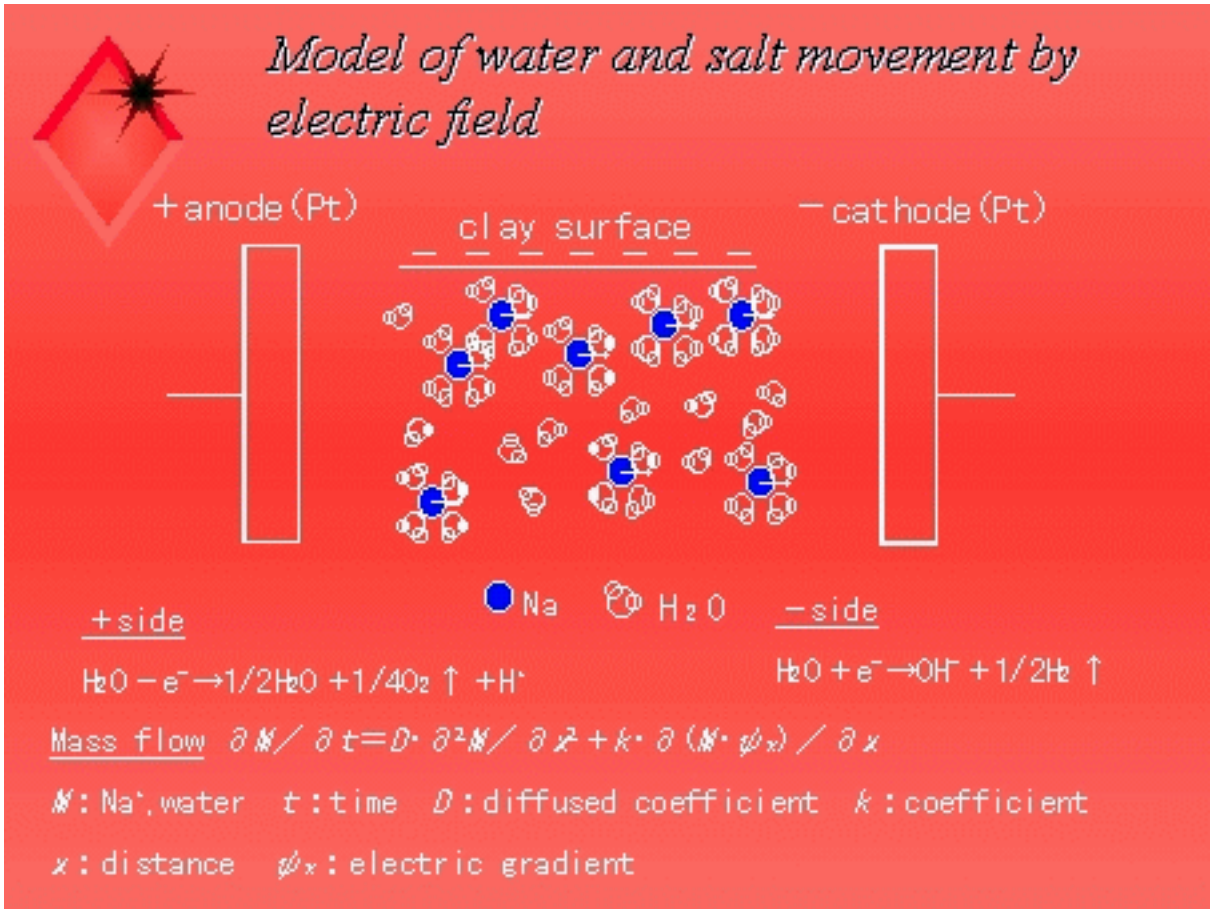
ELECTRO-OSMOTIC PULSING TECHNOLOGY LABORATORY

A Division of the **UWM Radon Research Laboratory**

What is "Electro-Osmosis" ?

When electrodes are placed across a clay mass and a direct current is applied, water in the clay pore space is transported to the cathodically charged electrode by electro-osmosis. Electro-osmotic transport of water through a clay is a result of diffuse double layer cations in the clay pores being attracted to a negatively charged electrode or cathode. As these cations move toward the cathode, they bring with them water molecules that clump around the cations as a consequen ce of their dipolar nature. In addition, the frictional drag of these molecules as they move through the clay pores help transport additional water to the cathode. The macroscopic effect is a reduction of water content at the anode and an increase in wate r content of the clay at the cathode. In particular, free water appears at the interface between the clay and the cathode surface. This excess of free water at the cathode has lubricating effects.



Background

The original electro-osmotic experiments showed that flow of water through a clay-water system (with the applying of an electric field to the soil) is initiated by the movement of cations that are closely attrac ted to the surface of the clay particles. Electro osmosis is possible in clay soils since clay minerals have a net negative charge. As a result of this charge, a gradient in electrical potential forms (O that extends into the water surrounding the particl e. Cations are attracted to the surface of clay particles when the soil is hydrated to balance the negative potential.

The cations that are attracted to the surface of the particle can be separated into two regions. The first region consists of cations, which are held tightly to the particle. This region is called the Stern layer. The second layer is the diffuse layer, where a layer of attracted but mobile cations extends into the surrounding liquid. These cations are attracted to the surface by the electrical potential but contumely move away from the particle because of thermal f luctuations. The concentration of cations in the double layer diminishes as the distance from the surface of the particle increases. Ultimately, the double layer blends into free water.

Electro-osmosis occurs in clay soils when cations in the double layer are driven by the

application of an electrical field, and as a result, a velocity field in the pore fluid develops, as shown in Figure 1. The ve locity distribution changes rapidly near the particle's surface, but then becomes flat at the edge of the double layer. Therefore, electro-osmotic flow appears as plug flow through the pores of soil.

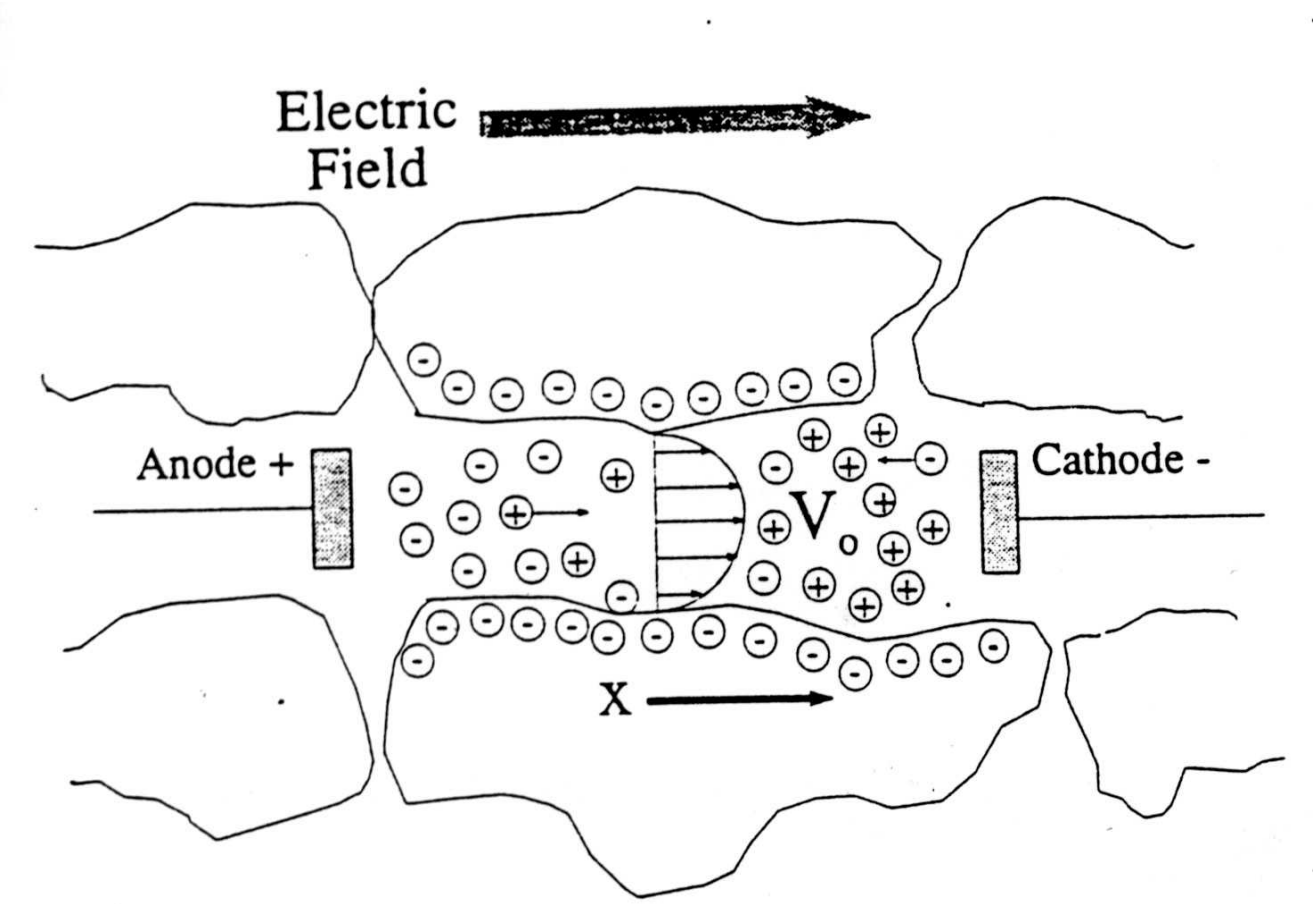
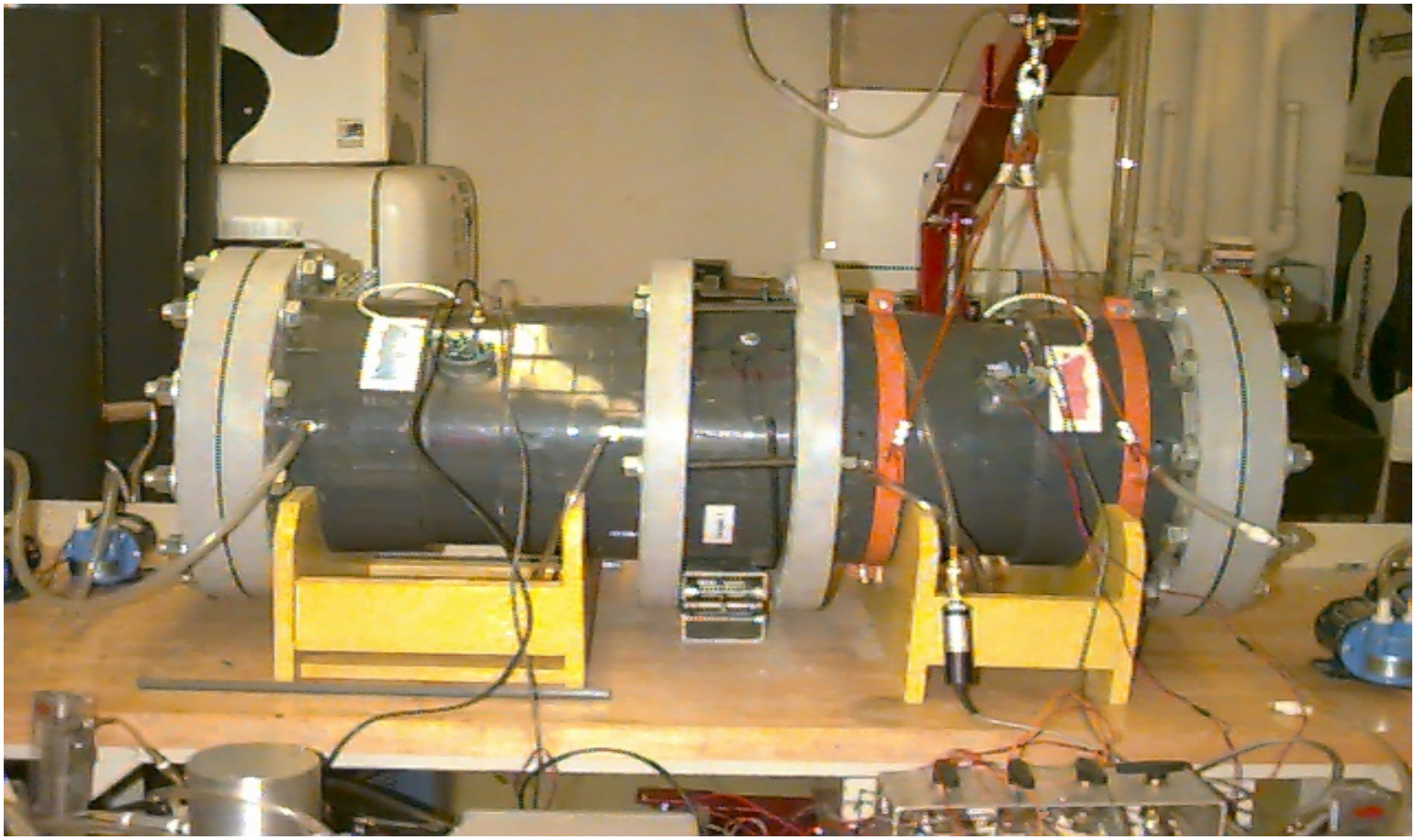


Figure 1. Movement of Cations in a Soil Pore by Electro-Osmosis.

Pulsating Electro-Osmosis

The pulsating electro-osmosis consists of a positive voltage pulse, a negative voltage pulse and a period when there is no voltage applied. Figure 3 shows an example waveform for the EOP system. The positive voltage pulse ha s the longest interval and the negative voltage pulse has the shortest interval. As a result of this, the pore fluid and cations move (on the average) in one direction.

The Electro-Osmosis Pulsing experiment apparatus :



The Schematic of Electro-Osmosis Pulsing experiment apparatus :