Dry Barrier Applications for Landfills

Technology Need

Landfills, surface impoundments, waste piles, and some mine tailings are required to be covered with an engineered cover, or cap, upon closure. The cover can vary from a simple soil cover to multiple layers of earthen materials and geosynthetics depending on regulations, risks associated with the waste materials, and conventional practice in a particular industry. Covers limit the downward movement of meteoric water through the waste and subsequent mobilization of hazardous constituents.

Improved landfill cover designs are needed. Many conventional designs feature a compacted soil layer, which can suffer from desiccation, root and animal intrusion, and other concerns. Geosynthetics, increasingly used in cover designs, do not address all of the shortcomings of compacted soil layers and can add substantially to the cost of the cover system. Alternative designs such as capillary barriers show promise, but they have not been widely applied, and their performance has not been fully demonstrated.

Project Description

The Dry Barrier concept is being developed as an additional component in a landfill containment system. A dry barrier is a layer of geologic material dried by air flow. Water that is evaporated from within the cover system by air flow is less likely to become leachate. To create a dry barrier, air flows into a layer within the cover where it accumulates water vapor as it passes through the layer and then emerges as moist air. As covers typically include multiple, laterally continuous layers with contrasts in material properties, air flow is channeled through relatively coarse, air-permeable layers (Figure above). Active and passive systems are possible, with the active systems using blowers and fans to move air through a high air-permeable layer.

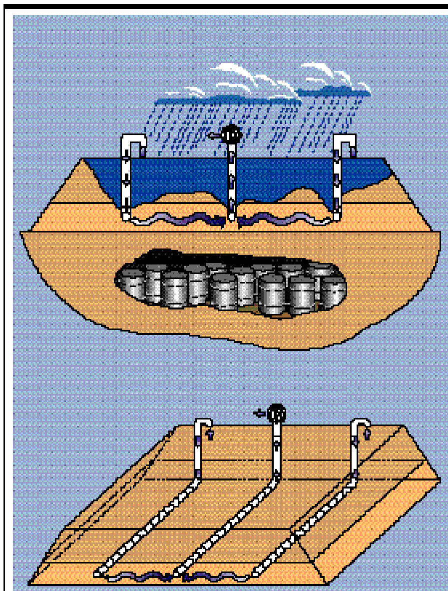


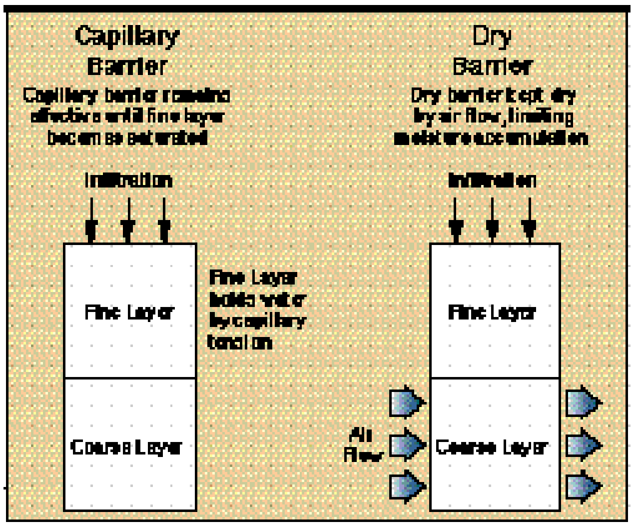
Figure 1. Dry Barrier Cover Application

A passive system exploits atmospheric phenomena such as pressure fronts, atmospheric tides, and wind to induce air movement through the coarse layer. A passive system could maximize the exposure of a coarse layer to prevailing winds or to exploit barometric pressure fluctuations. Other passive systems can be envisioned, including wind-powered and thermal vents, which would penetrate the coarse layer.

The principal design challenge for a dry barrier containment system is related to the air flow rates required to remove downward moving water. After water moves from the overlying fine layer to the coarse layer, it moves relatively quickly through the coarse layer into the underlying waste. This breakthrough happens periodically when the cover system has been subjected to sustained precipitation.

To intercept all of the water moving through the coarse layer, the air flow rate must be relatively great. These high air flow rates can only be accomplished with active systems using high output, high energy consumption blowers.

A substantial improvement to the dry barrier concept can be made by using a coarse layer material which has a significant primary storage. In this design, water which moves from the fine layer into the coarse layer is held by the primary storage of the coarse layer. Air flow through this layer can then remove the water over a much greater time than if the water was not held in the primary porosity of the coarse layer. Consequently, the air flow rate requirement can be met with smaller, less expensive blowers, and passive systems become viable because of the reduced air flow requirements.



A capillary barrier contrasted to a dry barrier.

Typical coarse layers, e.g., gravel, do not have primary storage because each particle is solid. Materials capable of water storage include non-welded tuffs, scorias, and sandstones. For example, the primary porosity of scoria is about 30%, and a typical secondary porosity for a coarse material is about 40%. A 1-m thick layer of this material can store about 18 cm of water. Depending on the site, the coarse layer storage may be able to hold the maximum amount expected to breakthrough from the fine layer. The water in the coarse layer could be removed over many months by an air flow rate that may be achieved with passive means such as wind turbines.

Advantages

Dry barriers, as compared to capillary barriers, when used in arid climates permit less downward movement of potential waste products (Figure above). As compared to compacted soil barriers, they are subjected to fewer problems related to desiccation and are also less expensive than multi-component covers.

Costs

The costs for a dry barrier system depends upon the existing cover design (e.g., is there already a coarse layer suitable for air flow?). Electricity costs amount to approximately 90% of an active system's operational cost. A passive system has no appreciable operating costs. More field data is needed to determine maintenance costs for both systems.

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