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A COMPARATIVE STUDY OF INFILTRATION RATES OF DIFFERENT SOLVENTS IN DIFFERENT SOILS

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ABSTRACT:

The importance of soil-water system in nature and in the life of men has been realized since the beginning of the civilization and men's awakening about his surroundings. The geochemical changes give rise to various kinds of formation of soils. The soil of Gujarat state is saline, saline-alkali or alkali in nature. The different soils have different permeability, which is affected by various parameters. Solvent is a one of these important parameter, hence in present study, the effect of different solvents on the infiltration rates of different types of soil has been studied. For the present study, various solvents like CCl4, CH3 OH, H2O, CS2 etc. are used.

KEY WORDS: *Permeability, Infiltration, Soil and solvent.*

INTRODUCTION:

It is well known that different soils have different permeability. The problem is quit important in irrigation, agriculture and especially in saline and alkali soils. Plant growth on soil depends directly on the presence of air, water, nutrients as well as on suitable conditions of temperature and light. A large number of influencing the physical properties of the soil, the capillary power of the soil as consisting of both distance and speed of movement are reported.

The texture and structure of the soil affect the capillary conductivity as they influence the number, size and continuity of the pores. The soil spore space and its effective diameter is affecting pores flow of air in to a column of soil. Clay and humus controlled the physical properties of the soil, due to high surface activity of clay colloidal matter, the soil colloids will suffer either dispersion due to the presence of high amount of sodium or will from larger arrogates in presence of Ca^{+2} or organic matter.

It is now known that the deterioration of soil structure is due to a deflocculated state of soil colloids caused by a large amount of exchangeable sodium in the soil. This deflocculation begins as soon as the concentration of salts falls below a certain limit.

The texture and the structure of the soil effect capillary conductivity, as they influence number, size and continuity of pores. In general the capillary permeability of different textural groups are:

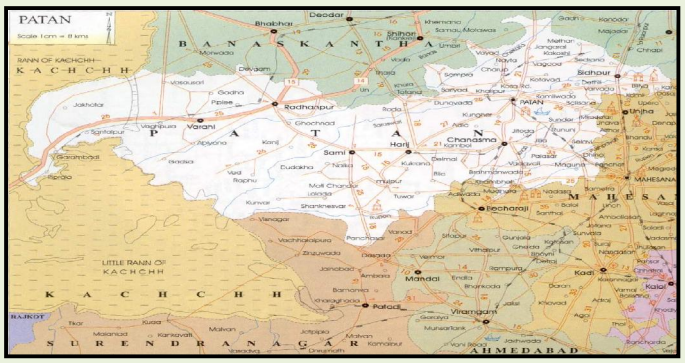
Sand < fine sandy loam < Light clay < Clay

In order to understand the nature of hydrolysis, the nature of solvolysis and its correlation with the movement of water to movement of solvent in various soils a few solvents were selected and their movements were measured. It is also well-known that similar to hydrolysis, alcoholysis also obstructs rate of movement of alcohol but to a lesser degree than in the case of water, especially to explain some structural relation between the nature of solvents and nature of the soil.

The downward entry of the water into soil is referred as infiltration. Similarly, the infiltration rate is defined as the volume of water passing into the soil per unit area and per unit time.

We know that estimation of ESP valves of soil is extremely difficult and yield results which are incorrect. In low salinity range as well as in high salinity range ESP estimated does not agree with ESP calculated. Therefore, in order to classify a sample in to its own class, the infiltration rates of soil with polar solvents like water, alcohols and non-polar solvents like Benzene and Carbon disulphide may be useful.

With this view in mind, infiltration rates of different soil of different clay type have been studied in the present work.



North Side = Banaskantha District
South Side =Mehsan District
East Side = Mehsana District
West Side = Kutch District

2. EXPERIMENTAL MATERIALS

No.	Chemicals	Specification
1	CS_2	BDS
2	CCl_4	SD Fine
3	C_6H_5-Cl	AR Grade
4	CH_3OH	LR Grade
5	$C_6H_5NH_2$	SD Fine
6	H_2O	Natural water

METHOD:

In the present work, several soil samples were collected from Patan District of North Gujarat region. The soil of Patan is K-M-I (Kaolinite, Montomorillonate and Iolite) type, which affect the rate of infiltration, as well as, rate of infiltration of the respective soils.

The estimation of ESP valves of soil is extremely difficult and yield results which are incorrect. In low salinity range as well as in high salinity range ESP estimated does not agree with ESP calculated. Therefore, in order to classify a sample in to its own class, the infiltration rates of soil with polar solvents like water, alcohols and non-polar solvents like Benzene and Carbon disulphide were studied as per standard methods.

The infiltration rates of the soil samples were measured by the Tube method, as well as, the rate of infiltration was determined by Marshall and Strik method.

RESULTS AND DISCUSSION:

Results of the rate of infiltration with respect to various solvents are presented in following tables.

Table 1: CHARACTERIZATION OF SOLVENTS

Sr. No.	Solvent	Type	Structure	Dipole movement	Dielectric constant	Viscosity at 20 C
1	Carbon Disulphide	Non Polar	CS_2	0.0	2.62	0.376
2	Carbon Tetra Chloride	Non Polar	CCl_4	0.0	0.975	2.24
3	Chloro Benzene	Polar	C_6H_5-Cl	1.57	5.80	0.571
4	Methanol	Polar	CH_3OH	1.60	33.0	0.596
5	Aniline	Polar	$C_6H_5NH_2$	1.50	7.2	4.40
6	Water	Polar	H_2O	1.84	81.07	1.005

Table 2:Infiltration Rate cms\hr for Polar and Non Polar Solvents in different Soils

Patan District : Clay Type : K-I Soil : Normal

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	874	728	802	400	384	166
2	592	624	576	270	188	94
3	454	454	218	202	146	68

4	-	-	130	110	56	54
5	-	-	62	70	48	24
6	-	-	-	38	36	12
7	-	-	-	30	36	12
8	-	-	-	24	24	12
9	-	-	-	12	18	06
10	-	-	-	12	06	06

Table 3: Infiltration Rate cms\hr for Polar and Non Polar Solvents in different Soils

Patan District : Clay Type : K-I Soil : Na (Sodium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	872	718	724	608	314	116
2	562	362	530	328	186	92
3	374	242	210	186	124	24
4	-	-	126	98	68	18
5	-	-	-	90	48	12
6	-	-	-	66	-	12
7	-	-	-	36	-	06
8	-	-	-	18	-	06
9	-	-	-	12	-	06
10	-	-	-	12	-	06

Table 4: Infiltration Rate cms\hr for Polar and Non Polar Solvents in different Soils

Patan District : Clay Type :K-I Soil :K (Potassium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C6H5NH_2$	H_2O
1	602	548	538	624	330	242
2	362	314	240	338	242	182
3	454	216	182	194	208	74
4	-	110	-	98	100	68
5	-	-	-	90	54	24
6	-	-	-	66	30	18
7	-	-	-	-	-	18
8	-	-	-	-	-	12
9	-	-	-	-	-	06
10	-	-	-	-	-	06

Table 5: Infiltration Rate cms\hr fo-r Polar and Non Polar Solvents in different Soils

Patan District :Clay Type : K-I Soil : Ca (Calcium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	638	368	292	242	196	184
2	430	254	246	182	106	118
3	302	188	142	124	90	36
4	-	70	98	78	54	36
5	-	-	54	38	30	30
6	-	-	36	24	24	30
7	-	-	36	24	12	24
8	-	-	24	12	12	24
9	-	-	-	12	12	12
10	-	-	-	12	12	12

Table 6:Infiltration Rate cms\hr for Polar and Non Polar Solvents in different Soils

Patan District : Clay Type : K-I Soil :Mg (Magnesium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	634	362	230	234	190	128
2	326	242	202	170	104	80
3	248	188	122	104	90	36
4	-	96	78	76	54	24
5	-	-	72	70	36	24
6	-	-	-	-	30	12
7	-	-	-	-	24	12
8	-	-	-	-	24	12
9	-	-	-	-	12	06
10	-	-	-	-	06	06

Table 7: Infiltration Rate cms\hr for Polar and Non Polar Solvents in different Soils

Patan District :Clay Type : K-I Soil : NH_4 (Ammonium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	572	362	482	396	202	160

2	362	202	242	184	70	34
3	300	150	182	106	64	30
4	-	70	-	54	48	18
5	-	-	-	46	36	18
6	-	-	-	-	30	12
7	-	-	-	-	24	12
8	-	-	-	-	12	06
9	-	-	-	-	12	06
10	-	-	-	-	-	06

Table – 8:Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District :Clay Type :M Soil : Normal

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	794	362	382	190	256	98
2	542	238	250	100	190	36
3	362	180	156	98	72	24
4	-	110	102	70	34	18
5	-	94	70	64	24	12
6	-	-	64	36	24	12
7	-	-	-	24	18	12
8	-	-	-	12	18	06
9	-	-	-	06	12	06
10	-	-	-	06	06	06

Table 9: Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District : Clay Type : M Soil :Na(Sodium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	706	338	422	130	158	86
2	572	170	188	66	56	80
3	300	136	122	38	28	20
4	-	104	98	24	12	12
5	-	-	52	24	12	12
6	-	-	-	24	12	06
7	-	-	-	18	06	06
8	-	-	-	18	06	06
9	-	-	-	12	06	06
10	-	-	-	06	06	06

Table – 10:Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District : Clay Type : M Soil : K(Potassium)

Time (min)	Carbon Di sulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	658	296	212	136	180	128
2	334	158	126	74	56	86
3	184	110	88	68	32	72
4	-	74	68	36	18	30
5	-	38	54	36	12	18
6	-	32	30	24	12	12
7	-	24	24	18	12	06
8	-	12	12	18	12	06
9	-	12	12	12	06	06
10	-	-	-	12	-	06

Table 11:Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District :Clay Type :M Soil : Ca (Calcium)

Time (min)	Carbon Di sulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	576	486	288	190	134	174
2	348	216	128	78	70	94
3	104	166	86	50	36	52
4	68	108	68	36	36	48
5	54	84	54	36	30	38
6	30	-	36	24	30	26
7	-	-	30	24	24	12
8	-	-	30	18	18	06
9	-	-	24	12	12	06
10	-	-	-	12	12	06

Table 12: Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District :Clay Type :M Soil :Mg (Magnesium)

Time (min)	Carbon Di sulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	518	404	284	122	128	130
2	338	196	116	96	56	34
3	110	148	80	56	36	22
4	74	106	54	44	26	12
5	-	-	36	30	18	06
6	-	-	24	24	18	06
7	-	-	12	18	18	06
8	-	-	12	12	06	06
9	-	-	06	06	06	06
10	-	-	-	06	06	06

Table 13:Infiltration Rate cms\hr for Polar and Non Polar Solvents in Different Soils

Mehsana District :Clay Type :M Soil : NH_4 (Ammonium)

Time (min)	Carbon Disulphide	Carbon Tetra Chloride	Chloro Benzene	Methanol	Aniline	Water
	CS_2	CCl_4	C_6H_5Cl	CH_3OH	$C_6H_5NH_2$	H_2O
1	520	302	286	170	146	118
2	482	160	154	74	62	40
3	122	124	96	66	56	34
4	-	84	54	66	38	24
5	-	-	30	58	30	18
6	-	-	24	48	30	18
7	-	-	24	42	24	12
8	-	-	-	30	18	06
9	-	-	-	18	12	06
10	-	-	-	12	12	06

CONCLUSION:

The infiltration rates for different solvents in different soils, differ due to solvent properties

From all the tables, we can find that water (H_2O) has the lowest infiltration rates. This can be explained on the basis of water's action on soil-complex . Hydrolysed soil complex has the lowest infiltration rate. Again it has high dielectric constant, i.e. high dipole-moment, which will also restrict its movement from a soil column.

The infiltration rates for methyl alcohol (CH_3OH) are higher than water (H_2O) in the biginning but nearly the same as water in final stages (i.e. after 7th to 8th minutes). This is due to the fact that Methyl alcohol has also high di-electric constant (33-0) and high dipole moment [1.60 (micron)]. Moreover this will be a H-bonding solvent.

The infiltration rates for Carbon Disulphide (CS_2) and Carbon Tetrachloride (CCl_4) are much higher than other solvents. This is due to the fact that both these solvents have zero dipole moment and they are also symmetrical in structure.

We find infiltration rate 454 cm/hr at 3rd minute in normal K-I soil for CS_2 and CCl_4 as compared to 146 for Aniline, 218 for Chloro Benzene, 202 for Methanol and only 68 for Water of course the value of infiltration rates differ K-I soil and M-soil in case of normal soil the values of

K-I soil > M-Soil For all the solvents.

The solvents Aniline and Chloro-Benzene are polar solvents and their infiltration rates are intermediate between non-polar CS_2 and CCl_4 and highly polar H_2O and CH_3OH.

This is quite in concurrence with the di-electric constant of the solvents.

$$H_2O > CH_3OH > C_6H_5NH_2 > C_6H_5Cl > CS_2 > CCl_4$$

Di-electric constants (81.07) (33.0) (7.2) (5.8) (2.62) (0.975)

The order for infiltration rate for normal K-I soil; At 3rd minute.

CS_2	=	CCl_4	>	C_6H_5Cl	>	CH_3OH	>	$C_6H_5NH_2$	>	H_2O
454		454		218		202		146		68

- The order of di-electric constant affecting infiltration rate is changed only for Methanol and Aniline. Here the factor of viscosity must be playing its own role (viscosity of Aniline is 4.40, as compared to methyl -alcohol which is 0.596).
- On comparing infiltration data in Table 2 with Table 3 and Table 8 with Table 9 for normal K-I soil with sodium K-I soil and normal M-Soil with sodium M-Soil, We find that infiltration rate for sodium soils are lower than normal soil all splvents.
- Infiltration rate for H_2O and CH_3OH are higher for K-soil, as compared to Na-soil (both type)

- Infiltration rate for H_2O is higher for Ca-soil as compared to Na-soil for both types of soils. In case of K-I soil, infiltration rate for CH_3OH are higher for Na-soil, hence mineral structure is also a contributing factor.
- Comparing infiltration rate data in table 5 with table 6 and 11 with table 12, we find that infiltration rate for Ca-soil is higher than those for Mg-soil.
- For Na-soil compared to Mg-soil, the order for infiltration rate is Na soil > Mg soil. For CS_2, CCl_4, CH_3OH and H_2O, but Na soil < Mg soil. For $C_6H_5NH_2$ and C_6H_5Cl we find above order of K-I soil and M-soil.
- Comparing NH4-soil, infiltration rate with Normal-soil, infiltration rate , we find that Normal soil > NH_4 soil for all solvents .
- Hence continued addition of large doses of Ammonium fertilizers should be done with caution.

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