Application of Roughing Filters as Pretreatment Systems in Sri Lanka

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Abstract: - Most of the existing slow sand filters are without pretreatment and some of them have already abundant due to lack of pretreatment. Roughing filter is a very simple and community manageable system. Hence this is an appropriate technology for rural water supply schemes. Use of roughing filters started in early 80s in Udatenna water supply scheme. As the initial applications were failed, field trials were carried out to improve the system with recent developments in filter technology.

There are three main types of filters, namely the Horizontal flow, Upflow and Downflow. Until recently, only horizontal flow filters (HRF) were used and therefore some field trials were done to assess the suitability of other filters as pretreatment systems.

The field tests carried out in Anuradhapura sacred city water supply scheme have shown that the HRFs has an ability to remove algae up to about 85% at 1.5m/h filtration velocity. The turbidity and colour removal is about 50%. In this test, granite was used as filter media for one filter and found that there is no significance difference between granite and pebbles.

In a performance comparison study carried out at Udatenna scheme to compare the performance of HRF and Intake Type down flow filter, it was found that the Use of intake type filters are economical than HRF in removal of turbidity, suspended solids and colour in low turbid mountain streams.

Study of application of Intake and Dynamic filters for high turbid raw water was carried out in Ukuwela Water treatment plant. It was found that the removal efficiency of turbidity decreases with high turbidity and it is economical to operate filtration velocity between 1 and 2. m/hr. Average reduction of turbidity is about 40% at this velocity. Average reduction in turbidity at higher velocities is about 25%.

In conclusion it can be started that the Horizontal flow and Intake roughing filters are very effective in removal of suspended solid & turbidity in low turbid raw water. When Dynamic filters are used in high turbid water, an additional pretreatment should be used before slow sand filtration.

01. Introduction.

Most of the existing Slow Sand filters are without pretreatment and some of these filters are not being used due to lack of pretreatment. Roughing filters are very appropriate systems if it is properly design and constructed. Therefore some field trails were carried out in three existing slow sand filter sites at Anuradhapura Sacred City, Udatenna and Ukuwela to assess the suitability of roughing filter for different pretreatment applications.

2.0 Horizontal flow filter for Algae removal.

Testing of 6m. Long HRFs was carried out in Anuradhapura Sacred City water supply scheme. This filter had 3 compartment filled with three different size of filter media and filter was tested for Algae, Turbidity and Colour removal at different filtration velocities. Two filters with granite and pebbles as filter media were also tested for suitability of granite as filter media.

According to the result (Fig.3), it was found that the an 85 % algae counts removal could be achieved while 55 – 60% colour & turbidity being removed. The best economical operating velocity is around 1.5 m/h. There were no significant differences in performance between granite and pebbles filter media.

3.0 HRF and Intake filter for low Turbidity Water.

Existing HRF at Udatenna scheme was not functioning due to some cleaning problems. Therefore it was modified with the new design guideline and tested for turbidity, colour and suspended solid removal. It was found that the filters are very efficient in turbidity and suspended solid removal in low turbidity sources with short peaks.

However capacity is low when compared to the size. Therefore similar size Intake filter was constructed by modifying an existing old HRF and tested both filters to compare the performance. In this test it was found that (table 2,fig.4&5), 3 –4 time higher capacity could be achieved in Intake type filter with a 10 – 15 % less removal efficiencies in Turbidity, SS and colour. Also it was noted that the behavior for turbidity peaks are similar. Hence intake filter is much more economical.

4.0 Application of Intake / Dynamic filters for high turbidity Water.

Since there is no experience in application of Dynamic filter operating at higher filtration velocities, a pilot scale test was carried out at Ukuwela Scheme. In this test, it was noted that the removal efficiency of turbidity decreases with the Increases of raw water turbidity and filtration velocity. The removal efficiency of turbidity of Dynamic filter is about 25% at higher velocities (fig.6). The removal efficiency of suspended solids increases with raw water suspended solid levels (fig.7) and about 50%removal could be achieved. Velocity below 2 m/hr, Intake filter has a better removal than Dynamic filter.

5.0 General Discussion.

In the experiment carried out at Anuradhapura Sacred City. It was found that, very high percentage of algae population could be removed. However, later it was noted that remaining algae is grown in the slow sand filter due to the favorable environmental conditions for alga growth in dry zone area. Therefore an additional treatment should be introduced to remove at least one of the other factors necessary for algae growth such as nutrient, sunlight etc. Therefore use of slow sand filters for dry zone tank water should be further studied.

In general, the slow sand filters are used for raw water having turbidity below 10 NTU with short peaks. However due to the human activities in upper catchments, most of the existing sources need pretreatment. In these tests, it was found that roughing filter alone is sufficient to provide drinking water after chlorinating. There may be few occasions where the quality is not up to the standards. The cost of a roughing filter is about one tenth of a slow sand filter. Therefore, in limited funding situation or phase out implementation it may be worth to construct roughing filter in the 1st stage while keeping the provision for slow sand filter for the 2nd stage. This aspect should be considered in the design of a water supply scheme.

As a general practice, pebbles collected from riverbeds are used as filter media. This creates another environmental problem and also the pebbles are very expensive. Therefore the metal used for building industry is a cheap alternative for pebbles and also it is available all over the country.

According to the test results of the Dynamic filter, the removal efficiency of turbidity is low and cannot be used directly with Slow Sand Filter in high turbid water. However it can be used as the first unit in the multi barrier treatment system for high turbidity water.

There is no experience in upflow filters (URF) in Sri Lanka. However In some preliminary trials carried out with this system, it was found that the hydraulic cleaning system of URF is very efficient compare to the other type of roughing filters. Therefore this system may have less maintenance problems. Hence the study of these systems should be done to assess the possibilities of application in Sri Lanka.

06. Conclusions & Recommendations

- Horizontal flow and Intake type roughing filters are appropriate pretreatment systems for low turbid raw water having short turbidity peaks.
- In phase out construction it is advisable to construct roughing filter in the 1st stage and then the slow sand filter.
- Intake filters are much more economical than HRF for mountain streams having low turbidity.
- Dynamic filters should be used with additional pretreatment system in high turbid water.
- Granite could be used as filter media instead of pebble in roughing filters.
- Studies should be carried out for application of upflow filters.

Reference

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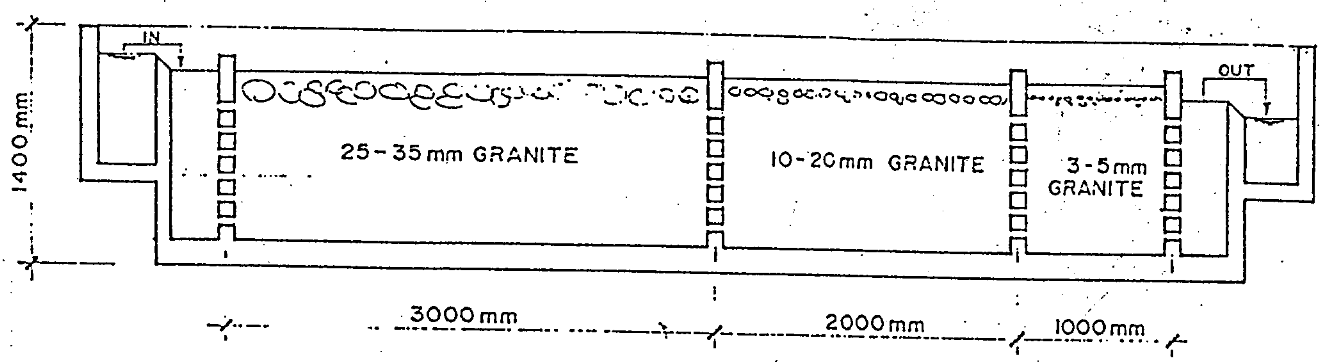


Fig-1 LONGITUDINAL SECTION OF THE HRF

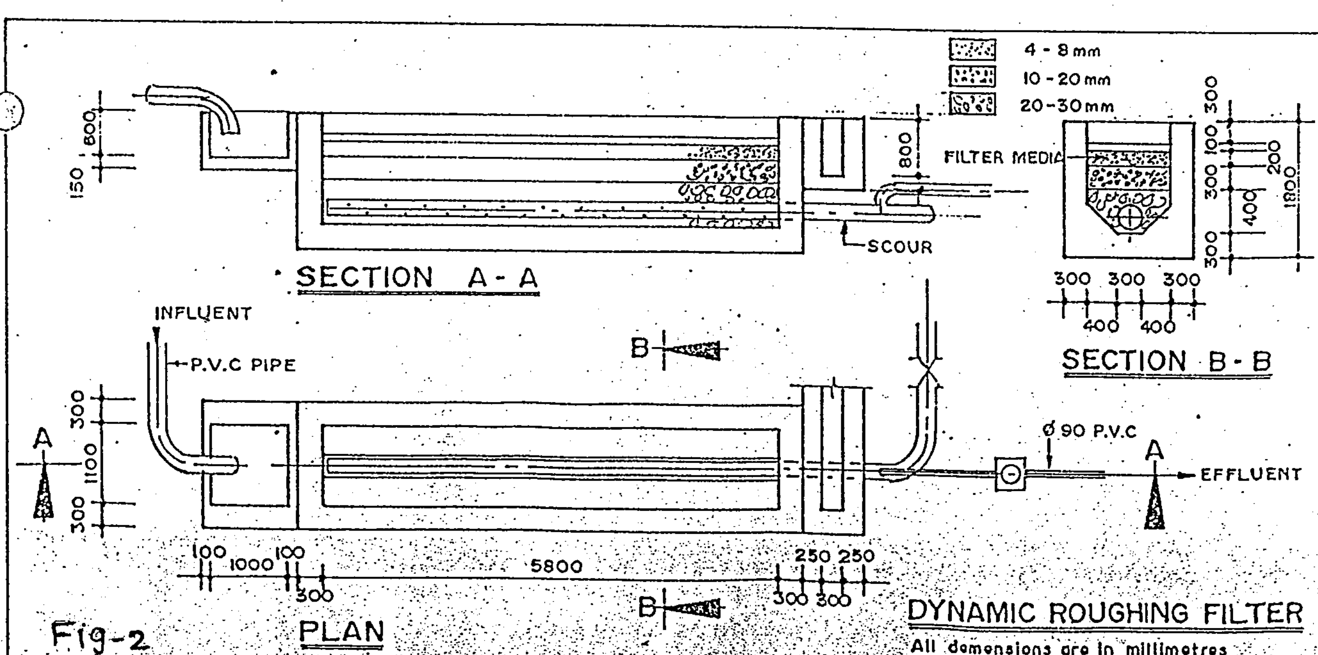


Fig-2

Table 1. Variation of Algae count, colour and turbidity along actual filter at 1.5 m/h. velocity.

	Algal Count	$(*10^5)$/ml	Colour	(Pt-Co)mg/l	Turbidity	FTU
Inlet	129	95	215	204	38	34
After 1st Filter media	32	26	106	98	19	19
After 2nd Filter media	25	21	97	86	17	14
out let	15	12	83	82	14	14
% Reduction	88.3	87.3	61.5	63.1	58.8	50.0

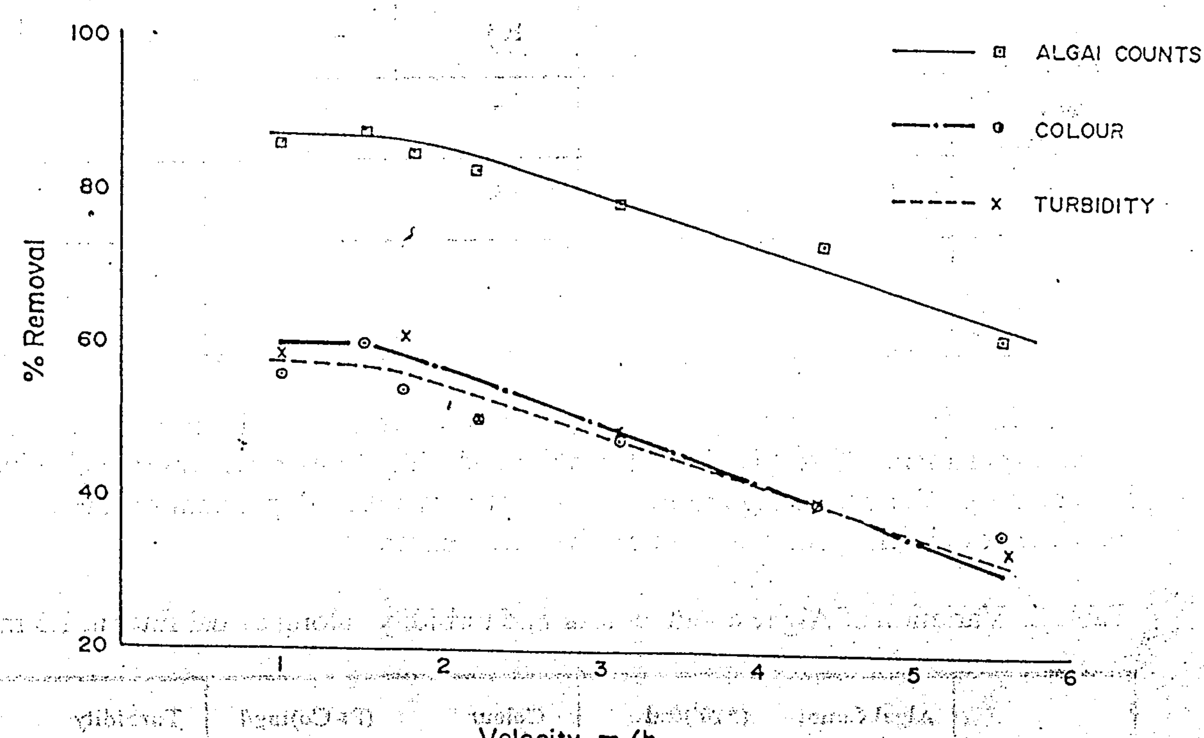


Fig-3 - Variation of Percentage removal with Flow velocity

Table 2 - Percentage reduction in Turbidity Suspended solids and Colour.

	Intake filter	HRF
Turbidity	40 - 85	50 – 90
SS	35 – 80	40 – 80
Colour	40 – 80	50 – 95
Capacity(m^3/hr)	30	7 – 11

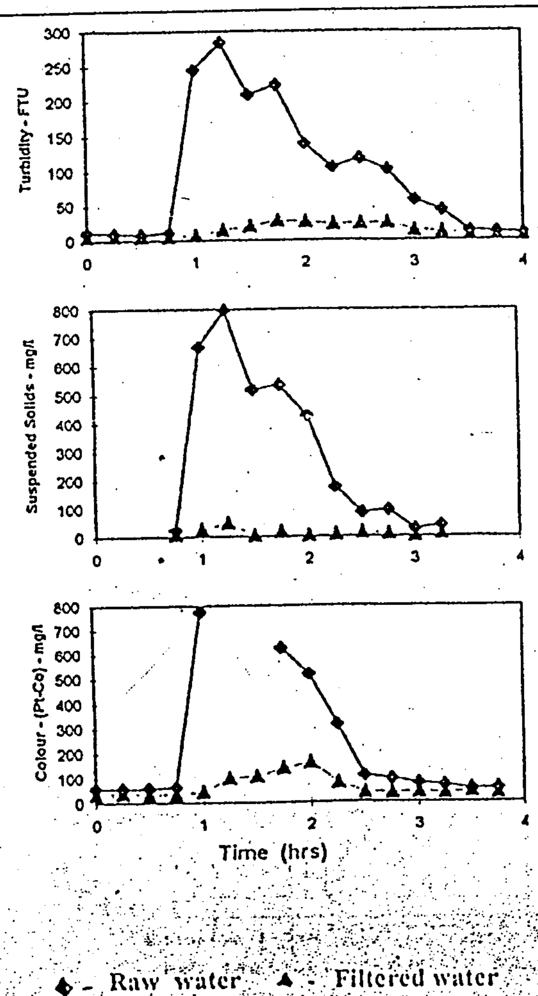


Fig 4 Behaviour of the IRF during a rainy weather

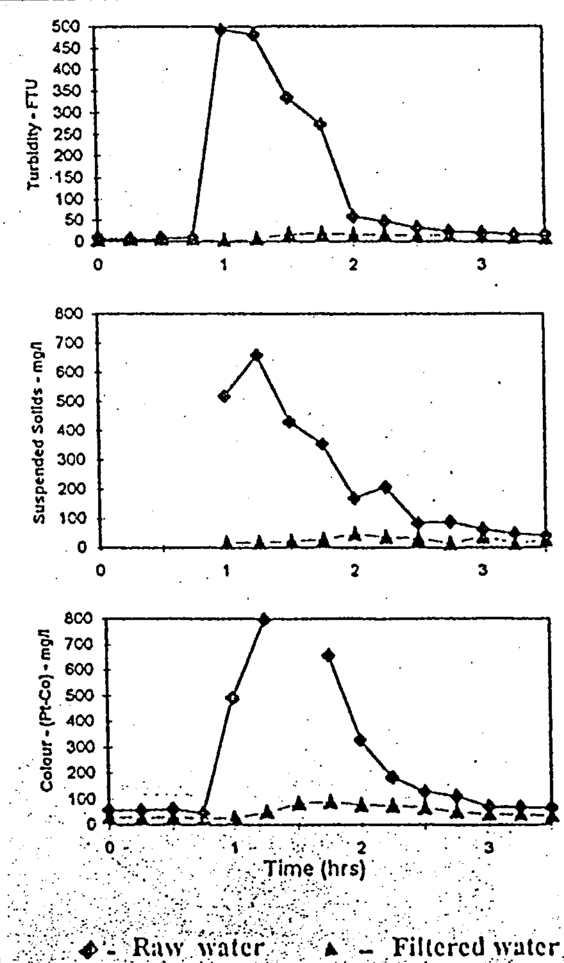
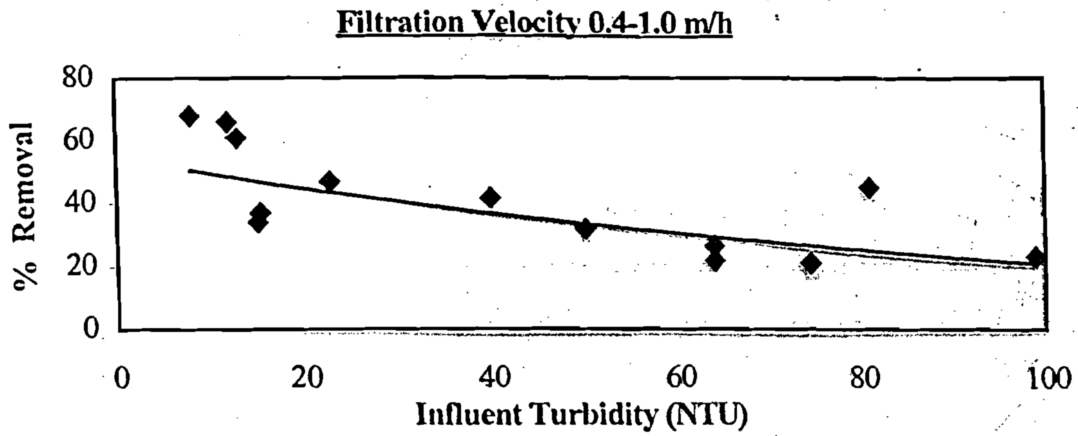
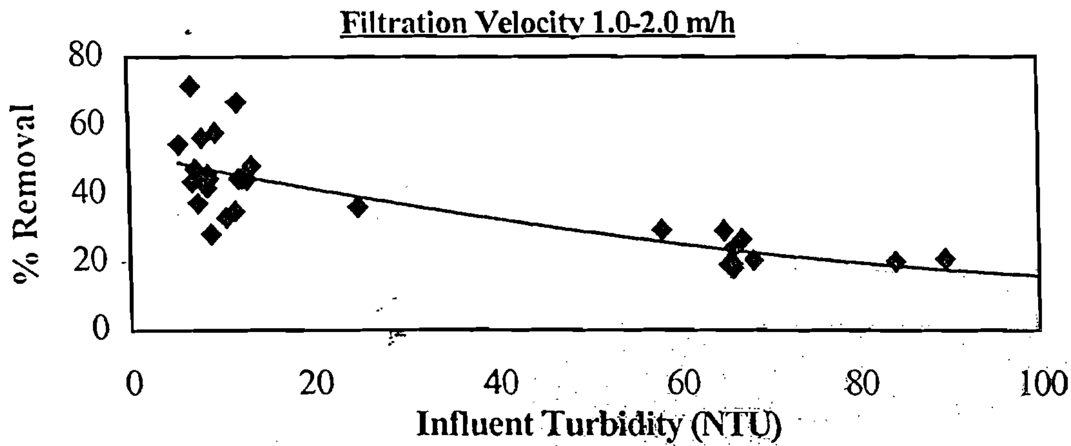


Fig 5 Behaviour of the HRF during a rainy weather





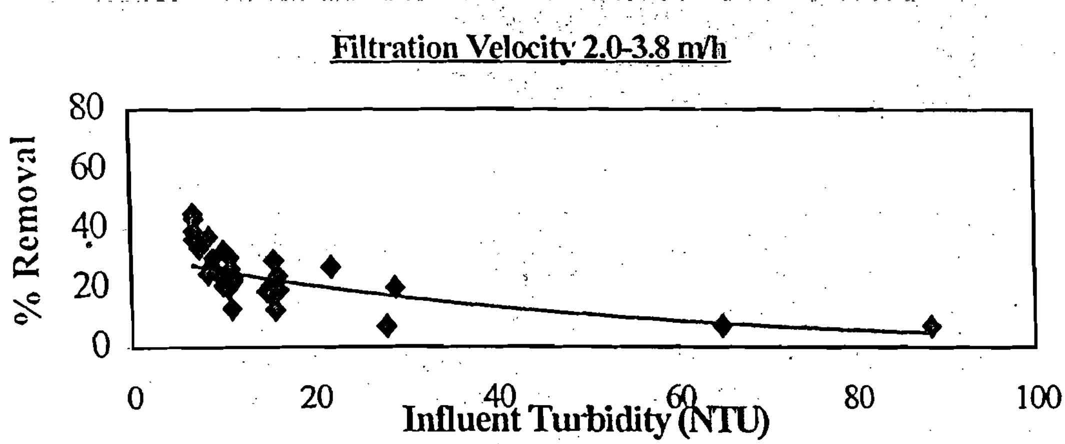


Fig 6. *Turbidity removal at different filtration velocities*

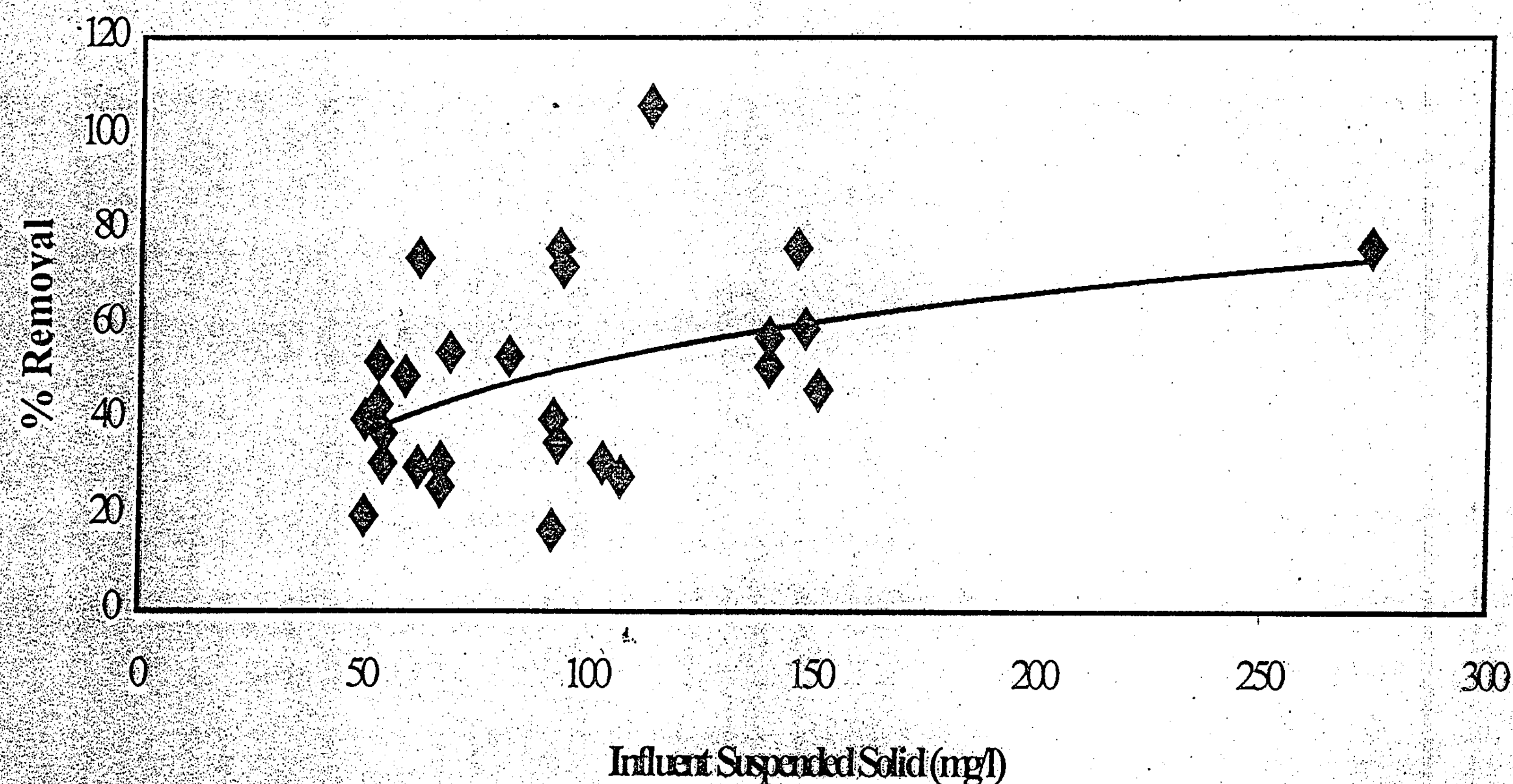


Fig 7 *Removal of suspended solid* - DYNAMIC FILTER