Dewatering a Clay Soil Slurry using Electrokinetics

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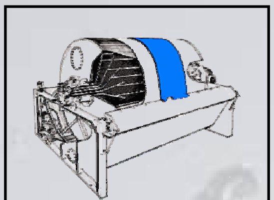
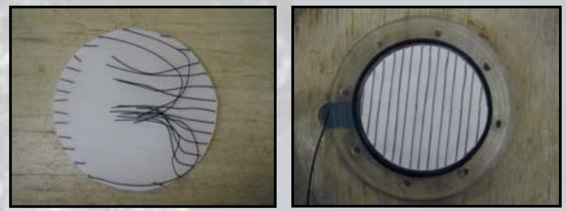
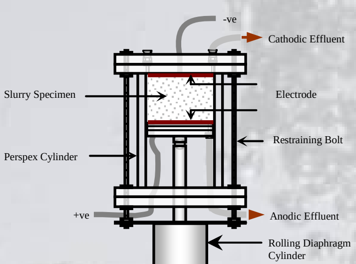


Examples of different solid-liquid separation techniques; sedimentation (left) and drum vacuum filtration (right)

Introduction: Slurry waste dewatering is of paramount importance since it concentrates the sludge by making it as dry as economically possible, consequently reducing transport and disposal costs. Conventional techniques for slurry dewatering are based on the application of mechanical forces. Two common principles are filtration and sedimentation. Mechanical dewatering, however, is costly in terms of capital and running costs. The systems are also technically inefficient especially when the waste has a high volume of fine solids of the order of 50 μm or smaller. Another important disadvantage of these mechanical methods is the strong dependence of the dewatering rate on the permeability of the sludge. Introduction of a technique in which the linear flow rate of the water in the pores is independent of the pore diameter would be attractive, especially for the dewatering of slurries containing fine particles for which dewatering is difficult. An example of such a technique is electrokinetic dewatering, i.e. by a combination of electroosmosis, which is defined as the transport of water through porous media under the influence of an electric field, and electrophoresis, the transport of solid particles in a liquid by an electric field.



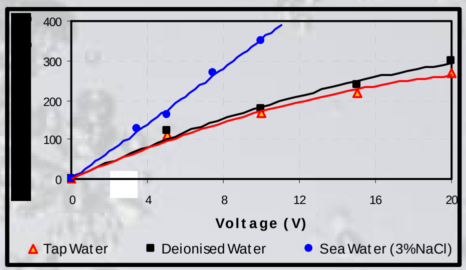
Electrode Preparation - In order to form an electrode system, titanium wires 0.7 mm in diameter, were fixed equidistantly onto a 2 mm thick polyester woven geosynthetic (141 mm in diameter). The ends of each wire were folded behind the filter cloth, joined and then connected to an insulated copper wire leading to the power supply.



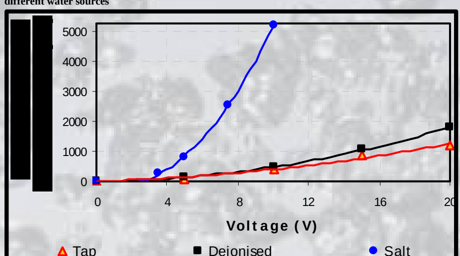
Schematic of Test Cell

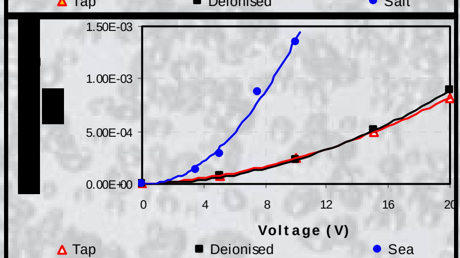
Objective: The aim of this research was to prove the concept, and thereby produce a generic technology, that can separate water from slurries, and clay particles from other fines, expediently, hone the technology for application in a wide range of industries.

Benefits: It is hoped that if the separation concept is practically-achieved and an economic system developed, it will permit both the recovery of the particulates and the reuse of the water to create a 'closed-loop' production process. Potential users of the technology would range from the aggregates industry to the food processing industry (where 'wash-water' could again be recycled and the residual soil-organics mixture potentially composted and blended with the clay-silt mixture above to create saleable topsoil).



Results of total effluent water versus potential applied for the clay specimens initially mixed with different water sources





Graphs show the different responses with respect to volume of gases evolved and power consumed as the applied voltage is increased

Results

Table showing summary of results

Property	Voltage (V)	Electrolyte: Deionised Water	Electrolyte: Tap Water	Electrolyte: Sea Water
Change in Temp (degC)	3.5	0	0	2.5
	5			6.8
	7.5			25.7
	10	7.5	5.5	55.9
	15	21.4	17.7	
	20	47.8	35.1	
Decrease in Water Content* (%)	3.5	19.8	17	18.4
	5			29.1
	7.5			29.2
	10	30.6	24.3	51.5
	15	38.8	34	
	20	45.1	36.7	
Total Effluent Volume (ml)	3.5			127.4
	5	121.5	110.0	163.8
	7.5			268.3
	10	473.6	166.4	351.6
	15	236.1	217.8	
	20	328.5	268.4	
Total Power Consumed (kWh) X 10^{-3}	3.5			2.53
	5	1.47	1.21	8.27
	7.5			28.4
	10	6.74	5.99	69.0
	15	19.7	16.9	
	20	40.2	328.5	

* Engineering water content measured as the ratio of mass of water to mass of dry solids

Test Cell. Laboratory-scale EK dewatering apparatus consisted of two main parts: a cylindrical perspex specimen compartment (236 mm long and 143 mm in diameter) and a piston connected to a rolling diaphragm cylinder for application of a back pressure. The former was made of perspex because of its chemical resistance to the acid and alkali environments generated by the electrode reactions.

Methodology: In this study, dewatering of the London clay slurry is studied using the electrokinetic processes. A laboratory-scale dewatering apparatus was developed based on a 236mm long and 143mm diameter cylindrical perspex cell. Slurry was poured into the cell and sandwiched between two geosynthetic (with conductive elements embedded in them) and back pressure load of 75 kPa applied. The testing programme specifically addressed treatment of 50 mm thick specimens. A maximum voltage gradient of 4 V/cm was applied to induce the movement of water within the specimen for a time period of one hour.

Results show that:

1. Electrokinetic process contributes significantly to dewatering of clay slurries
2. Specimens mixed with saline water dewater better and but consume more energy.
3. The higher potential used in treatment, the more power is used. However, higher energy consumption results in higher water removals.
4. Increasing voltage also increases process associated with gas emissions such as electrolysis

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