TEMPERATURE AS AN INDICATOR OF LANDFILL BEHAVIOR

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(Received 27 July, 1981; Revised 28 October, 1981)

Abstract. The utility of landfill temperature measurements both as a means of understanding landfill behavior and the interpretation of anomalous data points is explored by demonstration in a case study application. The availability of a pathway facilitating easy intrusion of atmospheric $O_2$ into a landfill is shown to cause aerobic conditions and spontaneous combustion, during landfill pumping experiments. The landfill temperature measurements provide an effective means of isolating the extent of the problem.

1. Introduction

Substantial interest is being given to the possible use of landfill-generated $CH_4$ gas as an energy source. (For example see Crutcher et al., 1981a; Datzel, 1979; Solid Wastes Journal, 1979, 1980; Rhyne, 1979; Stearn, 1980; Conestoga-Rovers, 1981c.) Readily apparent from the publication dates associated with the preceding references is that they are very recent and the state-of-the-art has progressed beyond the purely research stage to conditions of engineering design. Nevertheless, there are still a large number of unresolved questions regarding the utilization of landfill-generated $CH_4$ gas. As a means of determining more about the reliability and longevity of this energy source, a 3 yr experimental research program has been carried out on a sanitary landfill site at St. Thomas, Ontario.

The results of this research program are discussed elsewhere in greater detail (see Conestoga-Rovers, 1981a), but briefly it has involved gas extraction from either one or two pumping wells and the utilization of the extracted gas as the heating source for a greenhouse and the exhausting of excess gas to the atmosphere. Monitoring of concentration and pressure levels within the landfill at 57 probes located at various distances from the probes was undertaken at weekly intervals.

A major emphasis of the study was to determine the drawdown curves of $CH_4$ gas in response to various rates of pumping and thus to allow a quantitative characterization of the extent to which the landfill was impacted. Information for selecting pumping well locations and the extent to which energy recovery could be accomplished could thus be obtained.

The generation and propagation of $CH_4$ gases in a landfill are, however, stochastically varying phenomena that make the quantitative characterization of impact a difficult task.
Short-term variations in CH₄ concentrations can be caused, for example, by measurement techniques which necessarily entail an uncertainty in the determination of gas concentrations and gage pressures, the temporal extent of the sampling must be restricted due to budget constraints, and variables such as temperature and moisture conditions change which, in turn, affect the generation and propagation of landfill gas.

The impact of the concerns suggested above is that the magnitude of the confidence intervals which can be used to reflect the uncertainties in predicting responses to imposed pumping conditions, is sizable. Thus a means of interpreting, and in some cases rejecting, certain data outliers, which could thence be used to decrease the magnitude of the confidence intervals, can have significant merit.

An important finding of this recently-completed research study is that in fact, landfill temperatures are very useful for gaining an understanding of landfill behavior (and state) and in interpreting some of the anomalous data points. For example, overpumping of the landfill as a means of extracting additional quantities of landfill gas creates problems and thus interferes with subsequent short-term utilization of the landfill gas; this type of concern is of considerable importance for engineering design of facilities that wish to use landfill gas.

It is the intent of this paper to examine the utility of temperature measurements in landfills. The results of the case study application to the St. Thomas landfill site are presented and recommendations made for future temperature monitoring programs.

2. Case Study Area

The section of interest of the St. Thomas landfill site (owned and operated by St. Thomas Sanitary Collection Services Limited) was in operation from approximately 1967 to site closure in 1978. The landfill site received primarily domestic and industrial solid waste to a depth of approximately 12 m. The site was operated primarily as a sanitary landfill, using the cell method of operation with little daily cover. Presently there is approximately 0.3 m of final clay till cover soil.

A gas recovery and utilization system was installed in the fall of 1978 and modified in 1980. The gas recovery and utilization system consists primarily of two gas extraction wells, a pump house and a greenhouse facility. The completed system, depicted in Figure 1, extracts the gas from either one or both of the pumping wells and either pumps the gas to the furnace (inside the greenhouse) or wastes the gas to the atmosphere. It is estimated that the gas wells are located in waste deposited during 1972–73.

Monitoring of concentration, pressure and temperature levels at 57 monitoring probes was conducted at weekly intervals. The monitoring probes are installed at 3 m depth intervals in sixteen individual boreholes augered in the refuse and also immediately adjacent to the gas production wells. The landfill temperatures were measured at the bottom of the monitoring probes using a battery-powered Model 435C Tele-thermometer. The meter was connected to a temperature probe attached to a shielded cable which was lowered to the desired depth.