STUDY THE INFLUENCE OF WATER QUALITY ON FILTER PERFORMANCE WITH DIFFERENT FLOW RATE AND CONTAMINANT CONCENTRATIONS

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ABSTRACT
The high initial cost of drip irrigation system is considered to be its limitation for large scale adoption. Due to high initial cost, the marginal land holders are not in a position to install drip irrigation system and thus will not in a position to increase the crop production. Out of all components, filter unit is the most expensive component. But it is essential, without filter unit, drip system will not run efficiently. This study will enable to select the proper type of filter required by the farmer depending upon the water quality. The filtration efficiency was determined for the known concentration of impurities i.e. 100, 200, 300 and 400 ppm for sand, screen and disc filter at three constant flow rates viz. 1.5 lps, 2 lps and 2.5 lps. The pressure drop characteristics were monitored at inlet and outlet of the filters. The result of experiment depicts that the filtration efficiency decreased with increase in levels of concentrations of impurities. The efficiency of the disc filter was found maximum, followed by the screen and sand filter. The pressure drop across the filter increased with different levels of concentration of impurities with elapsed time and flow rates. It was found that the time required to develop 5 m of pressure drop across the disc filter was minimum, followed by the screen and sand filter.

Keywords: Impurities, filters, water quality, pressure drop

INTRODUCTION
The most economic use of water resources for increasing irrigation potential is need of present day. In India only 41.2 million ha area is under irrigation (Mohanalakshmi *et al.* 2009) and it can be increased by creating additional irrigation resources or utilizing more judiciously the already existing irrigation resources. Therefore, for efficient use of irrigation resources there is need to adopt modern irrigation techniques like drip irrigation, sprinkler irrigation etc.

Drip Irrigation is best suited to scarcity areas and regions where irrigation water quality is marginal or low. Drip irrigation becomes a significant part of the farming which is used on a wide variety of crops. The objectives of drip irrigation are to save water, enhance the yield, improve the quality of produce, reduce the disease spreading and save fertilizers. Drip irrigation can deliver water and nutrients in precise amount and at controlled frequencies directly to root zone of plants. Efficiency of drip irrigation is high (more than 90 per cent) as compared to other irrigation methods. A filter unit which cleans the suspended impurities in the irrigation water to prevent blockage of holes and the passage of drip nozzles is an essential part of drip irrigation system. The efficient performance of drip nozzle lies in the effective performance of filter unit.

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MATERIAL AND METHODS

The experiment was conducted at the Department of Irrigation and Drainage Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola which is situated in Vidarbha region of Maharashtra State and comes under subtropical zone. The experimental setup was consisting of pumping unit, by-pass assembly, filter assembly and monitoring equipments. Water from the underground water storage tank was pumped in the HDPE tank with capacity of 3,000 lit. The water with different concentration of impurities was prepared in the HDPE tank. The water with different concentration of impurities was pumped with 5 HP pump and passed through the sand, screen or disc filter. A by-pass arrangement was provided with the control valve to maintain the flow rate through the filter. The by-pass outlet was extended up to the base of the tank. Thus this by-pass flow act as agitator in the tank and avoid settlement of impurity at the base of the tank. The water meter was provided at the inlet of the filter assembly to measure the flow rate. The pressure gauges were provided at inlet and outlet of the filter assembly to measure the pressure drop across the filter for each trial with different flow rates and concentration of impurity. The tests were conducted from the month of September 2011 to March 2012. The samples were passed through a zero number qualitative filter paper. The filter paper was sun dried for 24 hrs. The weight of sun dried filter paper was subtracted from weight of the filter paper then concentration of impurity of the filtered water was calculated to determine the filtration efficiency. The test was performed for the selected concentrations of impurity of 100, 200, 300, and 400 ppm for all the three filters i.e. sand, screen and disc filter at three constant flow rates viz. 1.5 lps, 2 lps and 2.5 lps. The filtration efficiency was calculated by using the formula given by equation (Gideon *et al*., 1980),

$$Fe = 100 \times \left\{1-\frac{S_o}{S_i}\right\} \text{ Where,}$$

F_e - Filtration Efficiency, (%)
S_o- Component concentration of filter outlet, (ppm).
S_i - Component concentration of filter inlet, (ppm).
The sand filter is cleaned by backwashing. This operation consists of reversing the direction of water flow in the sand filter. The screen filter is cleaned by removing the screen element and washing it under strong flow of water and by using suitable brush. During cleaning of the disc filter, the housing is removed. The telescopic shaft is expanded, and the compressed discs separated for easy cleaning.

RESULTS AND DISCUSSION

The chemical analysis of water was carried out to determine the quality of water. Water source was open dug well. The results obtained are presented in Table 1.

Table 1: Chemical analysis of water

Sr. No.	Water quality parameter	Observation	Sr. No.	Water quality parameter	Observation
1	pH	7.5	6	Mg (mg l^{-1})	2.5
2	EC (dS m^{-1})	0.33	7	Na (mg l^{-1})	0.3
3	HCO_3 (mg l^{-1})	2.4	8	K (mg l^{-1})	0.1
4	Cl (mg l^{-1})	2.9	9	SAR	0.20
5	Ca (mg l^{-1})	2.2	10	Water quality	C_2, S_1

Table.1 depicts that the pH of water ranged from 7.3 to 7.7. The electrical conductivity varied from 0.33 to 0.34 dS m^{-1}. The water quality falls in C_2S_1 class which is medium in salinity and low in sodicity. The filters were tested for their efficiency corresponding to 5 m of pressure drop with three different flow rates for each contaminant concentration of 100, 200, 300 and 400 ppm and results are presented in Table 2.

Table 2 Filtration efficiency at 5 m of pressure drop versus different flow rates

Contaminant concentration (ppm)	Flow rates (lps)	Filtration efficiency (%) at 5m pressure drop		
		Sand filter	Screen filter	Disc filter
100	1.5	70.2	80.1	82.0
	2.0	69.6	77.5	78.1
	2.5	68.6	74.3	77.5
200	1.5	68.5	73.8	79.1
	2.5	60.0	71.7	75.1
300	1.5	65.4	69.8	74.1
	2.0	60.5	67.0	73.3
	2.5	59.0	65.3	72.3
400	1.5	58.6	67.5	70.1
	2.0	54.8	60.1	67.0
	2.5	49.8	59.8	65.0

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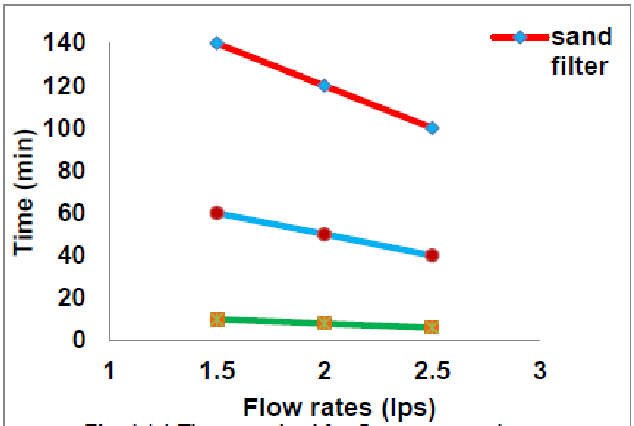

Fig. 1 (a) Time required for 5m pressure drop across different flow rates with 100 ppm concentration of impurities

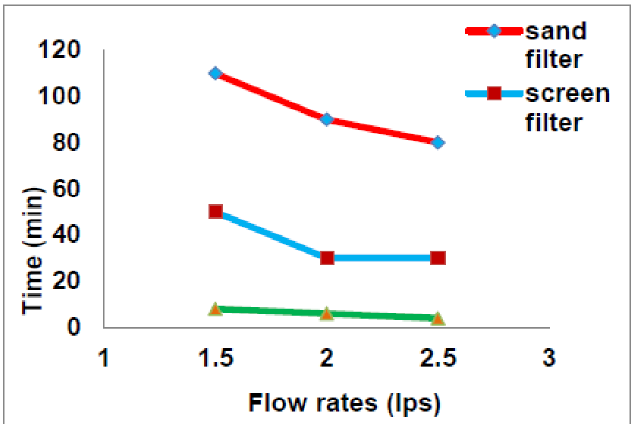

Fig. 1 (b) Time required for 5 m pressure drop across different flow rates with 200 ppm concentration of impurities

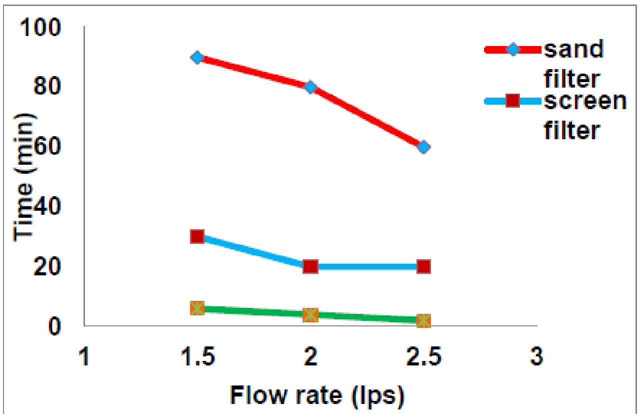

Fig. 1 (c) Time required for 5 m pressure drop across different flow rates with 300 ppm concentation of impurities

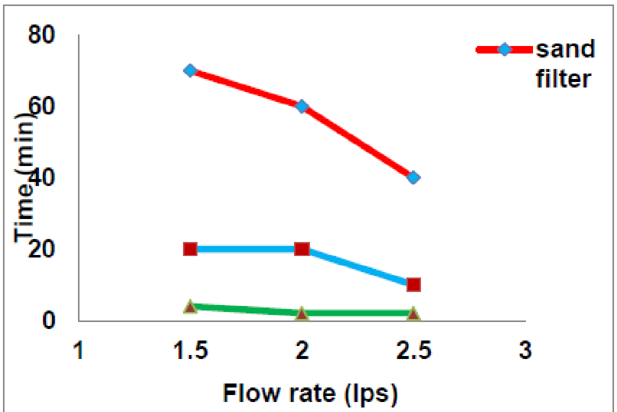

Fig. 1 (d) Time required for 5 m pressure drop across different flow rates with 400 ppm concentation of impurities

Table 2 shows that maximum efficiency was found with lower contaminant concent ration (100 ppm) as compared to higher contaminant concentration (400 ppm). Maximum and minimum filtration efficiency obtained. In screen filter the time required to develop 5 m of pressure drop is varying between 60 min. to 10 min. for all the four concentration of impurities. The time required to develop pressure drop of 5 m is decreasing with increasing flow rate and also with increasing level of concentration of impurities.

In disc filter the time required to develop 5 m of pressure drop is varying between 10 min. to 2 min. for all the four concentration of impurities. Disc filter clogged in 2 min. for 2.5 lps flow rate with contaminant concentration of 400 ppm. Kamble (1989) observed the similar trend.

The data is also presented in Fig. 1(a), Fig. 1(b), Fig. 1(c) and Fig. 1(d) depicts that the time required for 5 m of pressure drop was maximum in sand filter followed by the screen filter and disc filter, respectively.

It is also observed that the time required for 5 m pressure drop decreases with increase in the flow rate for all the three filters. The pressure drop across the filter increases with increase in discharge passing through the filter using water with impurities. Further they also observed that the head loss across the filter was more for water with impurities than the head loss across the filter with clean water for all the filters (Nikam and Matche, 1989). This is due to higher filtering efficiency of disc filter than screen and sand filter, respectively. From the Fig. it is clear that time required to develop 5 m of pressure drop across filters was maximum with lower concentration of impurities and minimum time required in higher contaminant concentrations.

The rise in head loss is associated with filtration velocity and rise in head loss becomes steeper with concentrations (Adin and Alon, 1986). In disc filter 5 m of pressure drop occurs quickly as compared to sand and screen filter.

CONCLUSIONS

Filtration efficiency of the disc filter was found maximum, followed by screen and disc filter. Time required to develop 5 m of pressure drop across the disc filter was minimum, followed by screen and sand filter. Comparative study shows that disc filter was better than screen and sand filter to remove the suspended impurities, but it requires more frequent cleaning for efficient and reliable performance.

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