Quantifying Gas Flow through Soils.

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Abstract: Gas Flow studies have been performed on compacted sand, sand-clay mixture and clay using nitrogen gas under varying moisture conditions. Inlet and outlet gas pressures were monitored .A certain threshold moisture control is observed for all cases before gas migration started to occur in the system. Additionally, entire process is correlated with the electrical resistivity. Using AC current, the resistivity is measured in 3 directions has been measured. Changes in electrical resistivity were also monitored with time and gas leakage is measured.

1. Introduction

Understanding gas migration through soil is one most important issue to control gas leakage in and around oil wells. Gas migrating from mines, oil and gas formations affect those areas where human activity exists(Gurevich, Endres, Robertson, & Chilingar, 1993) .Past studies have shown that the migration of gas has serious risk explosion and affects human health.

Gas migration from the source is a continuous or discontinuous. Leakage of gas from is soil is difficult to measure and a few measurement methods have been devised. Lappala and Thompson (1984) have used soil gas samples from depths as shallow as 1 and 3 m to detect the presence of volatile organic compounds in groundwater at water table depths of 10 and 30 m, respectively. Eklund et. al.(I) described an emission isolation flux chamber for determining rates of emission of selected volatile organic species, from spill sites, landfills, surface impoundment's and remediation sites. Flux chamber method is recommended by EPA,it encloses an area of $0.13m^2$ (Erno & Schmitz, 1996) .Soil scientist generally use flux chambers to ascertain gas migration through soil.

In this paper, electrical resistivity of the specimen during gas migration is studied.

2. **Objective**. The objective was to study the gas flow thorough different soils and determine the at which the gas leaks.

3. Materials and Methods-

Four different set of soil were treated with similar moisture content.

Table 1 Soil Composition

	Sand (gm)	Kaolinite (gm)	Water	Moisture Content (%)	Resistivity (Ωm)
Mix 1	350	50	150	37.5	14.9
Mix 2	300	100	150	37.5	14.5
Mix 3	200	200	150	37.5	13.3
Mix 4	100	300	150	37.5	11.9

The initial resistivity of the soil is measures using soil conductivity probe. The initial resistivity is used to convert the electrical resistance measured by LCR device during the test progress The prepared samples are put into the HPHT device and sealed. Gas migration test is conducted using nitrogen gas in High Pressure and High Temperature device. Four probes were inserted in HPHT device, from which the electrical resistance is measured using LCR device.

The water discharged from each of the soil type is collected and point is recorded at where gas migration is observed. Further the outlet discharge vs the inlet discharge is studied.

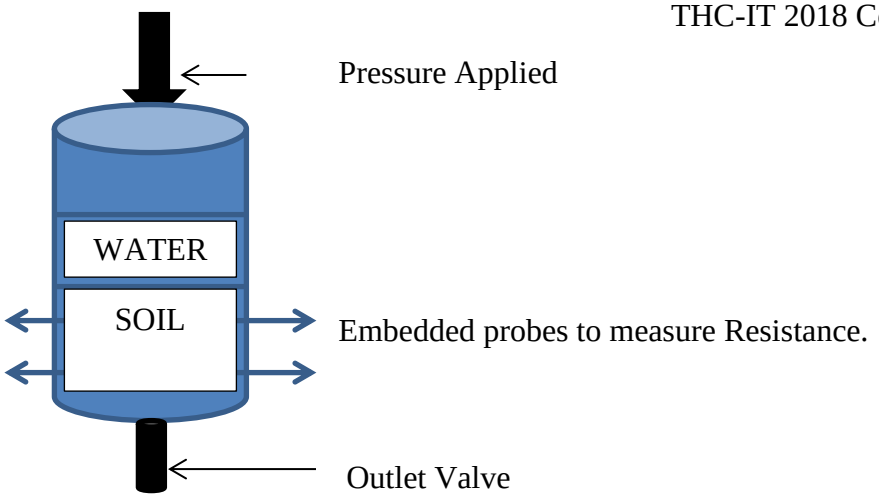

Figure 1.Schematic Diagram of Test Set up

4.1) Discharge under Applied pressure– A pressure of 5 psi was applied on the HPHT device and the discharge was recorded for each of the specimen. For each of the specimen, the discharge of water and time of gas release was noted.

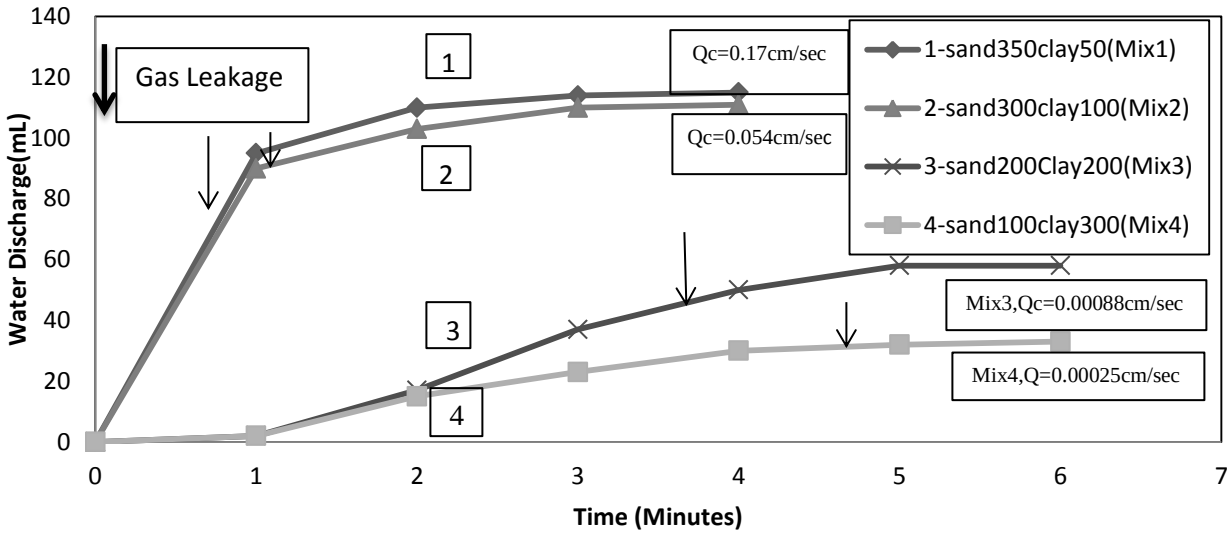

Figure 2.Water Discharge Vs Time

A Constant pressure of 5psi was applied and water discharged was collected in a beaker. Discharge recorded for Mix 1, Mix 2, Mix 1 and Mix 4 are 115ml, 111ml, 58ml and 33ml respectively. The gas leakage was observed after discharge of 85ml, 80ml, 42ml and 30ml. Threshold moisture content is found for each of the mixes above which gas migration through the system is observed.

Gas velocity after complete discharge of water from each of the mixes was calculated for applied constant pressure .Outlet velocities for Mix 1, Mix 2, Mix 3 and Mix 4 were 0.17cm/sec, 0.054 cm/sec, 0.00088 cm/sec and 0.00025 cm/sec respectively. As the silt content increased in the specimen, substantial drop in the velocity is observed.

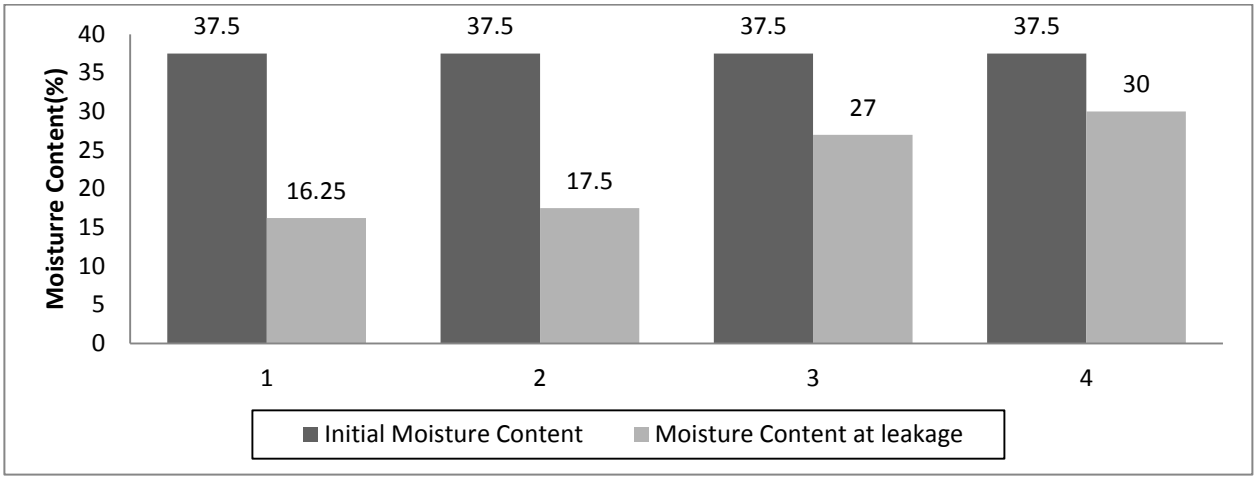

Figure 2. Variation of Initial moisture Content and Moisture Content at Gas Leakage

From Fig 2, it is observed that gas migration starts to occur through Mix 1, Mix 2, Mix 3 and Mix 4 when the moisture content drops below 16.25, 17.5,27 and 30 percent. From the gas migration studies conducted over the specimen, it was observed that each specimen has a critical moisture content which prevents the gas from passing through the system. When moisture content, drops below this, moisture content, constant gas flow is observed in the system. The gas leakage moisture will vary for different pressures.

4.3) Resistivity Change under Gas Flow- The sensitivity of the resistivity as measurement under gas flow is reflected in the change in resistivity. Change in resistivity for specimen 4 is plotted and the change in resistivity in vertical, horizontal and diagonal direction is measured and shown.

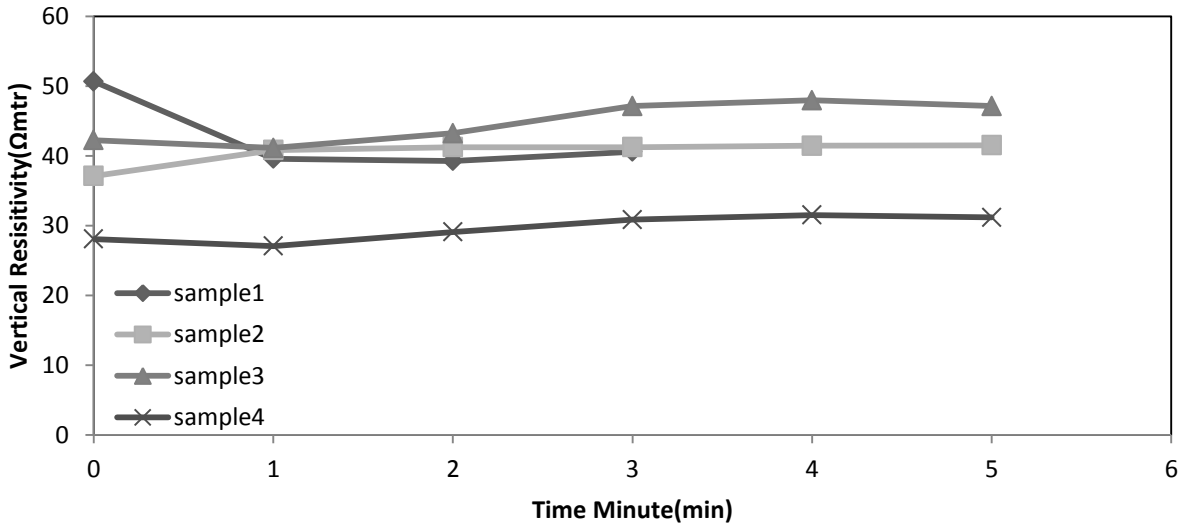

Figure 3.Variation of Resistivity with Time

In Fig 3, the vertical resistivity has been plotted with time. Immediately, change in resistivity is observed due to gas migration. As Gas Migration starts, there is immediate change in resistivity due to the influx of gas into the specimen. The overall resistivity of all the six combination increases and drops when the pressure is released. The test results show that, resistivity is directional in nature and is extremely sensitive to gas migration occurring in the system.

5. Conclusion: Critical moisture content was observed for all the specimens below which the gas starts to pass through the system. Simultaneously, the resistivity if the specimen in the vertical, horizontal and diagonal direction were measured. Real time change in resistivity was detected while gas migration occurs through the system.

6. Acknowledgements:

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7. References.

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