Measurement of in situ moisture content of municipal solid waste in landfills using innovative electrical resistance sensors.

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Introduction

Moisture content (MC) is a crucial parameter for degradation of solid waste in landfills. The measurement of in situ MC in landfills poses a challenging task for researchers. Most of the MC measurement techniques suffer from challenges related to variation in porosity and conductivity of liquid phase, and the limitations of a specific measurement technique. A composite moisture, temperature, and gas (MTG) sensor was developed for in situ measurement of these parameters in landfills by researchers of University of Central Florida, University of Florida and Mercer University. Moisture content is measured as a function of resistance across the granular sand matrix contained in the sensor, which has been found to correlate well with municipal solid waste (MSW) moisture content.

Granular matrix moisture sensor

Earlier electrical resistance soil moisture sensors used soluble salt that served to insulate the sensor from fluctuations in salinity of external environment. The salt that was used was highly soluble calcium sulfate (gypsum). Past use of these sensors has shown that once wetted, they tend to remain wet. This newly developed sensor measures the electrical resistance of the moisture between two electrodes in a granular insoluble media. The resistance is inversely proportional to moisture content in the granular matrix. The sensor body is an 20-cm (8-in) section of 5-cm (2-in) diameter Polyvinyl Chloride (PVC) well screen, shown in Figure 1.

Figure 1. MTG granular moisture sensor.

A slot size of 0.32 cm (1/8 in) was used. Two solid PVC plugs were made for the top and bottom of the sensor. A small indentation was filed in one of the edges of the top plug to allow access for the mesh wire. A 15-cm (6-in) by 16-cm (6.4-in) rectangle of market-grade stainless steel mesh (sized according to the particle size) was prepared. A short piece of 18-gauge copper wire was soldered onto the long edge of the mesh near the middle. A 20-cm (7.7-in) piece of #6 stainless steel threaded rod was cut. All the PVC fittings were primed. The bottom plug was glued into one end of the PVC slotted pipe. The mesh was inserted into the slotted pipe with the 15-cm (6-in) edge running parallel to the pipe axis and with the copper wire at the top. The #6 rod was centered and the sensor then filled with sand media to a height just exceeding that of the mesh. The upper plug was then glued in place. The wire and # 6 rod were attached to electrical connectors serving as the electrodes of the sensor. In order to enhance the transfer of moisture into the sensor, glass fiber wicks were provided.

Sensor calibration

Initial experiments were conducted on the sensor to arrive at the optimum size of the granular matrix for the required measurement sensitivity. The conductivity of moisture was found to affect the resistance values. As a change in leachate conductivity in the landfill is expected, the sensors were calibrated in the laboratory using MSW with varying moisture contents and moisture conductivities. It was found that the sensor cannot measure a moisture content below approximately 30 to 35 %, wet basis. Temperature was found to have a significant effect on the resistance values. A temperature compensation factor must be applied to the resistance reading for sensors installed in a landfill. Field comparison of gravimetric moisture content and laboratory experiments are being carried out to improve data interpretation from these sensors.

MTG sensors were installed in Cells 1 and 2 of the New River Regional Landfills in Florida. Initial field data show an expected trend of increasing moisture content with depth in the landfill. Table 1 provides sample values of moisture content measured from the MTG sensors.

Table 1. Sample temperature, resistance, and moisture content values from the landfill.

Monitoring location		Temperature (^{o}C)	Resistance (kOhm)	Moisture Reading (% wet MC)
Well #	Level			
D3	Lower	53.97	0.022	66.39
	Middle	43.91	1.937	46.33
	Upper	45.19	1.903	48.25