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Method Article

Laboratory investigation of steam transmission in unsaturated clayey soil under osmotic potential

Mehdi Jalili[a,*], Mahmoud Nikkhah Shahmirzadi[a], Mahdi Kaseb Hazrati[b], Hamed Ahmadi[b]

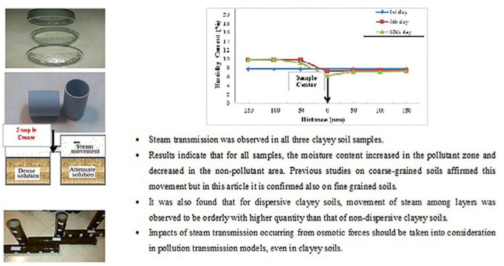
[a] *Department of Civil Engineering, Technical & Engineering Faculty, Semnan Branch, Islamic Azad University, P.O. Box: 35135-179 Semnan, Iran*

[b] *Geotechnical Engineering, Department of Civil Engineering, Technical & Engineering Faculty, Semnan Branch, Islamic Azad University, Semnan, Iran*

HIGHLIGHTS

- The impact of osmotic force from various salinities on steam transmission in non-dispersive and dispersive clayey soil examined.
- For all samples the moisture content increased in the pollutant zone and decreased in the non-pollutant area.
- For dispersive clayey soil, movement of steam among layers was orderly.

GRAPHICAL ABSTRACT



ABSTRACT

Liquids coming from different sources like wastewaters, agricultural and industrial activities and leakages of chemical substances often have high concentration of chemical compositions and the osmotic gradient generated around such sources causes a considerable transmission of the Contamination. The steam transmitted by non-polluted soils moves to polluted masses, causing an increase in the volume of pollution zone and movement of pollutants. Therefore, such physical and chemical processes should be taken into account in pollution transmission models. Using Crumb method, laboratory investigations were conducted on non-dispersive and dispersive clayey soil samples obtained from three areas in Zanjan Province of Iran. A simple experimental setup has been used and hereby introduced. The impact of osmotic force from salinities of 0.5, 1, and 1.5% on steam transmission in clayey soil was examined. Results indicate that for all samples between 5 to 15 days, the moisture content increased in the pollutant zone and decreased in the non-pollutant area. Also it was observed that for dispersive clayey soil, movement of steam among layers was observed to be orderly and its amount was higher than that of non-dispersive clayey soil.

* Corresponding author.
E-mail addresses: m.jalili@semnaniau.ac.ir (M. Jalili), m.nikkhah@semnaniau.ac.ir (M.N. Shahmirzadi), mehdi.hazrati58@yahoo.com (M.K. Hazrati), hami_c2000@yahoo.com (H. Ahmadi).

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Method details

In engineering sciences, soil is a non-integrated mix of various chemical compositions grains and decayed organic substances whose empty spaces are occupied by water, air (gases), and chemical pollutants. As an important construction material, soil is extensively employed in civil engineering and most structures are founded on soil. Therefore, civil engineers have to make a thorough study on soil properties such as origin of grading, water drainage capability, land subsidence, shear strength, compressibility, bearing capacity, steam transmission, etc. Transmission of steam in unsaturated soils is performed under the effect of thermal and osmotic gradient. Substances in the water available in soil pores bring about osmotic potential. Osmotic potential gradient is able to generate substantial water flow and steam in soils with high concentrations of chemical compositions. For water transmission to happen in soil through osmotic processes, a semi-permeable membrane is required to block passage of ions while freely permit water in.

In atmospheres with semi-permeable membrane properties, water under the impact of osmotic potential flows from area of low concentrations to areas of high concentrations. In the presence of such semi-permeable membrane, osmotic potential can cause a pressure difference in fluid. Steam transmitted from non-polluted soils to polluted masses by steam condensation above polluted and concentrated solutions may bring about an increase in volume of pollution zone and horizontal movement of pollutants in liquid form. Such physical and chemical processes, therefore, should be taken into consideration in pollution transmission models. It should be mentioned that the polluted zone means the zone with high concentration of the chemical compositions.

In recent years, geotechnical practice has increasingly encountered situations where the pore-fluid chemistry of soil varies under environmental impacts [1]. In some studies such as those performed by Gurr et al., Jury and Letey, Nassar et al. and Salzmann et al., steam transmission as a result of thermal gradient was investigated [2–5]. In studies conducted by Goudarzi et al., steam transmission was examined in three soil types of silty clayey loam, loam, and sandy loam in unsaturated conditions at three salinity levels [6]. Results of their experiments showed that transmission of steam in light sandy soils and coarse-grained soils at all salinity levels are more and quicker than those in soils with heavier texture that contains more clay content.

Ma et al. proposed a conceptual constitutive model for unsaturated soils is to explain the influence of pore-fluid chemistry on the chemo mechanical behaviour of unsaturated clayey soils which is capable of addressing the effect of water content, concentration and species variation on the mechanical behaviour of the clayey soil [7]. Osmotic adjustment is a complementary strategy consisting in a decrease of plant osmotic potential through the accumulation of internal solutes without affecting cellular volumes [8]. This allows the plant to maintain a favourable water potential gradient and to absorb water for turgor maintenance [9].

The hormonal profile in relation with osmotic adjustment under salinity in Solanum lycopersicum and its halophyte wild relative Solanum chilense investigated and results suggested that the capacity to use inorganic ions as osmotic may improve salt resistance in Solanum chilense and those phytohormones could be involved in this process [10]. Salt stress has received substantial attention in recent years compared to other stresses, because it is progressively claiming arable land worldwide, hence threatening global agricultural production in the near future [11]. The experimental study was undertaken to examine the influence of salt stress on the vegetative growth of the plant by subjecting