Geoelectrical Detection and Location of Leaks through Plastic Geomembranes

I. Introduction

The geoelectrical leak detection survey is the most practical method of testing of plastic geomembranes for any perforating damage after the geomembranes are installed on site. The method provides a cost effective tool to Construction Quality Assurance, helps to protect the environment as well as to save money.

A typical application of the method is testing of soil covered geomembranes (landfill liners), however, it is also suitable for other geomembrane applications such as lagoons, reservoirs, canals, etc...

II. Technical Description

The geoelectrical leak detection method exploits the electrical insulating properties of plastic geomembranes and is dependent on electric current transmitted through electrically conductive media on both sides of the membrane.

The method involves creation of an artificial electric field. The electrical field is generated by a DC power supply and a set of power electrodes placed on either side of the tested membrane (i.e. outside and inside of the inspected pond). Leaks are detected and located by mapping the electric potential across the inspected area. If the plastic membrane is not perforated, the voltage impressed across the membrane produces no or a very low current flow and a relatively uniform voltage distribution. If there is a perforating damage to the membrane, electric current flows through the puncture in the otherwise insulating membrane and causes a localised anomaly in the distribution of electric potential.

To carry out measurements, measuring electrodes have to be placed close to the inspected geomembrane. This can be done in two ways (i.e. the geoelectrical leak detection can be done in two ways):
A/ Walkover Geoelectrical Leak Detection Survey (utilizing a fully portable equipment)

B/ Fixed (built-in) Leak Detection System (some components permanently installed on site)
The WALKOVER SURVEY is normally conducted after the completion of the construction of the soil layer covering the geomembrane, before the landfill is put in operation. The survey is carried out with a fully portable set of equipment and does not include any additional material to be delivered and installed at site.
The BUILT-IN LEAK DETECTION SYSTEM allows for a long term monitoring of the integrity of the membrane. The geomembrane can be tested at any time after it has been covered with a protective soil layer or some liquid.

The system requires installation of some simple hardware along with the geomembrane. An array of sensing electrodes is usually placed into the clay layer under the membrane. The electrodes are via cables connected to a monitoring terminal(s) located near the perimeter of the monitored landfill/pond. The monitoring terminal allows for plugging a measuring device in order to take readings. In this way, the integrity of the geomembrane can be checked not only after the placement of the protective/drainage cover on the top of the membrane, but also repeatedly at any later stage. The system is technically quite simple, its installation is straightforward and would cause no delay to other works on site.

Typically, the measuring electrodes are arranged in a 10 x 10 m array. The electrodes are usually stainless steel, size approx. 100 x 30 x 1.2 mm. Multiwire cables are used (PVC inner coating, HDPE outer coating).

1 – copper core, 2 – PVC coating, 3 – shielding (Al, PE), 4 – Outer coating (HDPE)

Cables with electrodes are delivered to site in coils – typically 300m each.
Each electrode is attached to a cable which runs to the edge of the site into the anchor trench and along the anchor trench to a monitoring terminal. A standard monitoring terminal can accommodate connections to max. 128 (or 224) electrodes. For large cells multiple terminals are used.

Power electrodes are installed on the respective side of the membrane.

The best performance of the leak detection system is achieved in a single geomembrane system, where sensing electrodes are placed under geomembrane in a clayey soil (clay, sandy clay, clayey sand, bentonite enhanced sand, alternatively bentonite mat).

The standard life time of the BHF system is **5 years**. The life time can be extended on request by using more durable components (electrodes, cables, connectors).

**Manual, Semi-Automatic, and Automatic Electrical Leak Detection Systems are available:**

![BHF Fixed Leak Detection System – Terminal for manual and semi-automatic readings](image)
BHF Fixed Leak Detection System – Manual readings

BHF Fixed Leak Detection System – Semi-automatic modification with a portable automatic measuring station
BHF Fixed Leak Detection System - Automatic on-line modification.
BHF Fixed Leak Detection System - Automatic on-line modification.

Readings are taken automatically at pre-set intervals and results are sent electronically to the BHF office for interpretation. The system can also be controlled from the BHF office via a telephone line or internet. Some basic data interpretation is provided automatically for every set of readings and can be displayed on the site office’s computer screen.
Examples of Detected Leaks
Double liner systems

The leak detection system can also be used to monitor double liner systems. This application, however, has some more limitations than monitoring of single liner systems. This is because for some double liner design alternatives it is difficult to generate an electrical field in the intermediate layer.

The design of the electrical leak detection system has to comply with the design of the liner system. Ideally, before a given design is finalized it should be discussed with respect to the test feasibility. It means that, ideally, the design should be left open for some modifications.

Exposed membranes

Exposed membranes are tested with a water-puddle tester and/or a high-voltage spark-tester.