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To Investigate the Performance of Disc Filter in Retaining Clay and Sand Particles.

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Abstract:

Drip irrigation is rapidly growing technology in Pakistan. Initial high investment on drip irrigation installation worth only when its life can be maximized. There are number of factor which determine successful life of this system. Among others factors one important factor is clogging. In modern day technology, different types of filter are used to retain particles that may clog the drippers. In majority of the system installed in Pakistan, disc filters are used. This research is conducted to evaluate performance of these filters in retaining clay and sand particles. It is observed that with increasing flow rate head loss in filter increases which in term results in increased filtration of sand particles. Furthermore, it is found that in normal operation, disc filter can't retain clay particles. But after formation of clay cake, disc filter start retaining clay particles as well. Efficiency of filter in retaining sand particles ranges from 33 to 90% and for clay efficiency ranges from 22 to 37% for a flow range of 4 m^3/hr. to 24 m^3/hr.

Key words: Disc filter, Filter efficiency, Drip irrigation system, Head losses, Clogging, Filtration.

Introduction:

With increasing water scarcity, drip irrigation system is becoming more popular as an alternate irrigation method. As the initial cost of drip irrigation system is very high, it's very important for its adoptability that life of this system shall be very long. Among other important factors, clogging is main factor in determining the life of system. Every drip irrigation emitter has long and very narrow passage for water transmission. These passages are very prone to clogging, that's why special filters are used in these system. (Vedat et al, 2009). Main aim of all sort of filters used in drip irrigation system is to remove all such particles which may clog the drippers. Primarily these filters include Sand media filter, hydro cyclone filter and disc or screen filters. (Douglas and Bruce, 1985; Keller and Bliesner, 1990). Mainly used filters in drip irrigation system is screen filters as they are economical, simple and easy to manage. Although disc filters are also simple and easy to manage, but they are introduced, recently. (Capra and Scicolone, 2004).

Filtration are very effective in reducing clogging of drippers. Success of filtration depend upon the selection of proper filter for any given impurity in irrigation water. Installing all type of filters will, no doubt reduces the risk of clogging but on the other hand will increase the energy cost. So it's very important to know exactly what filter is to be used. Next important step is to use proper size of the filter. Reducing size of filter will result in low initial cost but high energy cost and low filtration. While selecting large size of filter will decrease energy cost and will increase filtration capacity at the cost of high initial cost. So, its critically important to select not only proper type of filter but to select proper size of filter as well (Haman, Smajstrla, and Zazueta). Every part of drip irrigation system is a source of head loss but most of the energy loss occurs in filters. In calculating head losses in filters, filtration area is very important and it's influenced by impurities in irrigation water and flow rate. (Gilbert and Fort, 1986; Haman, Smajstrla, and Zazueta).

Vedat et al, 2009, conducted a research on head losses occurred in different type of disc filters available in local community and they concluded that L type of disc filter gives highest head loss as compared to LT and Y type filters. Furthermore, they noticed that head losses in curly grove shape disc were less than linear grove shape discs. They recommend Y and LT type disc filters with curly shaped discs.

Yurdem, Demir, Degirmencioglu, 2008, developed a mathematical model to predict energy losses in disc filters. Dimensional analysis technique was used in this research. Variables which effect friction losses in disc filter were consider to be internal diameter of outlet and inlet pipes, internal dia of filter body, inflow and outflow area where the out let and inlet pipes intersect with filter body, effective area of disc filter cartridge, outer and inner dia of discs, kinematic viscosity of fluid and fluid velocity in inlet and outlet pipes.

Nieto, et al, 2016, developed a model for early prediction of filtered volume and outlet values of dissolved oxygen and turbidity. Similarly Duran-Ros, et al, 2010, developed energy loss model for predicting head loss in disc filters, with the help of dimensional analysis.

With development in plastic industry, drip irrigation system is widely adopted. Due to many advantages, shortage of water and Govt. subsidy, drip irrigation is prevalent in Pakistan. Locally many research has been done on uniformity of drip irrigation systems, head loss in lateral length, but unfortunately as such no research is carried out on performance and efficiency of filters.

Initially this study was intended to determine efficiency and performance of disc filters of different brands mainly used in Pakistan, but due to shortage of funds, objectives of the study was constrained to:

1. To investigate the efficiency of disc filter of brand A in removing sand Particles
2. To investigate the efficiency of disc filter of brand A in removing clay Particles
3. To investigate the head loss with increasing flow rate.

Material and Methodology:

In this study disc filter with 2-inch inlet and outlet diameter was used. All experiments were performed using this same filter. All physical data and specifications are mentioned in Table 1. Experiment setup is shown in Fig.1.

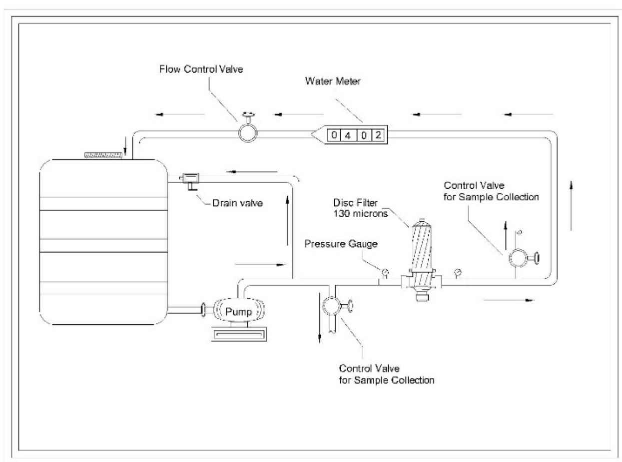

Figure # 1: Layout plan of Experimental Plan.

Said disc filter consist a filter body with inlet and outlet points, filter cartridge, a lid and clamp for locking the lid with filter body.

This disc filter has helix effects as well due to centrifugal action device (centrifugal deflector), installed at the bottom of filter cartridge.

3HP pump was used to force soil mixed water into filter from 0.2 m^3 plastic tank. For measuring flow rate water meter was used downstream of filter. Outlet of water meter was connected to the top of tank with the help of 50.8mm uPVC pipe. Bypass valve and flow control valve was also installed to maintain the desired flow rate. Upstream and downstream of disc filter pressure gauges was installed along with two take off for taking samples.

Filter cartridge was cylindrical shaped plastic rings, staked on plastic core. Rings have linear groves on both sides as shown in Fig 2.

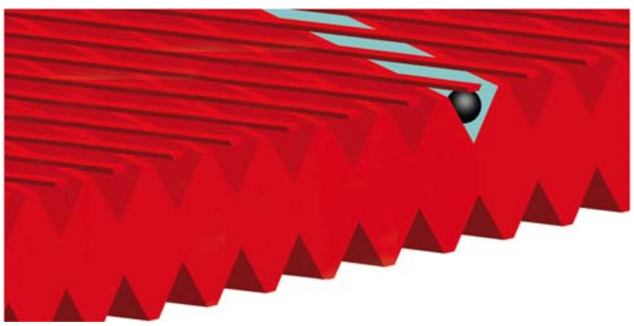

Figure # 2: Groove pattern of Disc Filter

Initially clean water was used to determine clean water head loss and later on soil mixed water was used.

Three different flow rates was maintained during experiment and data was collected respectively along with upstream and downstream water samples. These samples were tested in laboratory at Department of Agricultural Engineering, UET Peshawar.

Results and Discussions:

Head Loss:

Figure 3 shows head loss with increasing flow rates. Same trend is being reported by Demir, et al 2009. Head loss curve is not a linear, its due to the fact that with increasing flow rate, soil particles also increases for constant filtration area and also due to presence of centrifugal deflectors installed at the bottom of filter cartridge. Due to these deflectors some of the soil particles

were seen in the at the top of filter cartridge in a cavity provided for same job. Also due to

S.No	Parameter	Value
1.	Filter Type	T
2.	Capacity (a)	30 m^3/hr.
3.	Filtration grade (b)	0.13 mm
4.	Inlet pipe diameter (c)	50.8 mm
5.	Outlet pipe diameter (d)	50.8 mm
6.	Inside diameter of filter body (e)	177.8 mm
7.	Length of filter cartridge (g)	297.18 mm
8.	Nos. of discs in filter cartridge (h)	279 Nos
9.	Inside diameter of disc (i)	101.6 mm
10.	Outside diameter of disc (j)	129.54 mm
11.	Depth of discs (k = j - i)	27.94 mm
12.	Surface area of filter cartridge (l = pi*j*g)	4804.41 mm^2

helix effect of these deflectors it is seen that filter cartridge was not as dirty as compared to filter cartridge seen in the field without these type of deflectors.

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Table 1: Physical Data and Specifications of Disc Filter

It can be concluded that with increasing flow rate filtration efficiency of disc filter will increase but time interval between two back flushing will decrease. See Fig 3.

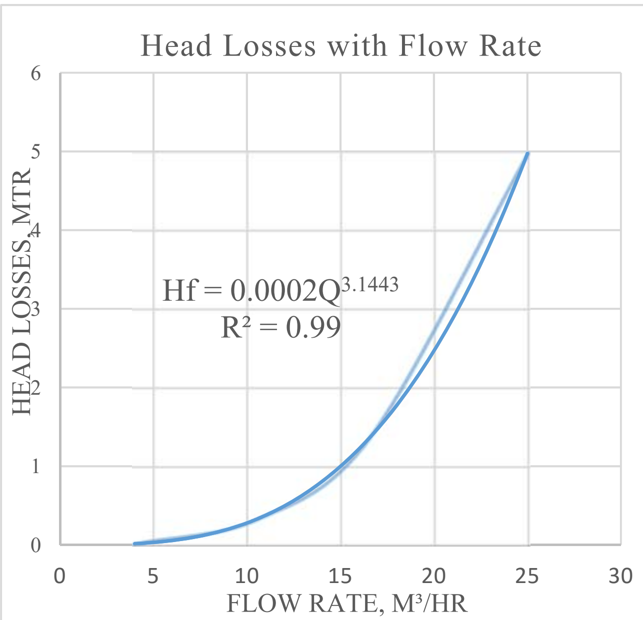

Figure # 3: Head losses vs Flow Rate

Filtration efficiency:

The filtartion efficiency in this reaserach is categrozied in two major groups, i.e. filtration efficiency of disc filter for clay particals and for sand particals.

Fig 4 shows percent of sand particles removed/retained by disc filter with increasing flow rates. It can easily be seen that with increasing flow rate, retention of sand particles increases. This means that at high flow rates, unlike sand media filters, filtration efficiency of disc filter will increases with increased head loss. In other words frequency of back flushing will increases. See Fig 4.

Sand Filtration Efficiency:

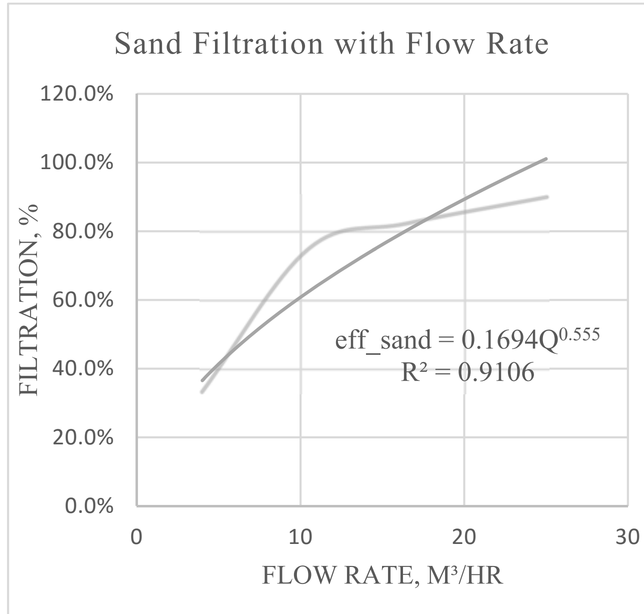

Figure # 4: Percentage of Sand filtered vs Flow Rate.

It can be seen that filtration efficiency increases from 33% to 90% with flow range of 4 m^3/hr to 24m^3/hr. This increase in filteration efficeincy is due to increased head loss and due to clogging of filter cartridge opening with sand/clay particles.

Clay Filtration Efficiency:

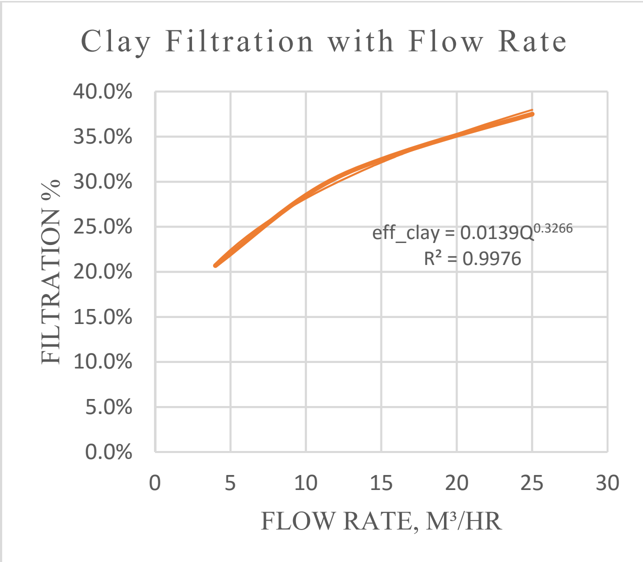

Figure # 5: Percentage of Clay filtered vs Flow Rate.

Fig 5, shows filtration efficiency of disc filter in retaining clay particles.

Although clay particles are very small in size to be retained by 130Micron filter, but it can be seen that filter udner discusion has efficiency ranging from 22% to 37%.

This happened due to the formation of clay cake on filter cartridge. With increasing flow rate cake formation become more prominent and hence increase in clay filtration. It can be said clay filtration is not due to disc filter by itself rather presence of clay cake prevent clay particles from passing through the filter.

It can be evident from rapid increase in head loss, Fig 6.

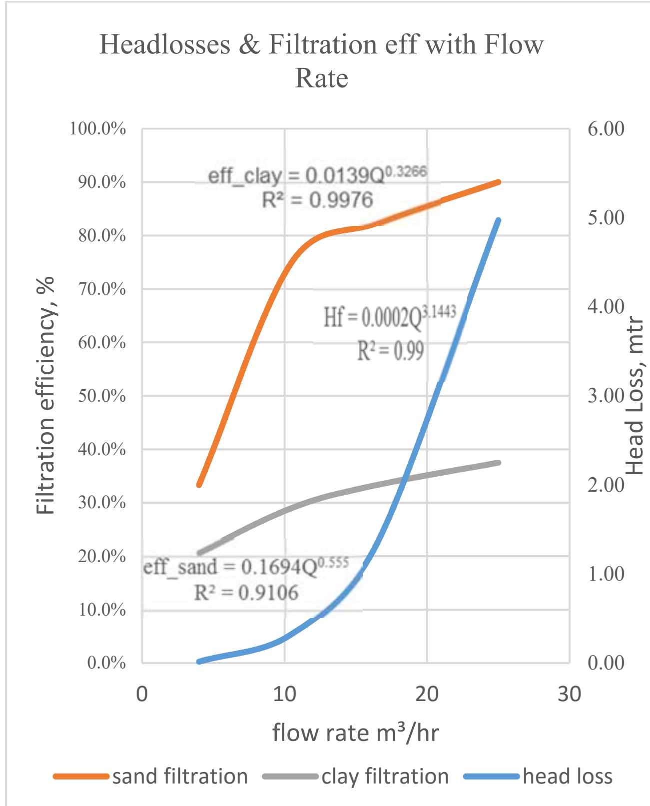

Figure # 6 Head Losses & Filtration Efficiency vs Flow Rate.

Conclusion:

Disc filter is most suitable for retention of sand particles as compared to clay particles. Clay particles can only be retained after formation of clay cake on filter cartridge. But in that case head loss increases and frequency of back flushing increases, which is not desirable.

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