatment process also. For raw water sources with turbidity less than 40 JTU, a single media filter of burnt rice husk, fed at filtration rate of 0.25 $m^3/m^2/hr$, proved to be satisfactory to provide a high efficiency of turbidity and coliform removal.

Sevilla (1971) studied water filtration using local materials, pea gravel, coconut husk fibre, burnt rice husk, raw rice husk and sand as filter media. In preliminary test runs two levels of filtration rate were studied: semi-rapid rates of 2.5 and 1.25 $m^3/m^2/hr$. Two levels of turbidity were investigated 300 JTU and lower and 1000 JTU and higher. Secondary filter runs were designed for the purpose of determination of the performance of media at low turbidity loading level used was 50 JTU average and filtration rate was held at 0.25 $m^3/m^2/hr$. All influent water used in these two test runs were synthetic water. River water taken from Chao Phya River was used as influent filter in another series of tests and filter performance was compared to that using synthetic water. This test run was carried out for both slow sand and semi-rapid rate. All the runs except burnt rice husk, breakthrough occurrence was highly dependent on the filtration rates, porosity of media more than the influent turbidity. Burnt rice husk removed turbidity so efficiently at any level with a defined head loss that a secondary filter might not be needed if it was found reliable in terms of chemical and biological effects. Because of the difficulty in cleaning filter media, burnt rice husk, raw rice husk, and coconut husk fiber, after using, it was more practical to discard them at the end of filter run.

CHAPTER III

MATERIALS AND METHODS

Irrigation water is mostly found contaminated with physical, chemical and biological impurities. Appropriate filtration can help to extend the life and improve the maintenance of an irrigation system. For drip irrigation, filtration is a basic need to avoid clogging. Proper filtration is critical to protect all components of the system from the pump to the emission devices. The various materials used and the methodology adopted to carry out the research is explained under the following subheads.

3.1 Selection of filter media

3.2 Design and development of filter

3.3 Work flow of the developed filter

3.4 Evaluation of developed filter

3.5 Comparison of filters with different media

3.6 Testing of filter for emitter flow

3.1 SELECTION OF FILTER MEDIA

Filter media are the portion of a filtering system that separates unwanted particles from the substance being filtered. The filter media should have the features of maximum turbidity entrapment and low acid solubility. There are different filter media available for filtration of particles from the irrigation water. Different filter media used in this study are fine sand, silex sand, gravel, metal stone, charcoal, metal chips and clay roof tiles. Gravel is an extremely effective filter media because of its ability to hold back precipitates containing impurities. Also it has less chance of being contaminated with pathogens or organic materials. Gravels with fine, medium and coarse size is used at different filtration depth, which affects the filtration efficiency. Activated charcoal is the ideal water filter as it removes toxins from the water without stripping the water of salts and important minerals. It works through the process of adsorption. The reason that activated charcoal makes such a good material for water filters is that it is natural and effective in removing many toxins from the water, such as volatile organic compounds and chlorine, without the use of chemicals. The designed filter system consist of two chambers, primary chamber and secondary chamber. Two experiments were done by changing the filter media.

3.1.1 Experiment I

For the first experiment, primary chamber was filled with gravel (3 mm), metal stone (11 mm) and clay roof tile (40 mm) from bottom to top. The order of arrangement of the filter media in primary chamber for the first experiment is shown in Plate.3.1. The secondary chamber was filled with gravel (3 mm), metal chips (7 mm) and charcoal from bottom to top. Each layers of media were filled with a thickness of 15 cm. A view of different filter media used for secondary chamber for the first experiment is shown in Plate.3.2.

Plate.3.1 Layers of gravel, metal stone and clay roof tile in primary chamber - expt I

Plate.3.2 Layers of gravel, metal chips and charcoal in secondary chamber - expt I

3.1.2 Experiment II

For the second experiment, primary chamber was filled with fine sand (0.2 mm), silex sand (2 mm) and gravel (3 mm) from top to bottom. The order of arrangement of the filter media in primary chamber for the second experiment was shown in Plate.3.3. In secondary chamber, filter media were same as in the first experiment-charcoal, metal chips and gravel. Each of the layers were filled at 15 cm thickness.

Plate.3.3 Layers of fine sand, silex sand and gravel in primary chamber - expt II

Fine sand is a filter media used in ideal pre-treatment process for water containing waterborne parasites, bacteria and suspended solids that cause turbidity, colour, taste and odour. It is effective at treating groundwater with high iron and dissolved gases. Fine sand is composed of grains ranging from size of 0.10 to 0.25 mm in diameter. Its grains are at the top of the sand layer with larger grains farther down the filter. Fine sand grains lead to slow filtration which means that the water stays a long time in this filter.

Silex sand is a silica, crystalline quartz media which can be used as highly efficient filter media for the reduction of suspended matter. Its fractured edges and irregular surface provides a high surface area and complex flow path for efficient removal of suspended matter throughout the filter bed. Its larger particle size creates less pressure loss through the filter and allows deeper sediment penetration into the bed for higher sediment loading and longer filter runs. Its size ranges from 2-3 mm particle size. It is inert to acids, alkalies & chemicals and gives good abrasion resistance.

Coarse media like metal stone, gravel, clay roof tiles and metal chips are used for lowering the pressure so that it can accept larger amounts of waste water than in fine particles. The coarse upper layer removes larger particles before they reach the fine layer, allowing the filter to operate for a longer period without clogging. Activated charcoal removes toxins from the water without stripping the water of salts and important minerals. It contains hundreds of tiny pores. These pores trap pollutants, making activated carbon excel as a chemical filter media.

3.2 DESIGN OF FILTER SYSTEM

Conventionally in sand filters, mild steel is used for the filter body. In this study, PVC is used for making the filter chambers in order to make it an alternative filter. The filter system consist of a primary chamber and a secondary chamber. The different parts and its details are explained as follows.

3.2.1 PVC Casing

PVC pipe of 160 mm diameter and 110 cm long was used as the chamber for housing the filter media. Both ends were closed with end cap of six inch, which is shown in Plate.3.5. Two holes were drilled on top and bottom side of the casing pipe for inlet and outlet as shown in Plate.3.4.

Plate.3.4 Casing pipe

Plate.3.5 Endcap

3.2.2 Inlet structure of primary and secondary chamber

One inch hole is drilled on the casing pipe 25 cm below the end cap for the inlet. And then it is connected with the pipeline using a tank connector of 1 inch diameter, which is shown in Plate.3.6. The inner diameter of tank connector is ¾ inch, so a pipe of the same is connected to the inside of the casing. This pipe was connected with another 2 inch PVC pipe using an elbow and a ¾×2 inch enlarger. Enlarger is covered by a 2 inch end cap .The enlarger and end cap were drilled for perforations of diameter of 4 mm. The holes were made for getting a showering effect and to reduce the impact of high pressure of water on media. The whole assembly constituted the inlet structure of primary chamber, as shown in the Plate.3.7. Then this inlet structure was fitted inside the PVC casing, at a distance of 25 cm from top of the casing pipe, by using tank connector, as shown in Plate.3.8. In the same way, another inlet structure with same dimensions were constructed and fitted inside secondary chamber using another tank connector.

Plate.3.6 Tank connector with strainer

Plate.3.7 Inlet structure

Plate.3.8 Fitting of inlet structure inside PVC casing using tank connector

3.2.3 Outlet structure for primary and secondary chamber

Another one inch hole is drilled 25 cm above the bottom of end cap, at the opposite side of the inlet structure of chamber. Tank connector was connected to a ¾ inch PVC pipe using an elbow. Then a 4 inch end cap was fixed over this ¾ inch pipe. The elbow and pipe were drilled with holes of 2 mm diameter and the end cap was drilled with 4mm diameter holes. The whole structure is wrapped by a PVC mesh and nylon net as shown in Plate.3.9. Same outlet structure were fabricated for second chamber also.

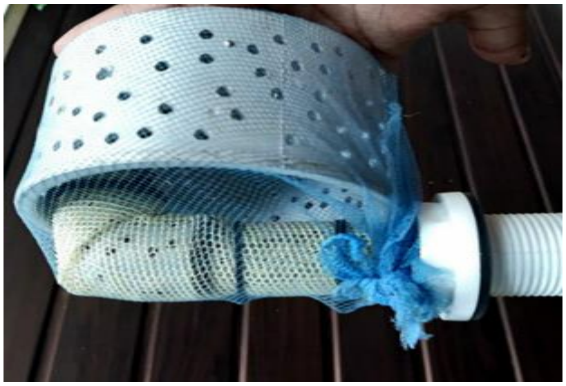

Plate.3.9. Outlet structure

3.2.4 Filling of filter media

Three layers of filtering media were filled in primary and secondary chambers, each of them having 15 cm thickness. For the first experiment, primary chamber was filled with gravel, metal stone and clay roof tile pieces and the secondary chamber was filled with gravel, metal chips and charcoal. For the second experiment, primary chamber was filled with fine sand, silex sand and gravel and in secondary chamber, filter media were same as in the first experiment-charcoal, metal chips and gravel. Each media were separated by PVC mesh as shown in Plate.3.10 to hold it in position while backwashing. During filtration process, water passes through the coarse layer of media and decreases its velocity. Leaving large particles on surface, then water flows through next layers.

Plate.3.10 PVC mesh

3.2.5 Fitting of filter chambers

Clamps were used to fix the filter chambers on wall as shown in Plate.3.11. Outlet of the primary filter chamber is then connected to inlet of the secondary filter chamber. The outlet of the secondary chamber was connected to the main line of drip system. The delivery line from the overhead tank of 75000 L at an approximate height of 20 m is connected to the inlet of the primary filter through a service connection.

Plate.3.11 Fixing of filter chamber on wall using clamps

3.2.6 Overall experimental setup

The overall experimental setup is shown in Fig.3.1. Ball valves were used to control the flow of water. Reducer was used to connect the pipes of different sizes. Elbow was used to turn the flow of water. Tee joint allows a line to split into two separate lines with a 90 degree connection and also it is used to connect two lines into one main line. Brass threaded adapter was used to connect the pipeline with the flow meter. Brass threaded tee was used to connect the pipeline with the pressure gauge. All the fitting accessories are as shown in Plate.3.12, Plate.3.13, Plate.3.14, Plate.3.15, Plate.3.16 and Plate.3.17.

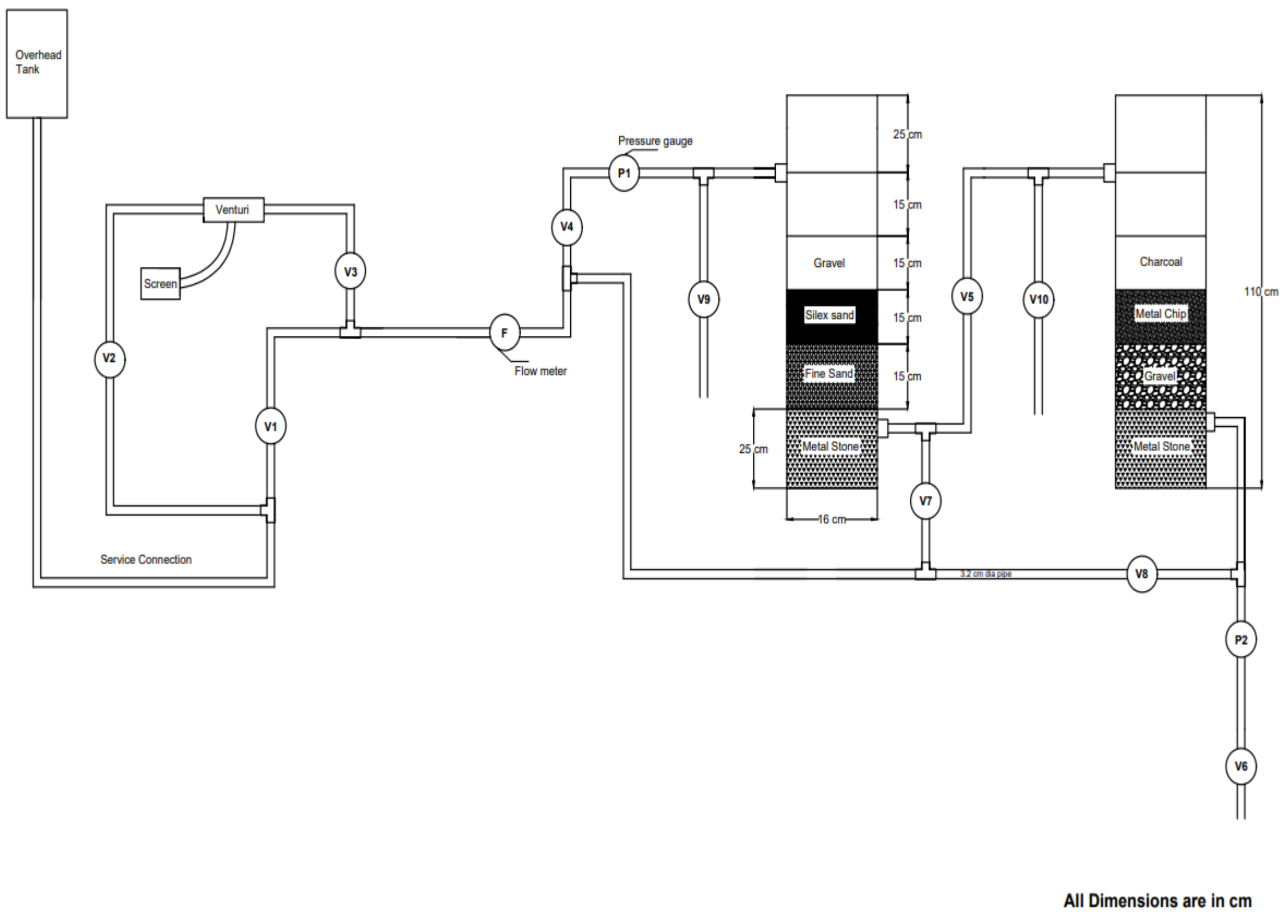

Fig.3.1 Schematic sketch of experimental setup

Plate.3.12 Ball valve

Plate.3.13 Reducer

Plate.3.14 Elbow

Plate.3.15 Tee joint

Plate.3.16 Brass threaded adapter

Plate.3.17 Brass Threaded Tee

3.3 WORK FLOW OF THE DEVELOPED FILTER

During the filtration process, water first enter into the primary chamber. When water passes from coarse filter media to fine media, its velocity gets decreases and sediments starts settling on the media. Below the fine layer, there is an aperture to collect filtered water, which in turn is connected to the secondary inlet. The water is then passes through the secondary chamber where further filtration is done. The detailed work flow is explained in the following subheads.

3.3.1 Filter line

For the filter line to operate, valve 1 (V_1), which is the first valve provided at the service line, is to be opened while, Valves V2 and V3 at the venturi line were closed. Valves V4, V5 and V6 were also opened. So water will flows through the filter chambers and flowmeter measures the volume of water. By making the volume of water constant, we took the discharge for various pressures, were also noted.

3.3.2 Venturi line

For the working of venturi, valves V2 and V3 were kept open and V1 was closed. Cock valve of the venturi was opened and valves V4, V5 and V6 were kept opened.

3.3.3 Backwashing

Back wash inlet was provided for cleaning the filter periodically, which is essential for long life of filter.

3.3.3.1 Backwashing of primary chamber

For backwashing of primary chamber, valves V2, V3, V4, V5 and V6 were kept closed and valves V1, V7 and V9 were kept opened. So reverse flow of water will takes place from bottom to top side of the primary chamber, by carrying the impurities and other unwanted particles.

3.3.3.2 Backwashing of secondary chamber

For back washing of secondary chamber, valves V1, V8 and V10 were kept opened and valves V2, V3, V4, V7, V6 and V5 were kept closed. Then backwashing will be occur through the backwash outlet of secondary chamber.

3.4 EVALUATION OF FILTER

The filter was evaluated by the following parameters.

3.4.1 Estimation of filtration efficiency

Muddy water (500g of mud in 10L of water) was given to the system through venturi and it get diluted when it mix with the water flows through the pipeline. Water samples at the inlet and outlet of filter were taken. Gravimetric method was used to determine the filtration efficiency. 250 ml of each samples were passed through Whatman filter paper and then it was dried in hot air oven at 105°C for 5 hours .Then dry weight of filter paper with dried sample as well as the weight of filter paper alone were noted. A view of applying muddy water to drip system and various instruments used for determining the filtration efficiency are shown in Plate.3.18, Plate.3.19 and Plate.3.20 respectively.

The efficiency of the filters was determined by the equation as follows.

$$E = \frac{(Sb-Sa)}{Sb} \times 100$$

Where,

E = Efficiency of the filter, %

Sb = Suspended solids before filtering, mg/l

Sa = Suspended solids after filtering, mg/l

Plate.3.18 Application of muddy water and evaluation of the collected sample

Plate.3.19 Hot air oven **Plate.3.20 Weighing of filter paper**

3.4.2 Estimation of Total Suspended Solids (TSS)

The suspended particles were quantified by gravimetric method. For finding suspended solids, the water is filtered through a fine Whatman filter paper and the suspended materials retained on the filter was weighed after drying it in an oven at 105º C for one hour.

$$\text{Total suspended solids (g/l)} = \frac{(W2-W1)}{V} \times 1000$$

Where,

W1 = Initial weight of filter paper, g

W2 = Weight of filter paper and the dry material retained on the filter, g

V = Volume of sample, ml

3.4.3 Determination of pH and Electrical conductivity (EC)

Muddy water (500g of mud in 10 litre of water) was injected to the pipeline by a venturi injector. 250 ml of water sample was taken at inlet and outlet of the filter to test EC and pH using pH-EC meter as shown in Plate.3.21.

Acceptable range of pH for irrigation water = 5.5-8.4

Acceptable range of EC for irrigation water= 0.7-3.0 dS/m

Plate.3.21 pH-EC meter

3.4.4 Determination of discharge vs pressure drop

A flow meter was fitted at the inlet of the filter to measure the volume of water and is shown in Plate.3.22. By keeping pressure constant, the discharge for various time intervals were also noted. The discharge vs time graph was drawn. The pressure gauge readings at inlet and outlet portion of filter system were taken to find the pressure drop across the filter. The pressure gauges used are shown in Plate.3.23. These readings were taken for both the experiments with different media. The pressure drop vs flow rate graph was also drawn.

Plate.3.22 Flow meter

Plate.3.23 Pressure gauge

3.5 COMPARISON OF FILTERS USING DIFFERENT MEDIA

For the first experiment, primary chamber was filled with gravel, metal stone and clay roof tile and secondary was filled with gravel, metal chips and charcoal from top to bottom. For the second experiment, primary was filled with fine sand, silex sand and gravel and secondary was chosen the same as before. The water was passed through both filter systems and were evaluated for finding discharge, pressure drop, pH, electrical conductivity (EC), total dissolved solids (TDS) and filtration efficiency. By comparing the values computed, the performance of the first and second filter were studied and found which filter is more efficient in purifying the water.

3.6 TESTING OF FILTER FOR EMITTER FLOW

A plot of 4 m×4 m was selected for laying the drip irrigation system. A PVC main line of 1 ¼ inch diameter was connected to the outlet of the filter. 16 mm LDPE laterals were connected at 1 m spacing using grommet and take off. 6 non-pressure compensating emitters of a discharge of 4 lph at 1 Kg/cm^2 were connected at a spacing of 60 cm on each lateral. A venturi is provided at the beginning of the connections for giving fertilizers along with the water for drip irrigation (fertigation). End caps were provided for each lateral and the main line. A cock valve was provided at the beginning of each lateral for controlling the flow of water. The individual discharge from each emitter was then determined by varying the pressure. A view of venturi system, PVC mainline and LDPE laterals are shown in Plate.3.24, Plate.3.25 and Plate.3.26 respectively. Other connection and fittings such as coupler, grommet & takeoff, end cap, coke valve and emitter are also shown in Plate.3.27, Plate.3.28, Plate.3.29, Plate.3.30 and Plate.3.31 respectively.

Plate.3.24 Venturi system

Plate.3.25 PVC mainline

Plate.3.26 LDPE lateral

Plate.3.27 Coupler

Plate.3.28 grommet and takeoff

Plate.3.29 End cap

Plate.3.30 cock valve

Plate.3.31 Emitter

CHAPTER IV

RESULTS AND DISCUSSION

An alternate media filter for drip system was developed using locally available materials. The various results and discussions pertaining to the development and evaluation of an alternate media filter for drip system are explained under the following subheads.

4.1 DEVELOPED DRIP FILTER

A view of the developed filter with its connections are shown in Plate.4.1. The filter system consists of a primary chamber and a secondary chamber with filter media as gravel, silex sand and fine sand in the first chamber and gravel, metal chips and charcoal in the second chamber was found more efficient in purifying water. The two vertical PVC pipe shown in the plate were the two chambers of the filter.

Plate.4.1 A view of developed drip filter with its connection

4.2 EVALUATION OF FILTER

The drip filter was evaluated based on the following parameters.

4.2.1 Filtration efficiency

Water samples were collected from the inlet and outlet of the filter. The samples were filtered, dried and its dry weight was taken. The sample was collected for both experiments. Filtration efficiency was determined from the dried weight of sample and was shown in Table 4.1 and Table 4.2 for experiment I and experiment II respectively.

Table 4.1 Calculation of filtration efficiency - expt I

Sample	Dry weight of sample (g)	Filtration efficiency (%)
Sample 1 (muddy)	0.87	50
Sample 1 (clear)	0.86	
Sample 2 (muddy)	0.9	60
Sample 2 (clear)	0.87	
Sample 3 (muddy)	0.93	62.5
Sample 3 (clear)	0.88	

Table 4.2 Calculation of filtration efficiency - expt II

Sample	Dry weight of sample (g)	Filtration efficiency (%)
Sample 1 (muddy)	0.89	75
Sample 1 (clear)	0.86	
Sample 2 (muddy)	0.92	85.7
Sample 2 (clear)	0.86	
Sample 3 (muddy)	0.93	87.5
Sample 3 (clear)	0.86	

The filtration efficiency of 1st experiment varied from 50 to 63% and the filtration efficiency of 2nd experiment varied from 75 to 88%. The filtration efficiency of the second experiment filter was improved by 25-30%.

4.3 TOTAL SUSPENDED SOLIDS (TSS)

TSS is estimated from the dried weight of water samples and its results are shown in Table 4.3 and Table 4.4 for experiment I and experiment II respectively. The TSS removal varied from 0.12 to 0.2 g/l for the 1st experiment and 0.12 to 0.28 g/l for the 2nd experiment.

Table 4.3 Calculation of TSS - expt I

Sample	Dry weight of sample (g)	TSS (g/l)	TSS removed (g/l)
Sample 1(muddy)	0.87	0.16	0.12
Sample 1 (clear)	0.86	0.04	
Sample 2(muddy)	0.9	0.2	0.12
Sample 2 (clear)	0.87	0.08	
Sample 3(muddy)	0.93	0.32	0.2
Sample 3 (clear)	0.88	0.12	

Table 4.4 Calculation of TSS - expt II

Sample	Dry weight of sample (g)	TSS (g/l)	TSS removed (g/l)
Sample 1(muddy)	0.89	0.16	0.12
Sample 1 (clear)	0.86	0.04	
Sample 2(muddy)	0.92	0.28	0.24
Sample 2 (clear)	0.86	0.04	
Sample 3(muddy)	0.93	0.32	0.28
Sample 3 (clear)	0.86	0.04	

4.4 DETERMINATION OF pH AND ELECTRICAL CONDUCTIVITY (EC)

The water samples collected at inlet and outlet of filter were analyzed in the lab for pH and EC using pH-EC meter. The observed pH and EC are shown in Table 4.5 and Table 4.6 for experiment I and experiment II respectively. The EC of filtered water for the 1st experiment varied from 0.83 to 0.95 dS/m and for 2nd experiment varied from 0.78 to 0.88 dS/m. Thus, both values were at acceptable range of EC for irrigation water (0.7 to 3 dS/m). The pH of 1st experiment varied from 6.45 to 7.9 and of 2nd experiment 5.42 to 5.61. These two were at acceptable range of pH of irrigation water (5.5 to 8.4).

Table 4.5 Calculation of pH and EC - expt I

Sample	pH	EC	
		µS/cm	dS/m
Sample 1 (muddy)	7.90	100	1.00
Sample 1 (clear)	6.65	95	0.95
Sample 2 (muddy)	6.60	95	0.95
Sample 2 (clear)	6.70	83	0.83
Sample 3 (muddy)	6.45	90	0.90
Sample 3 (clear)	6.60	88	0.88

Table 4.6 Calculation of pH and EC - expt II

Sample	pH	EC	
		µS/cm	dS/m
Sample 1 (muddy)	5.52	87	0.87
Sample 1 (clear)	5.61	78	0.78
Sample 2 (muddy)	5.58	95	0.95
Sample 2 (clear)	5.60	83	0.83
Sample 3 (muddy)	5.42	90	0.90
Sample 3 (clear)	5.47	88	0.88

4.5 DISCHARGE VS TIME

By keeping pressure constant the discharge for various time intervals were noted at the filter outlet. It was observed that as the time increases the discharge from the filter increases. The constant discharge with respect to time was due to the constant pressure drop maintained throughout the filter system. If the pressure increases the required discharge would acquire earlier, the rate of discharge may vary due to the difference in pressure drop and concentration of irrigation water (Mailappalli *et al*., 2007). The discharge vs time observations are shown in Table 4.7 and Table 4.8 for experiment I and experiment II respectively. Their variation are plotted in Fig.4.1 and Fig.4.2 respectively.

Table 4.7 Discharge vs time - expt I

Volume of water collected (l)	Time (s)	Discharge (m^3/hr)
9	30	1.08
13	36	1.30
15	40	1.35
21	45	1.68

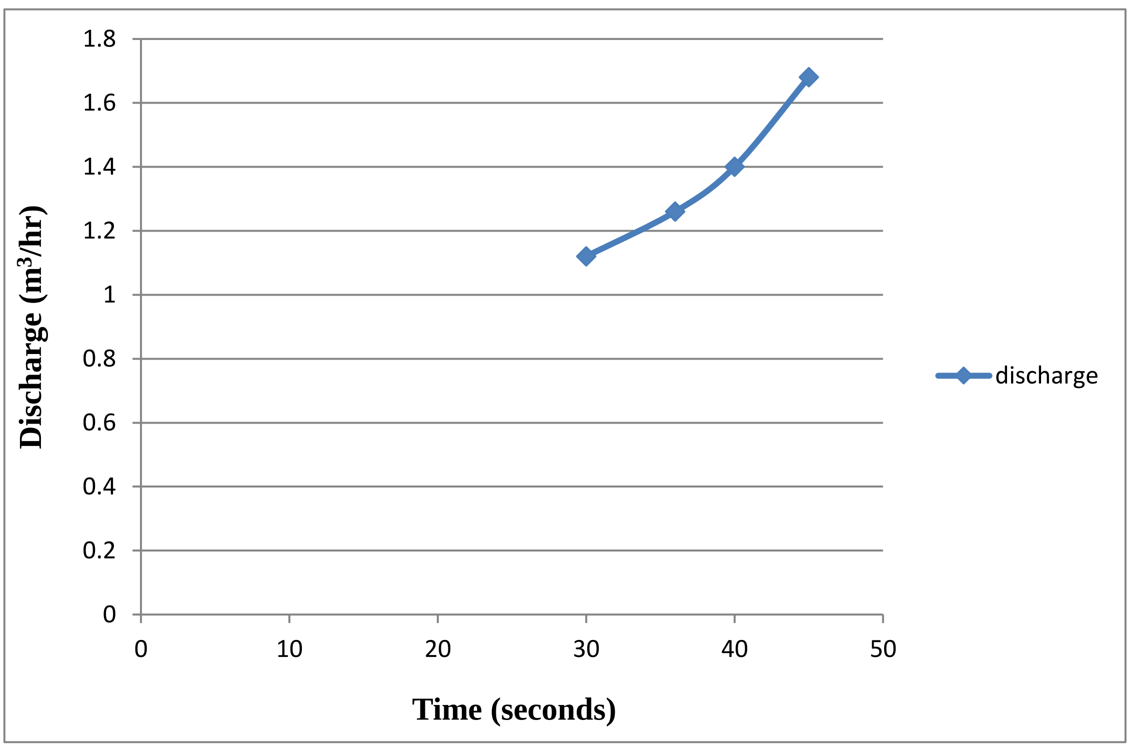

Fig.4.1 variation of discharge with time for experiment I

Table 4.8 Discharge vs time - expt II

Volume of water collected (l)	Time (s)	Discharge (m^3/hr)
12	91	0.475
13	97	0.482
14	101	0.499
16	106	0.543

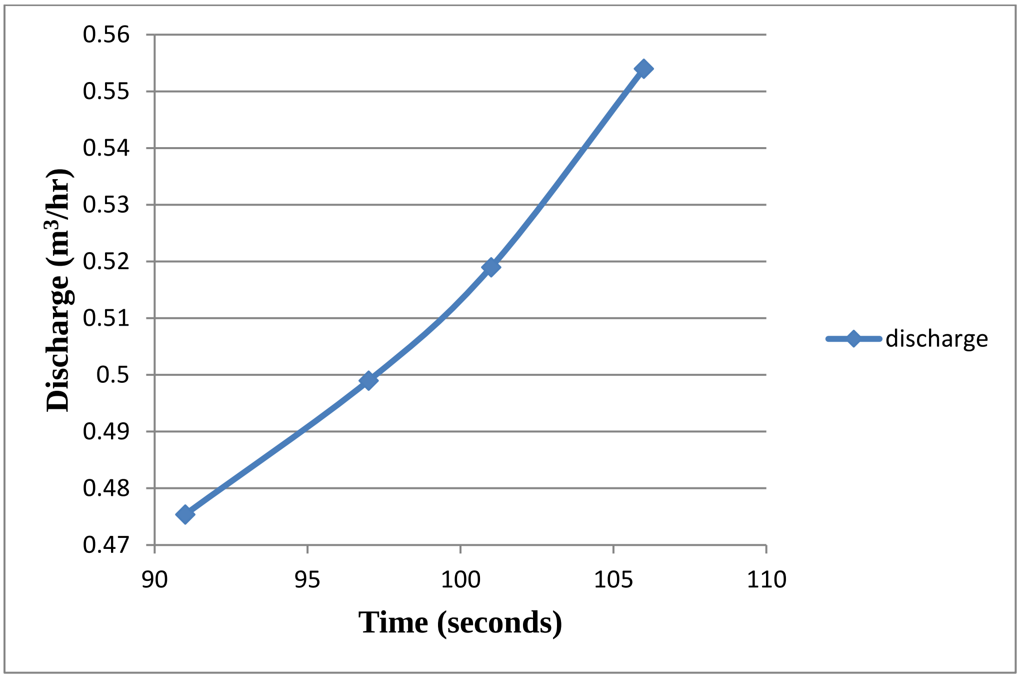

Fig.4.2 variation of discharge with time for experiment II

4.6 PRESSURE DROP VS FLOW RATE

In the filter outlet, by making the volume of water constant the pressure drop across the system is noted using pressure gauges fitted at inlet and outlet at various time intervals. Here pressure drop increased with increased flow rate. This is because when pipe diameter is constant, the flow rate will be constant and there won't be any change in pressure (Patil *et al*., 2013). Gideon *et al*. (1982) found out that quality of effluent produced by a media filter depends upon the flow rate through the filter, and the type of media used. The pressure drop across the sand media filter increased with increase in sediment load concentration levels. The filter pressure drop values increase in the presence of sand and with increasing bed width and decreasing sand effective size (Chang *et al.*, 1999). The observation and graph for both experiment is shown in Table 4.9 and Table 4.10. The variation of pressure drop vs flow rate is shown in Fig.4.3 and Fig.4.4 respectively.

Table 4.9 Flow rate and its variation with pressure drop - expt I

Pressure drop (Kg/cm^2)	Volume of water collected (l)	Time (s)	Flow rate (m^3/hr)
0	14	60	0.84
0.1	14	48	1.05
0.2	14	38	1.326
0.3	14	32	1.482

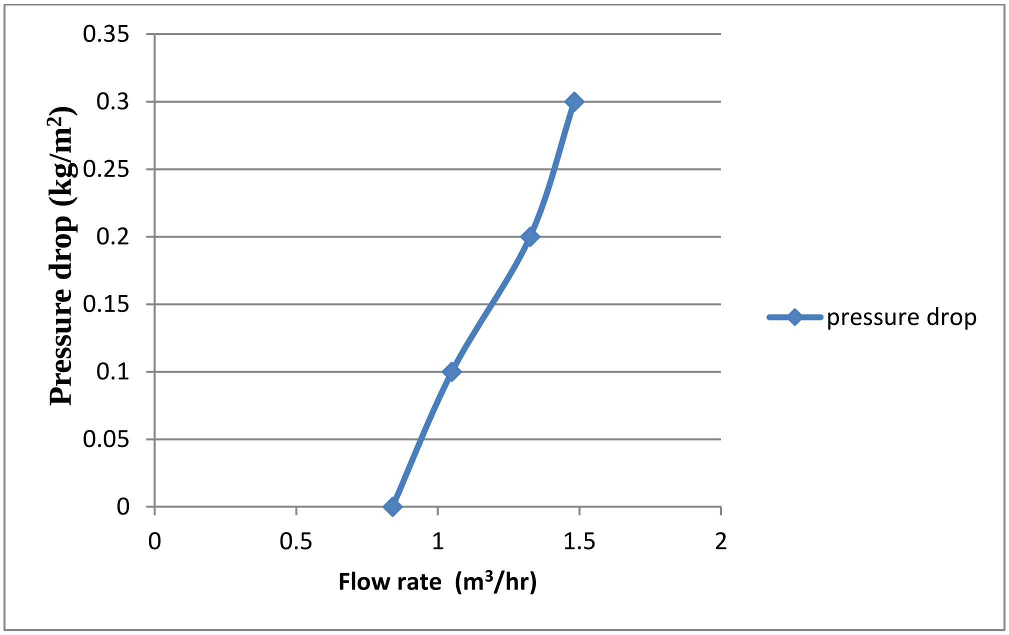

Fig.4.3 variation of pressure drop with flow rate

Table 4.10 Flow rate and its variation with pressure drop - expt II

Pressure drop (Kg/cm^2)	Volume of water collected (l)	Time (s)	Flow rate (m^3/hr)
0	14	60.06	0.839
0.1	14	47	1.145
0.2	14	37	1.362
0.4	14	30	1.68

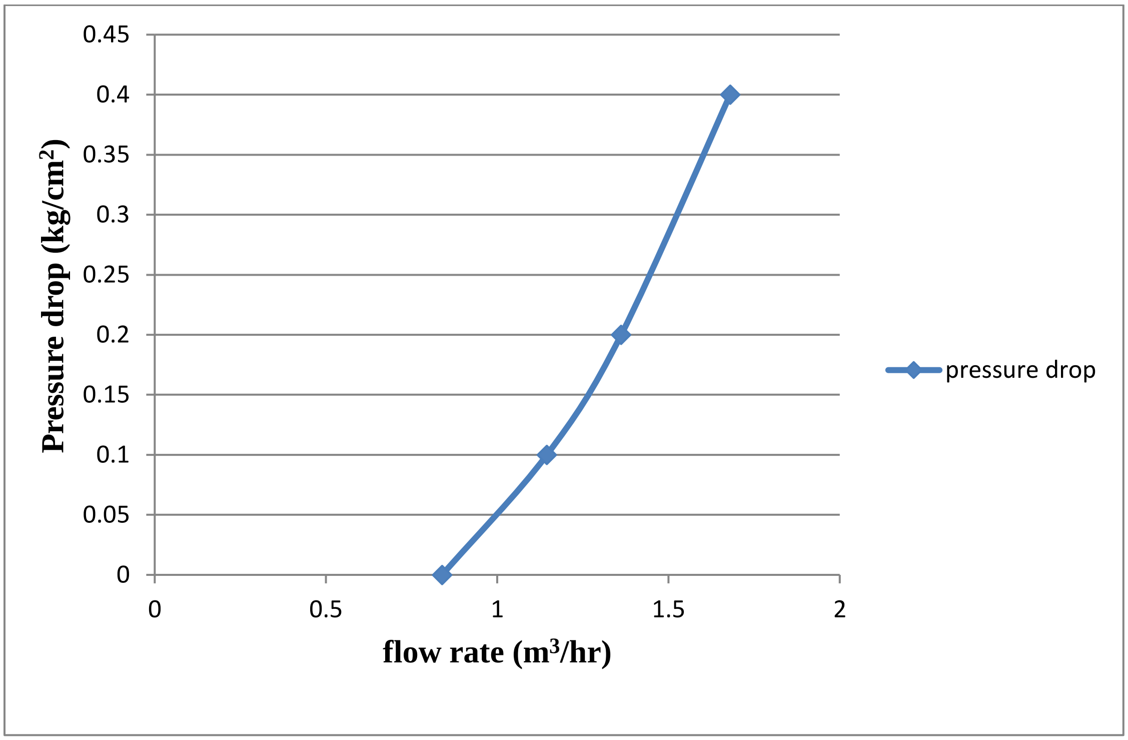

Fig.4.4 variation of pressure drop with flow rate

4.7 COMPARISON OF FILTERS WITH DIFFERENT MEDIA

The designed PVC filter system consist of two chambers, primary chamber and secondary chamber. Two experiments were done by changing the filter media. In first experiment, primary chamber was filled with clay roof tile, metal stone and gravel and secondary chamber was filled with charcoal, metal chips and gravel. In second experiment, the primary chamber was filled with gravel, silex sand and fine sand and secondary chamber media were kept same.

The filtration efficiency of 1st filter experiment varies from 50 to 63%. The filtration efficiency of 2nd filter experiment varies from 75 to 88%. Other evaluation parameters remain almost same for both experiments. TSS removal varied from 0.12 to 0.2 for the 1st experiment and 0.12 to 0.28 for the 2nd experiment. Thus TSS removed is more in 2nd experiment. Hence it is concluded that the second filter system is more efficient than the first filter system. This has to be tested further by running the filter for long time to confirm the results.

4.8 TESTING OF 2ND EXPERIMENT FILTER FOR EMITTER FLOW VARIATION

Since the 2nd filter performed better than the 1st filter, 2nd filter was tested for emitter flow variation. Each emitter was tested for its discharge at various pressure. The observation were taken at 0.2 Kg/cm^2, 0.4 Kg/cm^2, 0.6 Kg/cm^2 and 0.8 Kg/cm^2 and are shown in Table 4.11, Table 4.12, Table 4.13 and Table 4.14 respectively. The discharge were collected for a time interval of 10 minutes time.

Table 4.11 Emitter flow variation for the second filter at 0.2 Kg/cm^2

Lateral	Emitter 1 discharge (lph)	Emitter 2 discharge (lph)	Emitter 3 discharge (lph)	Emitter 4 discharge (lph)	Emitter 5 discharge (lph)	Emitter 6 discharge (lph)
1	1.17	1.14	1.23	1.32	1.53	1.53
2	1.14	1.14	1.2	1.23	1.47	1.47
3	1.08	1.14	1.38	1.29	1.38	1.23

Table 4.12 Emitter flow variation for the second filter at 0.4 Kg/cm^2

Lateral	Emitter 1 discharge (lph)	Emitter 2 discharge (lph)	Emitter 3 discharge (lph)	Emitter 4 discharge (lph)	Emitter 5 discharge (lph)	Emitter 6 discharge (lph)
1	2.08	2.01	2.07	2.15	2.17	2.35
2	2.15	2.2	2.36	2.39	2.46	2.48
3	2.16	2.45	2.405	2.63	2.44	2.85

Table 4.13 Emitter flow variation for the second filter at 0.6 Kg/cm^2

Lateral	Emitter1 discharge (lph)	Emitter2 discharge (lph)	Emitter3 discharge (lph)	Emitter4 discharge (lph)	Emitter5 discharge (lph)	Emitter6 discharge (lph)
1	3.42	3.6	3.54	3.6	3.39	3.66
2	3.15	3.39	3.39	3.39	3.18	3.6
3	3.3	3.39	3.66	3.6	3.63	3.66

Table 4.14 Emitter flow variation for the second filter at 0.8 Kg/cm^2

Lateral	Emitter 1 discharge (lph)	Emitter 2 discharge (lph)	Emitter 3 discharge (lph)	Emitter 4 discharge (lph)	Emitter 5 discharge (lph)	Emitter 6 discharge (lph)
1	3.3	3.51	3.87	3.45	3.285	3.335
2	3.225	3.42	3.36	3.39	3.36	3.918
3	3.315	3.345	3.705	3.63	3.54	3.885

The highest and lowest discharge in 1st case varied from 1.08 to 1.53 lph, in 2nd case it varied from 2.01 to 2.85 lph, in 3rd case it varied from 3.15 to 3.66 lph and in 4thcase it varied from 3.225 to 3.918 lph. Hence it was found that there was not much variation in emitter discharge. But this has to be tested for long period of run to check whether the emitter get clogged after prolonged use. The testing of emitter for flow variation is shown in Plate.4.1.

Plate.4.2 Testing of filter for emitter flow

CHAPTER V

SUMMARY AND CONCLUSION

Proper and adequate water filtration is essential requirement to prevent clogging in drip irrigation system for consistent emitter operation. Even though several filters such as disc filter, screen filter, hydro cyclone filter etc. are available in market, due to their high price they may be not affordable for farmers in the rural areas. So an alternate media filter was developed using locally available materials. Two experiments were done by changing the filter media. In first experiment, primary chamber was filled with clay roof tile, metal stone and gravel and secondary chamber was filled with charcoal, metal chips and gravel. In second experiment, the primary chamber was filled with gravel, silex sand and fine sand and secondary chamber media were kept same.

The filter was evaluated based on filtration efficiency, TSS, pH, EC, discharge vs time and pressure drop vs flow rate. The performance evaluation showed that, filters in both the experiments could worked successfully in removing the unwanted particles from the impure water. It was found that as the time increases discharge also increases at constant pressure drop, which means that, for long run clogging rate will be very low. The pressure drop and discharge also increases linearly. TSS removal varied from 0.12 to 0.2 g/l for the 1st experiment and 0.12 to 0.28 g/l for the 2nd experiment. Thus, TSS removal is more in second experiment. Also, TSS of filtered water samples in second experiment was found within acceptable range (0.02-.004 g/l) for irrigation purpose. The efficiency of filter increased from 50 - 63% to 75 - 88% when sand is used as a media. The EC of filtered water for the 1st experiment varied from 0.83 to 0.95 dS/m and for 2nd experiment varied from 0.78 to 0.88 dS/m. Thus both values are at acceptable range of EC for irrigation water (0.7 to 3 dS/m). The pH of 1st experiment varied from 6.45 to 7.9 and of 2nd experiment 5.42 to 5.61. Here also both are at acceptable range of pH of irrigation water (5.5 to 8.4). The testing of filter for emitter clogging concluded that all emitters showed almost uniform discharge at various pressure. Hence this filter could be used as an alternate filter to avoid clogging problem in drip irrigation system. This low cost drip filter might be preferred by farmers for their small home gardens.

Suggestions for further work:

- We can improve the efficiency of the filter by using sand as a media in both the filter units.
- A comparative performance of the developed media filter with disc and screen filter could have been taken up for further analysis.
- If the filter is to be tested for emitter flow for a large area, its tendency for clogging would have been checked.

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DEVELOPMENT AND EVALUATION OF AN ALTERNATE MEDIA FILTER FOR DRIP IRRIGATION SYSTEM

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ABSTRACT OF THESIS

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ABSTRACT

In areas where water is scarce, drip irrigation provides the most efficient way to conserve irrigation water. The performance of drip irrigation systems using waste water is mainly limited by emitter clogging and these discourages farmers from introducing it. Even though different filters such as screen filter, disc filters, hydro cyclone filter etc are available in market, the deciding factor is the price at which it is available. Also, the farmers in rural areas can't afford the high cost of these filters. So, this study focusses on development and evaluation of an alternate media filter for drip irrigation system. This study was conducted at an open field in front of hydraulics lab KCAET, Tavanur.

The designed PVC filter system consist of two chambers, primary chamber and secondary chamber. Two experiments were done by changing the filter media. In first experiment, primary chamber was filled with clay roof tile, metal stone and gravel and secondary chamber was filled with charcoal, metal chips and gravel. In second experiment, the primary chamber was filled with gravel, silex sand and fine sand and secondary chamber media were kept same. The efficiency of filter increased from 50 - 63% to 75 - 88% when sand is incorporated as the media. The TSS removal varied from 0.12 to 0.2 g/l for the 1st experiment and 0.12 to 0.28 g/l for the 2nd experiment. Hence, second experiment filter was found more efficient than first experiment filter. From the evaluation of the filter, it was observed that the discharge from the filter increases as the time increases. Also, pressure drop and discharge increases linearly. Electrical conductivity and pH were at acceptable range (5.5 to 8.4). While testing of filter for emitter flow, it was observed that each emitter gave almost uniform discharge at various pressure. Hence this filter can be recommended to reduce cost of drip system and preferred for rural areas in small scale farm applications.