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Effect of Sodium Poly Acrylate on Water Holding Capacity of Soak Pits

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Abstract: ***The artificial recharge of ground water these days is done mostly using soak pits. It is mainly used to improve the ground water recourses in various areas Soak pits are artificial ground water recharge beds. The primary objective of this technique is to preserve or enhance groundwater resources in various areas which include conservation or disposal of floodwaters, control of saltwater intrusion, storage of water to reduce pumping and piping costs, temporary regulation of groundwater abstractions, and water quality improvement by dilution by mixing with naturally-occurring groundwater (Asano, 1985). In such areas, there is need for artificial recharge of groundwater by methods such as water spreading, recharge through pits, shafts, wells. The choice of a particular method is governed by local topographical, geological and soil conditions the quantity and quality of water available for recharge; and the technological-economical viability and social acceptability of such schemes. This paper discusses various issues involved in the artificial recharge of groundwater.***
Keywords: Soak pits, artificial recharge, ground water table, Sodium polyacrylate.

I. INTRODUCTION

The increasing demand for water has increased awareness towards the use of artificial recharge to augment ground water supplies. Stated simply, artificial recharge is a process by which excess surface-water is directed into the ground – either by spreading on the surface, by using recharge wells, or by altering natural conditions to increase infiltration – to replenish an aquifer. It refers to the movement of water through man-made systems from the surface of the earth to underground water-bearing strata where it may be stored for future use. Artificial recharge (called planned recharge) is a way to store water underground in times of water surplus to meet demand in times of shortage. Soak pits is one of such methods used for artificial recharge of ground water. The main aim of this paper is to develop a soak pit that improves ground water level by using the eco chemical named, sodium poly acrylate as one of the layers. The huge quantities of water anticipated during floods can be effectively used to recharge the ground water using this technique.

II. LITERATURE REVIEW

Full list of author information is available at the end of the article novel adjustment measure water retaining agent has been proposed and applied to modify soil and improve soil water-holding capacity on soak pits and has been emphasized universally all over the world. Sodium polyacrylate with ultra- high molecular, which is one of the water retaining agents, has stronger water absorbent capacity, higher water absorption rate and lower price, and so has a wide application prospect.

1) *Sivapalan S:* Through a simulation test Sivapalan found out that after the application of cross linked poly acrylamide into sandy soil by 0.03% and 0.07% respectively and at the water suction of 0.01 Mpa the moisture capacity increased by 23% and 95% respectively in comparison with control[1].
2) *Fen H, Wu SF, Wu PT:* Through study Feng Hao found out that the application of three kinds of polymers (polyacrylic acid, polyvinyl alcohol, urea-formaldehyde resin) made soil water stable aggregate content increase by 17.27% averagely and density decrease by 11.18%, and soil water holding capacity increase by 2.8 times [2]
3) *Wenhua Zhuang1,2, Longguo Li1, Chao Liu:* Through stud Wenhua Zhang 1,2, longguo Lil , chao Liu used only sodium polyacrylate on water retention and infiltration capacity of a sandy soil. He conclude that infiltration capacity of sand soil only finally he found the pick point of storage capacity[3]
4) *Yang peiling:* He found that under the constant water head, after the application of water retaining agent of polymer, both conductivity and infiltration rate decreased[4]
5) *Johnson and Veltkamp (1985):* He described that the storage of water by these high expansion poly acrylamides is affected in two ways. The greater proportion (80-85%) is stored within the vacuoles as numerous minute reservoirs and the remaining (15-

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20%) is bound with greater tenacity but is still available to plants. The polymer bridges provide a physical resistance to outflow of water from the gel. This structural barrier is probably responsible for reduced evaporation losses from soils treated with such poly acrylamides[5]

6) *Johnson (1984a):* Reported that the water storage properties of these products were significantly affected by the nature and concentrations of dissolved salts in irrigation water[6].

III. EXPERIMENTAL PROGRAMMING

Experimental program is conducted in a cylindrical container of 6cm diameter and 12cm height. The cylindrical container is filled to model a soak pit with various materials and thicknesses as mentioned in Fig. 1 and 2. Sodium poly acrylate is added in various percentages by volume of the soak pit as 0, 0.5, 0.75, 1 and 1.25 % as one of the layers. Each cylinder is tested against water absorption capacity and the quality of water collected from various cylinders.

The following materials are used for the construction of geometrically modeled Soak pit in the laboratory:

Brick ballast:- Used ½ or ¼ parts of bricks this are taken from the local brick masonry at nallapadu, Guntur(dtc).

Gravel:- Crushed stone aggregate of maximum size 10 mm having Specific Gravity of concrete is 2.78.

Crushed sand:-Crushed sand available locally is used, which is free from silt content and waste materials. Specific Gravity of crushed sand is 2.65.

River sand:- River sand available locally is used, which is free from silt content and waste materials. Specific gravity of river sand is 2.6.

Coal power:- coal power available is used.

Sodium polyacrylate:- Sodium polyacrylate, also known as sodium salt of polyacrylic acid with the chemical formula $[-CH_2-CH(CO_2Na)-]_n$ and is of broad application in consumer products. Sodium polyacrylate is an anionic polyelectrolyte with negatively charged carboxylic groups in the main chain. While sodium neutralized polyacrylic acids are the most common form used in industry, there are also other salts available including potassium, lithium and ammonium. This superabsorbent polymer has the ability to absorb an approximate quantity of 200 to 300 times its mass in water.

A. *Methodology*

1) Step 1: Considering 3 feet dimension of model bucket.
2) Step 2: The pit arrangement of dimensions 1 foot deep and 6 inch wide (at bottom) is made to transfer the water to the soak pit. The longitudinal slope of the arrangement is maintained as 1 in 500 to ensure proper drainage of water toward the pit.
3) Step 3: A 0.25m clay layer is laid at the bottom of the pit arrangement. Above this, a layer with 0.35m of OTG stones laid.
4) Step 4: After that 0.15m of crushed sand layer is laid. Above this, a coal powder layer with 0.024m for purification purpose is laid
5) Step 5: Above the coal layer arrange the porous member layer is arranged then. Above this, a layer with required percentage on porous member formed with Sodium polyacrylate is laid.
6) Step 6: Later, the soak pit is loosely filled with rocks of various sizes, ensuring free flow of water in downward direction and no damage to the walls of soak pit arrangement. The rocks should be of sufficient amount to keep the concrete block walls from pushing inward. The top surface of the rocks is maintained just below the level of drain pipe.
7) Step 7: The drainage trench is also filled with a 2 inch layer of gravel to provide leveled surface for drain pipe.
8) Step 8: A PVC drain pipe is set on the gravel with its perforated side down. The pipe is ensured to extend into the center of the pit.
9) Step 9: A large, flat rock is placed under the end of the pipe in the pit to disburse the flow of water and prevent the erosion of the rocks below.
10) Step 10: The top of the pit arrangement is covered with a large sheet of metal or plywood.

B. *Working Mechanism*

1) As waste-water percolates through the soil from the soak pit, small particles are filtered out by the soil matrix and organic matter is digested by micro-organism.
2) With the usage of Sodium polyacrylate the absorbent capacity is increased by 300 times, thereby it creates more storage capacity.
3) Soak pit are best suited to soils with good absorptive properties; clay, hard packed or rocky soils are not appropriate
1) *Diagrammatic Representation:* Soak pit is geometrically modeled in the laboratory. Sodium poly acrylate is used in various percentages by volume of the soak pit and the effect of it on water absorption capacity is studied. Also, the quality of water that

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is discharged through the soak pit is tested for any chemical changes. Cross sections along with various layers of the soak pit with and without the chemical as one of the layers are shown in Fig. 1 and Fig. 2 respectively.

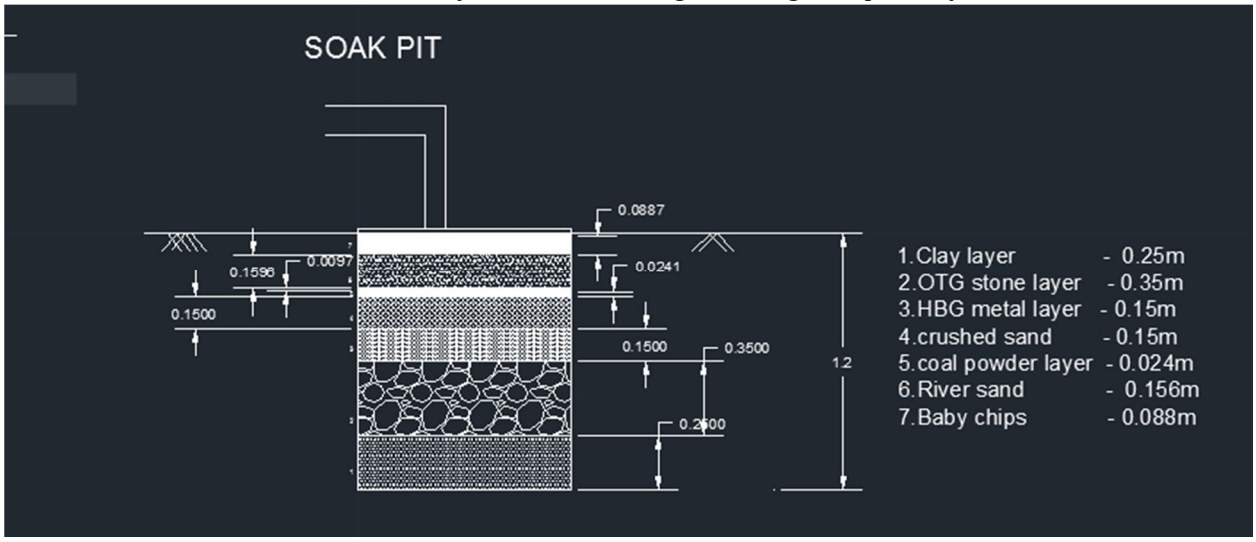


Fig. 1: Cross section of the Soak pit without sodium poly acrylate layer

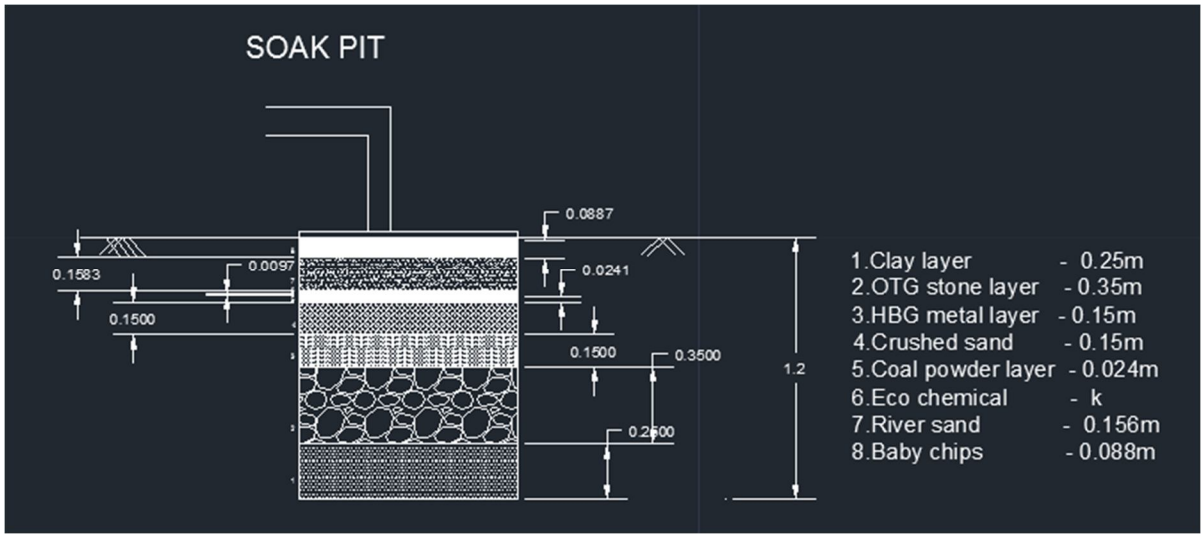


Fig. 2: Cross section of the Soak pit with sodium poly acrylate layer

The project model dimensions are 1m x 1m x 1.2m. It is composed of layers (from top) as described below:
OTG stone layer 0.35m

a) HBG metal of ½ or ¼ part bricks
b) Crushed sand layer 0.15m
c) Coal powder layer of 0.024m
d) River sand layer 0.156m
e) Baby chips layer 0.088m

IV. RESULTS

A. Results

The water absorption capacities and discharges at all the percentages are listed in the table 1. It is observed from the table that the instant discharge is getting reduced with increase in the percentage of sodium poly acrylate. It is clearly evident from the results that, the absorption capacity of the soak pit increased with the increase in the percentage of the sodium poly acrylate. The increase

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in the absorption capacity started becoming less significant at the larger percentages of sodium poly acrylate. Hence, 1.25% of sodium polyacrylate by volume of the soak pit can be treated as optimum percentage.

Table 1 Water absorption capacity of model soak

S. No.	% of Sodium polyacrylate by volume	Instant discharge (cc/min)	Sustained release of water by percentage
1	0.00	8.33	50.0
2	0.50	2.22	60.0
3	0.75	1.94	61.7
4	1.00	1.73	62.0
5	1.25	1.53	62.5

The water that is collected from the soak pits are tested for their quality against various sources of water to confirm with the standards of usable water. The water samples are tested for its pH, turbidity, alkalinity, Iron content, total hardness and total dissolved solids and the results obtained are presented in Table 2. All the mentioned parameters are also checked and compared with the samples of tap water (S1), sodium poly acrylate mixed with the tap water (S2), water sample collected from normal soak pit (S3), water sample collected from the soak pit with sodium poly acrylate (S4). It is observed from the results that the quality of water sample collected from the soak pit containing sodium poly acrylate is similar to that of other water samples. Hence, it is said that the chemical does not leave any harm full substances to the water that is passing through it and the water is safe to reach the ground water table.

Table 2 Water quality parameters and their standards according to IS: 10500-1991

S.No	parameters	units	Desirable	Maximum	S1	S2	S3	S4
1	pH	-	6.5-8.5	No-relaxation	7.61	7.45	7.66	7.7
2	Turbidity	NTU	5	10	2.6	2.1	3.7	3.5
3	Alkalinity	mg/l	200	600	230	240	270	300
4	Iron	mg/l	0.3	1.0	0.0239	0.02622	0.0272	0.02852
5	TH	ppm	-	-	315	215	400	475
6	TDS	mg/l	500	2000	250	350	550	620
7	Conductivity	-	-	-	2.0	1.9	2.2	2.9
8	Temperature	‘C	-	-	29	29	28	27
9	Chlorides	mg/l	250	1000	400	450	500	475

V. DISCUSIONS

A. Maintenance

1) The effluent should be clarified or filtered well to prevent excessive build up of solids.
2) The Soak Pit should be kept away from high-traffic areas.
3) Particles and biomass need to be cleaned or moved to prevent the clogging.
4) A removable lid may be used to seal the pit for future access.

B. Advantages

1) Can be built and repaired with locally available materials.
2) Area required is comparatively less.
3) Power conservative.

a) *Health Aspect:* As long as the Soak pit is not used for raw sewage, and storage/treatment technology is functioning well, health concerns are minimal. The technology is located underground and thus, humans and animals have no contact with the effluent. It is important however, that the Soak Pit is located a safe distance from a drinking water source (ideally 30m). The chemical doesn’t alter properties of soil in any manner. Since the Soak Pit is odorless and not visible, it can be accepted to even the most sensitive communities.

b)

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VI. LIMITATIONS

A. A Soak pit does not provide adequate treatment for raw waste water, as the pit clogs quickly. It may be used for discharging pre settled black water or grey water with minimized impact on the environment.
B. Soak pits are appropriate for rural and suburban settlements. They depend on soil with a sufficient absorptive capacity.
C. They are not appropriate for areas that are prone to flooding or have high groundwater tables.

VII. CONCLUSION

With the addition of Sodium polyacrylate the absorption capacity is increased by 300 times and water is released slowly thereby increasing storage capacity of soak pit. With no addition of Sodium polyacrylate the sustained release of water percentage is 50. With an increase in quantity of Sodium polyacrylate, the sustained release of water has increased. While the instant discharge decreased with increase in quantity of Sodium polyacrylate. The optimum percentage of Sodium polyacrylate by volume is attained as 1.25 at a sustained release of 62.5.

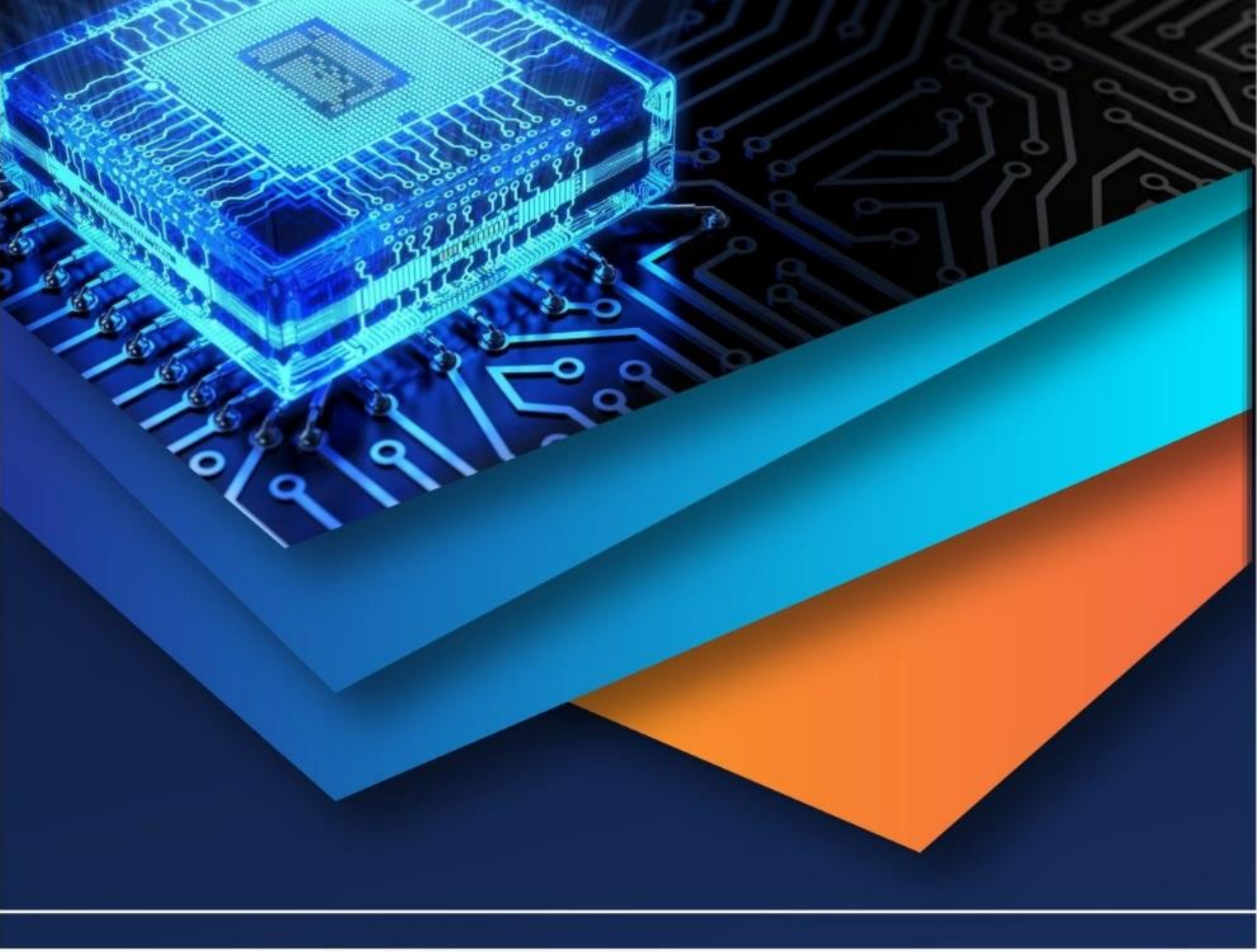
VIII. PROJECT IMPLEMENTATION

Test program results are used to recommend final, full-scale implementation of the project, including sites for new artificial recharge structures, additional wells or infiltration ponds (if necessary), potential future options for sourcing of surface-water, planning of recharge management during regular operations, and necessary monitoring. Focus is kept on keeping the system design flexible, so that changing needs of the client can be integrated with existing recharge operations and facilities.

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