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NOTE

Characterisation of Soil Suitability for Solar Salt Production

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One of the most important factors to be considered for suitability of particular site for salt farm development for the production of common salt by solar evaporation method is the soil and its characteristics. In the large farms, generally there are problems of brine shortage because of considerable amount of sea water and concentrated sea brine percolates at different places called reservoirs and in condensing areas with the result that the production of salt is less than the expected output. This shows that the type of the soil plays an important part in the production of good quality and quantity production of salt, keeping in view of the availability of brine, proper land contours for the gravitational flow and other factors like wind velocity, relative humidity and rain fall etc.

In view of this, it is felt necessary that the soil characteristics must be determined and defined well in order to ascertain the percolative nature of the soil for an efficient operation of the solar salt works.

Results and Discussion

Particle size classification : The commonly used particle size scale is suggested by the Massachusetts Institute of Technology which has been adopted by Bureau of Indian Standards of classification of soils as gravel particle (60–2 mm), sand (2–0.06 mm), silt (0.06–0.002 mm) and clay (0.002 mm and less). Thereafter, the fraction which passess through 240 BSS sieve (–240) was analysed for particle size below 0.063 mm by a Sedigraph 5000 D instrument (Micrometrics Instruments Corporation, U.S.A.) and the result is given in Table 1.

TABLE 1

Sample location :

No. 1 : 1 km East 200 m from Sonarai Creek, Bhavnagar

No. 2 : 500 m East towards sea, Bhavanagar

No. 3 : Between sea and old highway, Bhavnagar

	No. 1	No. 2	No. 3
Fine gravels (3.35–2.0 mm)	0.50%	0.10%	–
Mixed sand (2.00–0.063 mm)	5.00%	2.00%	1.20%
Coarse silt (0.063–0.002 mm)	91.60%	87.00%	95.00%
Clay (0.002 mm and less)	Balance	Balance	Balance

Coefficient of permeability, $K = 10^{-3}–10^{-6}$ cm s^{-1}.

Triangular classification chart : In this classification each corner of the triangle represents pure clay, pure sand and pure silt, whereas the sides represent the percentage proportions of mixtures of clay and silt, sand and silt, and sand and clay (Fig. 1). This chart has been employed for the mechanical analysis of the soils excluding the gravel fraction. To find the textural name of the soil composed of 5.00% sand, 91.10% silt and 3.90% clay the cross-section of these lines which fall point 1 in Fig. 1 is denoted. Similarly, points 2 and 3 are plotted based on percentage of clay, sand and silt. Depending upon the area in which the point falls they are termed as clayee or sandy-clay or sandy-clay loam, silt-loam etc.

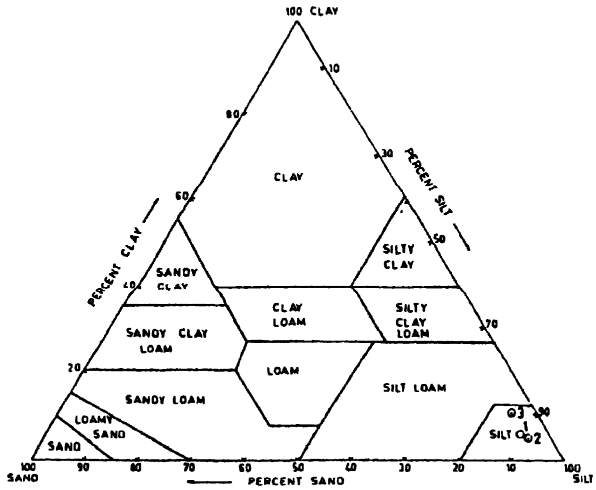

Fig. 1. Textural classification of soils.

The data of Table 1 and Fig. 1 show that points 1, 2 and 3 fall mainly in silt area having composition of coarse silt 88–90%, clay 8–9% and sand 2–1%. These were found to contain coarse silt having 0.063–0.002 mm size and clay of 0.002 mm. As the fine sand is < 2%, it has been analysed by a Sedigraph 5000 D instrument which can measure particle size upto 0.002 mm (diameter). From the triangular diagram we can see that the silt is very low and is the combined fraction of coarse and plastic clay to the tune of 88–90% of 0.006–0.023 mm particles and <0.002 mm size of silt particles.

Permeability : The percolation of water through soil was first studied by Darcy who demonstrated experimentally that for laminar flow conditions in saturated soil and the rate of flow or discharge per unit time is proportional to the hydraulic gradient and it could be expressed as

$$Q = K I A \quad (1)$$

where Q is the rate of flow of discharge (discharge per unit time), A the total cross sectional area of the soil mass perpendicular to the direction of flow, I the hydraulic gradient and K the Darcy's coefficient of permeability.

$$V = Q/A = K I \quad (2)$$

where the velocity of flow is defined as the rate of discharge of water per unit of cross-sectional area of the soil. The coefficient of permeability (simple permeability) is defined as the velocity of flow of the liquid which will occur through the total cross-sectional area of the soil under a unit hydraulic gradient. The permeability rating of the soils according to the U. S. Bureau of Reclamation is as follows which are accepted in general. These are pervious where K is greater than 1×10^{-4} cm s^{-1}. For semipervious K is 1×10^{-6} to 1×10^{-4} and for impervious K is less than 1×10^{-6} cm s^{-1}.

From the calculations, the coefficient of permeability of the above soil sample falls in the range of $1-10^{-4}$ to $1-10^{-6}$ cm s^{-1}. As the above site soil sample falls in the region of semipervious, the permeability of the soil is quite low, which indicates that the site chosen is suitable for the development of salt farm provided other requirements like availability of sea-water or subsoil brine, low rainfall, wind velocity and the evaporation rate etc. are fulfilled and the electricity, transportation etc. are met without any difficulty.

Experimental

Soil samples (5 kg) collected from different locations at a depth of 2–3′, were sun-dried, followed by drying in an oven (110 ± 0.1°). In each case, the sample (500 g) was mixed with H_2O_2 in order to remove organic matter, then water (500–700 ml) was mixed with it, stirred for 10 min and kept overnight. It was passed through sieves (18–240 BSS) and big and small fractions from the soil were collected and dried. The samples were weighed and percentage of different fractions, e.g. 0.850 mm (18 BSS) and 0.063 mm (+240 BSS) were determined. Composition of the soil is as follows : moisture, 56.89; SiO_2, 19.94; Al_2O_3, 15.25; Fe_2O_3, 0.45; TiO_2, 0.20; MgO, 3.00; SiO_2/Al_2O_3, 5.29; SiO_2/R_2O_3, 3.21%.

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