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Effect of Water Depth on Infiltration in Clogged Ground Water Recharge Basin

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Abstract—*A study has been made on the effect of different types of clogging materials ie organic and inorganic as well as the combination of both. When the water depth in basins containing clogging material is increased, the clogging layer is compressed. This causes infiltration rates to increase much less then expected from the water depth increase alone.*

1. INTRODUCTION

Artificial ground water recharge is of vital importance in present scenario to augument ground water table. This technique can be brought into application when surplus water is available at a period and stored water is to be used to overcome the water shortage at any other period of the year. Also this technique provides us the most suitable storage efficiency as the water once enters the aquifer, there are no chances of evaporation and pollution. Recharge also gives additional purification of water by filtration through the underground treatment (soil-aquifer treatment).

Major problem which is influencing artificial recharge basin is choking of its surface through sediments or clogging particles. So, their presence cannot be overruled

2. LITERATURE REVIEW

- Xi Chen, Zhi-Cai Zhang, Xin-Nan Zhang(1994) ; Compared ground water recharges from two precipitation events with different initial soil moisture content. A multi layered soil moisture model was used for simulating soil moisture dynamics and ground water recharge and losses.
- J.Trilla and J.Estalrich(1988); Evaluated artificial recharge need of an aquifer (Ridaura, Spain). Considered aquifer working in the same manner as surface storage, using probabilistic approach.
- Herman Bouwer, Jennifer T. Back and James M. Oliver; predicted infiltration for Artificial Recharge using Double Ring Infiltrometer.
- Herman Bouwer, R.C Rice ; as the water depth is increased on already clogged basin, permeability decreases due to the compression of clogging layer.

3. CASE STUDY AND OBJECTIVE

In mine research work a model is prepared to bring in the field conditions of artificial recharge site to :

1) know about the variation of impedance through clogged recharge basins with variation in water height above.
2) find if the variation of infiltration is same or different for organic, inorganic clogging material or the combination of both types of clogging material with varying water height above.

Experimental Setup: Model consists of transparent Acrylic pipe of 200 cm height, dia 10cm.

Cross sectional area=78.5cm^2 . Pipe was closed from bottom with PVC cap. A hole is made at its centre to drain out water. Pipe is calliberated from 0 to 200cm with every 5cm interval.

It is filled upto 6cm from bottom with gravels for the free drainage of water and upto 130 cm mark with sand passing 1.13 mm sieve. Remaining head of 70 cm is left for water.

Two piezometers are installed at 120 cm and 105 cm level, to know the water head variation at respective positions, for the calculation of Impedance.

Impedance: It is the opposition offered to the flow of water and is calculated as Head loss divided by infiltration.

Having dimension: Length/(Length/Time)=Time.

4. METHODOLOGY

Now Sand is Saturated with water for continuous water supply for 1 hour, till the drawdown becomes constant, now following concentrations of organic and inorganic clogging materials was made in water.

1) Concentration of Clayey Water 1g/l, upto195 cm ie 65 cm head.
2) Concentration of Algae Water 1g/l, upto 195 cm ie 65 cm head.
3) Concentration of Clay and Algae 1g+1g/l, upto 195 cm ie 65 cm head.

As the Cross sectional area for the pipe is 78.5cm^2. So, volume of water upto 65 cm height = 78.5X65=5.1 litres. So, the concentration is mixed accordingly.

Experiment 1 : Concentration of clayey water 1g/l.

S. No.	Water Level (cm) X	Time (min) t	Piezometric Head at 120cm (H)	Impedance for H Z {(X_n-H)/5}Xt
1	190	0	175	-
2	185	7	170.5	20.3
3	180	5	166.5	13.5
4	175	4	161.5	10.8
5	170	5	157	13
6	165	5	151.5	13.5
7	160	4	147	10.4
8	155	6	140.5	17.4
9	150	7	134.5	21.7
10	145	6	129.5	18.6
11	140	6	124	19.2
12	135	6	120	18
13	130	7	-	-

A picture showing clayey water conc.

Experiment 2 : Concentration of Algae Water 1g/l.

S. No.	Water Level (cm) X	Time (min) t	Piezometric Head at 120cm (H)	Impedance for H (Z1) {(X_n-H)/5}Xt
1	195	0	177.5	-
2	190	5	173	17
3	185	4	168	13.6
4	180	5	163	17
5	175	4	159	12.8
6	170	5	155	15
7	165	5	150	15
8	160	5	144.5	15.5
9	155	5	140.5	14.5
10	150	6	135	18
11	145	7	130.5	20.3
12	140	5	126	14
13	135	6	121	16.8

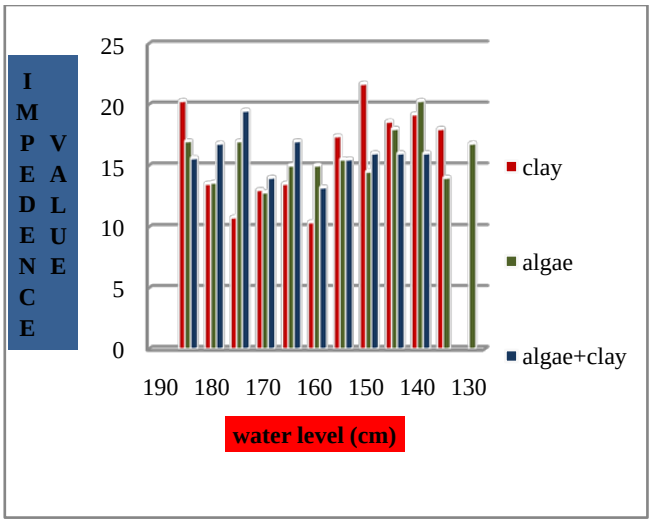
A picture showing algae water conc.

Experiment 3 : Concentration of both algae and clay.

S. No.	Water Level (cm) X	Time (min) t	Piezometric Head at 120cm (H)	Impedance for H (Z1) {(X_n-H)/5}Xt
1	195	0	174	-
2	190	4	169.5	16.4
3	185	4	165.5	15.6
4	180	4	159	16.8
5	175	5	155.5	19.5
6	170	4	152.5	14
7	165	5	148	17
8	160	4	143.5	13.2
9	155	5	139.5	15.5
10	150	4	134	16
11	145	5	129	16
12	140	5	124	16
13	135	6	-	-
14	130	5	-	-

Impedance values at various Heads, can be shown in the form of graph, as shown:

As it is clear from graph that more value of impedance is in case of Clay. This is due to the fact that very less pores are present in case of clay.



Now, very interesting result was obtained when additional experiment was done on conc. of both algae and clay mixture i,e 3rd experiment. First the clear water head of 20cm was maintained after whole of conc. water gets percolated, then impedance value was 20. Now as the head was increased to 40cm, impedance value came out to be 23.5. Again when the head was raised to 60cm, impedance value was 27.

As the water head above the clogging layer is increased, the infiltration rates should increase and impedance should decrease but conversely the impedance is increasing, which is indicating more resistance to the flow. This increase in impedance value was probably due to compression of clogging materials, thereby closing or blockage of the voids.

5. CONCLUSION

Both clay and algae are the major clogging particles present in Ground Water Recharge basin. So, their presence cannot b overruled. Maximum infiltration rates can be achieved by proper flooding, drying , cleaning of basins and also by pre treatment of water. Planning and feasibility studies for systems for artificial recharge of ground water must include estimates of infiltration rates, impedance values.

Also the degree of choking/ clogging can be calculated in terms of Impedance.

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