

This item was submitted to [Loughborough's Research Repository](#) by the author.  
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

## On-site water treatment

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

© WEDC, Loughborough University

VERSION

VoR (Version of Record)

PUBLISHER STATEMENT

This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at:  
<https://creativecommons.org/licenses/by-nc-nd/4.0/>

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Nath, K.J., S.D. Badrinath, and S.N. Kaul. 2019. "On-site Water Treatment". figshare.  
<https://hdl.handle.net/2134/28921>.



**WEDC** 12th Conference: Water and sanitation at mid-Decade: Calcutta 1986

K J Nath, S D Badrinath, S N Kaul

## On-site water treatment



### ABSTRACT

Water Supply Programmes in many developing countries have evolved gradually. A wider variety of onsite system designs are available for treatment of surface water. The type of treatment systems built often reflects the experience and preference of the designer. The various criteria for selection are public health considerations, cost, ease of operating and maintaining the treatment system. This introduces the necessity to initiate and follow up organised studies on novel water treatment techniques at a level that could be considered well within the scope of technical and equipment resources of the developing countries. In this paper, authors present experimental details of upflow clariflocculation unit with cost consideration.

### INTRODUCTION

Water should be filtered and protected against contamination to prevent from water-borne diseases. The approach of World Health Organisation is that the International Water Supply and Sanitation Decade (1981-1990) programmes must contribute to the implementation of health care. Water supply, storage and treatment should be associated with other areas of health development.

Water treatment has the object of removing undesirable dissolved, suspended and toxic or pathogenic materials from water. Many scientific processes are available. A wide variety of onsite system designs exists from which, proper selection of the most appropriate treatment techniques is required for a given raw water conditions. The primary criteria for selection of one design over another is the protection of the public health. Second criteria

are cost, ease of operating and maintaining the system. To achieve these goals, the developed countries are using units involving several new mechanical features, such as, heavy duty pumps and advanced water treatment methods. These methods, however, require skilled attention and are therefore inappropriate for developing countries.

The conventional rapid sand filter with its pipe gallery and filter rate controllers do not provide middle level communities due to frequent breakdown of the mechanical units, viz. gadgets used for backwashing operations, rate controllers etc. Obviously this indicates the need to try out a modified adaptation of these new processes at a level that could be considered well within the scope of available technical equipment resources in addition to cost considerations. The studies reported in this paper were undertaken in this context and aim at developing appropriate technology for effective method of treating surface water for middle community levels.

### LITERATURE REVIEW

Upflow solids contact clarifier which is used for water treatment, basically functions like a sedimentation basin. The earliest known units in the country were reported to be used in industry in conjunction with softeners in 1933(1). Since then only occasional applications were reported for community uses. However, the literature from abroad indicates certain precise developments under various trade names(2). These are sophisticated and their performance have been reported(2). The use of upward flow pebble bed clarifier which has been developed under similar lines has also been reported by Sparham(3), where this concept was

extended to the field of polishing treatment of wastewater effluents for solids removal. In the background of the encouraging results obtained from the above unit treatment processes, it was decided to undertake a pilot plant study to evaluate the design of a upflow clariflocculator.

#### EXPERIMENTAL SET UP

The pilot plant illustrated in Fig. 1 includes the basic unit operations such as, flash mixing, flocculation, clarification and filtration and introduces the concept of progressively reducing velocities of flow through this unit.

The squarish unit consists of a hopper bottom inclines at  $60^\circ$  to horizontal with rectangular brick work of 1.5 m x 1.5 m x 2.65 m.

The unit is filled up with the available local material of broken stones and pebbles. The grading and the depth of coarser materials are detailed in Table 1.

TABLE 1 - MEDIA COMPOSITION

Media Size (cm)	Depth (m)	Specific Gravity
10.0-12.5	0.75	2.65
5.0-10.0	0.30	2.65
2.0- 4.0	0.30	2.65

The combined porosity of the media works out to 0.47. A perforated PVC pipe grid of 50 mm and 37 mm was laid at a height of 0.3 m over the pebble bed. Water depth of 1 m over the rock pebble was maintained in the plant design. A stoneware pipe of 0.3 m dia. for 0.6 m height with control valve arrangement was used as an alum doser.

#### FUNCTIONAL CONCEPT

In operation, raw water with coagulant enters at the hopper bottom and rises through the bed of granite stones and rock pebbles.

A 10.0 to 12.5 cm stone layer helps in mixing and micro-floc formation. The subsequent layers help in promoting a mutual collision of flocs and their coalsence. Because of the gradual increase of the cross sectional area of the tank, velocity of flow gets progressively

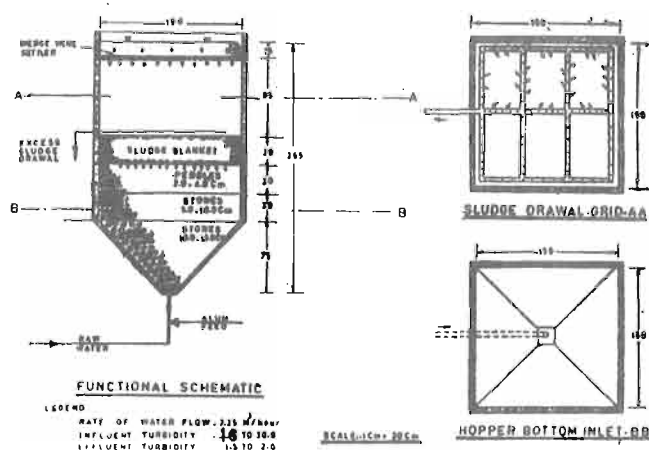


FIG. 1

decreased in its passage through the plant. This helps in further agglomeration of the flocs which remain suspended in a condition of equilibrium on exit from the media so long as the upflow velocity of the water equals the settling velocity of the floc particles. The newly formed flocs get continuously absorbed on older flocs and this allows only the clarified water to escape from the tap.

However, an excessive accumulation of these flocs is found to lead to a gradual deterioration in the quality of the final water. Under such conditions, the excessive sludge is removed by the opening valve of PVC pipe grid system at intervals which are usually once in 15 days.

## RESULTS AND DISCUSSION

The experiments were carried out in three phases, using surface raw water having turbidity levels of 16-30 mg/l. In the first phase, the flow rates of 32, 35 and 45 m<sup>3</sup>/day were tried with two independent alum doses of 30 mg/l and 35 mg/l. Turbidity and temperature variations were recorded for about 25 days for each combination of flow and alum doser. The temperature of the raw water during experiments was in the range of 32°C and 38°C. Jar test experiments were conducted to fix optimum alum dose. The optimum alum dose was in the order of 40-50 mg/l. The microflocs attract the newer flocs in the void space and therefore, the alum dose was tried still at lower levels. The results indicated that with an alum dose of 30 mg/l, the average per cent turbidity removal was of the order of 60, 67 and 58 per cent for the flow rates of 32, 35 and 45 m<sup>3</sup>/day respectively. With the increased alum dose of 35 mg/l, the percentage removals were of the order of 63, 65 and 65 respectively. When an optimum alum dose of 50 mg/l was tried, there was an excessive formation of sludge flocs from the sludge blanket zone. This indicated that a suitable combination would be 35 m<sup>3</sup>/day flow rate with 30 mg/l alum dose or alternatively, 45 m<sup>3</sup>/day flow rate with 35 mg/l alum dose.

In the second phase, fly ash in combination with alum dose was tried to the above successful combination. The results of these studies indicated that a slight improvement in turbidity from 67 to 70 per cent was obtained with 35 m<sup>3</sup>/day flow rate with alum dose of 30 mg/l and also the carryover flocs were minimised in this system.

In the third phase of experimentation, a screen mesh with 0.125 mm square openings was used over the top of the sludge blanket. The mesh was fixed to a peripheral wooden frame which was introduced into the unit, at 150 mm below the effluent launder. The results were found to be encouraging as shown in Fig. 2, which indicates higher turbidity removals. The unit under these conditions was found to be satisfactory from operational and maintenance point of view. The cleaning of the screen when found necessary was achieved by lowering the water level in the unit upto the sludge blanket.

## COST CONSIDERATIONS

The treatment cost for this unit is of the order of Rs. 0.45/m<sup>3</sup> for effluent turbidities in the range of 1.5 to 2.0 mg/l with raw water turbidities of 16-30 mg/l. Under similar conditions, conventional treatment involves clariflocculation and filtration and costs Rs. 1.00/m<sup>3</sup>. Further such minimal turbidities as 1.5 mg/l could not be arrived by the conventional treatment system. The benefit cost function for both these systems, considering the per cent turbidity removal and the unit cost/m<sup>3</sup> compares at 9:2 indicating a reasonably good degree of performance and reliability of proposed process.

## CONCLUSIONS

- 1 The method developed can effect turbidity removals of about 85 per cent with effluent turbidities in the range of 1.5-3.0 mg/l from raw water turbidities of 16-30 mg/l.

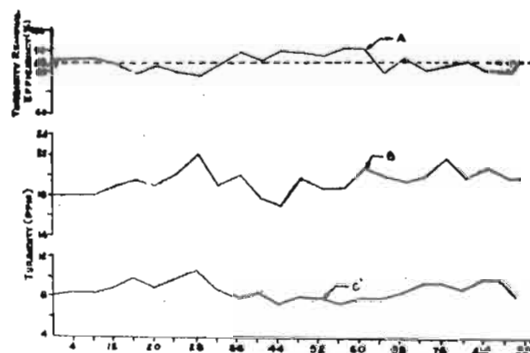


Fig. 2: Performance of the unit with Wedge Wire Settler At 35 m<sup>3</sup>/day, 30 mg/l Alum dose  
A—Turbidity Removal, B—Influent Turbidity, C—Effluent Turbidity.

- 2 The unit encompasses all the basic unit operations, like flash mixing, flocculation, clarification and filtration in a single unit. The cost of treatment by this experimental unit will be around Rs. 0.45/m<sup>3</sup> as against Rs. 1.00/m<sup>3</sup> for conventional clariflocculation and filtration units.
- 3 Multiple units can be provided for large capacities, if need be.

#### ACKNOWLEDGEMENTS

The authors are thankful to the All India Institute of Hygiene and Public Health, Calcutta and the Tamil Nadu Water Supply and Drainage Board, Madras for providing necessary facilities for carrying out the experimental study.

#### REFERENCES

- 1 Arceivala, S.J.  
'Upflow Solids Contact Tanks'  
Proc. Symp. on Problems of Water Treatment, CPHERI (India), 1964, 265.

- 2 Badrinath, S.D.  
'An Economical Upflow Clarification Unit for Surface Waters with Low Turbidities'  
IWWA, 1977, July/Sept., 233.
- 3 Sparham, V.R.  
'Improved Settling Tanks Efficiency by Upward Flow Clarification'  
J. WPCF, 1970, 302.