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Review on A New Concept in Water Treatment- Pebble Bed Flocculator

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SYNOPSIS

Provision of safe and adequate drinking water to rural communities is a herculian task since majority of the population lives in rural areas in India. Realising the need for providing adequate water supply, Government of India has set a target to cover 100 per cent population, both rural and urban, by the year 1990. With the limited financial resources and other constraints, it is of vital importance to develop appropriate technologies, for the treatment of water in order to meet the decade target. "Pebble bed flocculator" is one of the appropriate methods of water treatment. It needs no mechanical equipment nor skilled supervision. It is easy to operate.

The present review highlights the advantages of pebble bed flocculator alongwith the past work done on the process. Future research needs have also been presented in the paper.

1. INTRODUCTION

The International Water Supply & Sanitation Decade (1981-90) has been declared by the United Nations with a view to provide safe drinking water to the entire urban and rural Population on global basis. The rural population of India being about 80% of the total population, highest priority is being given to the problems of rural water supply schemes at national and international level. This aspect has also been included in the 20 point programme of our Hon'ble Prime Minister.

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2. NEED FOR NEW TECHNOLOGIES

The provision of adequate and safe drinking water to the growing population has been a challenging problem due to limited financial resources. The technology which is "appropriate" in a developed country becomes "inappropriate" in a developing country due to economic considerations. Besides economic considerations, there are other problems such as lack of trained manpower and poor operation and maintenance in rural water supply schemes. So, there is a need to develop new appropriate treatment technologies which are economically viable, scientifically sound, technologically feasible and socially acceptable.

One of the aims of research in the field of water treatment has been to evolve methods of bringing about the reduction in the cost of treatment. The use of conventional treatment methods of water purification based on sedimentation, rapid sand filtration, disinfection, etc. are not always justified either economically or from the health standpoint. New processes requiring less capital costs would be valuable in developing countries which have limited financial resources. The increasing cost of energy in conventional treatment units, will doubtless have an impact on water utility practice. More efficient treatment processes using less energy are the need of the day. In many plants, changes in mixing, flocculation and settling can improve the quality of treated water or increase the plant capacity without resorting to dual or multimedia filtration.

3. PEBBLE BED FLOCCULATOR

Pebble bed flocculator is a simple, economical and unconventional treatment technology. It occupies an important place in the list of 'Research Priorities' for the rural water supply schemes. The research is aimed at minimising the equipment requirements, reducing the capital costs, with additional benefit of easy operation and maintenance.

In pebble bed flocculator, the column is filled with pebbles of suitable size. Mechanical equipment like rotating paddles in conventional clarifies is totally absent. (Fig. 1). The unit is easy for

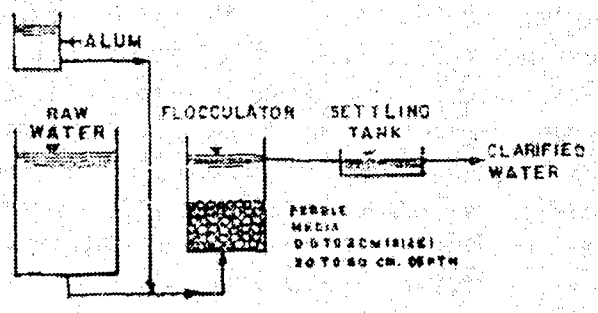

Fig. 1: Pebble Bed Flocculator.

operation and maintenance by the local population with no need of skilled supervision. This can be operated with minimum head of water and is most suitable for rural communities. In addition, the pebble bed flocculator has following advantages over the conventional unit :

(i) It is simple to construct using locally available material and labour which results in costs low enough to be affordable to low income rural inhabitants.

(ii) Operation and maintenance is easy since mechanical parts are totally absent. Complex mechanised system in conventional flocculator makes the operation and maintenance more difficult and beyond the reach of average village organisation.

(iii) It has reliability of operation with good performance efficiency with regard to water quality to meet the requirements. It is useful to meet the community needs.

(iv) All the above advantages will result in lower annual cost than more complex treatment methods which require skilled manpower for supervision and maintenance.

Table-1 shows the comparison of pebble-bed flocculator with conventional flocculator.

4. LITERATURE REVIEW

Bhole and Vaidyanathan[1] conducted studies on pebble bed flocculator using the principle of tapered velocity gradient. The unit consisted of 60 cms long PVC pipe. Pebble of sizes 0.5 cms to 1 cm, and 1 cm to 2 cm, were used for a depth of 60 cms. The model was tested for various rates of flow and raw water turbidities. The results indicated that irrespective of the rate of flow and raw water turbidity, the residual turbidity of the flocculated water, after 15 minutes of settling, was 4 NTU. The floes formed were more dense and compact which could be easily settleable in sedimentation tank. On an average, 80 per cent coliform removal was obtained. On 24 hours performance basis, total coliform removal was 98 per cent. The accumulation of the floes over the pebble-bed was not appreciable and floes did not spread over the significant height over the pebble-bed. The results proved that the pebble-bed flocculator, with tapered velocity gradient, can be expected to give more stabilised performance.

A pebble-bed flocculator consisting of pebbles of size 1 cm to 2 cm and the depth of bed of 50-60 cm was tried by Kardile[2] at Ramtek Water Works near

TABLE 1: COMPARISON OF PEBBLE BED FLOCCULATOR WITH CONVENTIONAL FLOCCULATOR

Item	Conventional flocculator	Pebble Bed flocculator
1. Unit	Concrete tank with mechanical devices	Vertical column with simple graded gravel of 0.5-2 cm size and 50-60 cm deep
2. Use of external energy	Yes. Required for driving unit	Not Required
3. Cost of Construction	High	Low
4. Operation and Maintenance	Speed of the drive unit has to be adjusted at optimum speed to obtain good dense floc. Maintenance is costly & time-consuming. Replacement due to wear & tear of machinery, Lubrication of bearings, and drive unit. Repairs to motor, reduction gear unit, starters, etc.	Operation is easy. Since mechanical parts are absent, maintenance is easy
5. Supervision	Skilled supervision is required	Skilled supervision not required
6. Retention time.	3-40 Minutes	3-5 minutes
7. Suitability	Suitable for large capacity plants	Suitable for small capacity plants of 2-5 MLD capacity. Can be used upto 10 MLD plants. Suitable for rural areas
8. Flash mixing	Required. Provision of mechanical flash-mixer is necessary	Mechanical mixing not required
9. Method of Cleaning	Desludging at frequent intervals by telescopic sludge pipe or by intermittent pumping	During backwashing the unit gets cleaned up

Nagpur. The flow was maintained from bottom to top. The unit is giving encouraging results and working satisfactorily at Ramtek.

Bhole[3] et al carried out studies on sand media flocculator using coarse sand of size 4-5 mm. A media depth of 40 cms was found to achieve satisfactory flocculation. The flow was from bottom to top and intensity of agitation was constant throughout the depth of bed. The removal of floc was achieved by flocculation and the sludge blanket was formed above the sand bed.

Kardile[4] conducted studies on gravel bed flocculator-cum-tube settling tank at Chandori village in Maharashtra. The pre-treater unit was of the size 4 m × 2.2 m with 3.6 m overall depth. Graded gravel of 20-50 mm size for a depth of 1.5m was used. The tube settler zone consists of a layer of rigid PVC square tubes of size 50 × 50 mm and 60 cm height which were fixed at 60° angle in the form of modules of size 0.3 m, 0.5 m height and 4.1 m length. Surface loading on the gravel bed was kept at 4500 lit/m²/hr and volumetric loading was 643 lit/m³/hr. The head-loss was observed between 2-3 cm throughout the runs. Turbidity of treated water was found to be 23 JTU with an average turbidity removal of 77%. On an average, 91% reduction in coliform count was obtained. The results of the studies revealed that for low turbidity waters (below 100 JTU), tube settlers may not be required. The unit should offer a solution to replace the conventional pre-treatment process for the small capacity plants.

Patwardhan[5] conducted studies on gravel bed flocculator and found dense flocs by passing pre-coagulated turbid water through a 4 mm gravel bed (600 mm deep) at a rate of 24 m³/m²/hr. This flocculator has no moving parts and will need very little maintenance.

Bhole, Deshpande[6] et al conducted studies on expanded bed flocculator. The tests were conducted on the suspension made from black cotton soil. It was found that for turbidities less than 100 ppm, variation in the expansion does not play significant role in flocculation, but removal of turbidity is high for greater values of turbidities. Lesser expansions were found to be much effective in reducing the concentrations. 10 per cent expansion of sand column and sand size of 0.3-0.35 mm gave optimum performance in turbidity removal.

T. C. Shea[7] conducted experiments on contact flocculation. The experiments demonstrated that with proper combination of media chemical addition and operating procedure, a contact flocculation system can effectively remove suspended solids from the turbid water and produce high quality effluent. Contact flocculation was found to be a technically feasible process for water clarification and can compete favourably with conventional system of flocculation, sedimentation and filtration when the suspended solids concentration of raw water is low.

5. RESEARCH NEEDS

Based on the review of earlier work done on pebble bed flocculator and the encouraging results obtained, it is of vital importance to look into further research on the aspect with the objectives given below :

1. To develop models of pebble bed flocculator with other accessories.
2. To study the performance of contact flocculators with varying media depth, size, gradation and rates of flow. In order to study the effect of fluctuating water turbidity, the unit can be operated covering the entire period.

3. To evolve and develop relationships between the various controlling parameters of flocculation process i.e. velocity gradient, detention time, floc size and head-loss.

4. To evolve physical and kinetic parameters so as to optimise the system which could give desirable results with minimal investment.

6. CONCLUSION

Pebble bed flocculator is one of the simplest and best suited method of flocculation with no mechanical parts. From the review of past research work, it is revealed that the unit can function satisfactorily without the need of skilled supervision and maintenance. Hence, it is most suitable for rural water supply schemes. There is scope to go in for in-depth studies on the functional aspects of the unit so that it can still be cheaper than the conventional treatment units.

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