EXECUTIVE SUMMARY

Objectives

The problems associated with sludge dewatering are widely appreciated and the search for improved dewatering techniques is being pursued worldwide, with new approaches and associated equipment regularly appearing on the market.

Recognising the importance of sludge handling and utilisation technologies the Water Research Commission entered into a two year contract with the CSIR Division of Water Technology to investigate the electroosmotic (EO) sludge dewatering which presents a novel approach in South Africa. This investigation had four objectives:

1. Literature review on the role of sludge liquid structure in sludge dewatering.

2. Laboratory investigation of electroosmotic dewatering and sludge behaviour when subjected to electroosmotic process.

3. Study of sludge dewatering using partly built (one stage) electroosmotic filter-belt scale model.

4. Investigation of sludge dewatering using the two stage electroosmotic filter-belt scale model.

Conclusions and recommendations

The literature review, which was undertaken as the first stage of the investigation, highlighted an important aspect of sludge behaviour and that is that the physical and chemical phenomena, which occur in the interface of the electric double layer, are indicative of the importance of the individual liquids fixed in the sludge particle. Better understanding of the distribution of water and of the forces that bind water within the sludge may lead to better dewatering performance. Inefficiency of mechanical dewatering in removing liquids held within electric double layer (minute capillary structures), can be overcame by dewatering enhanced by electroosmosis.

From laboratory experimental results it was concluded that electroosmotic dewatering has the ability to remove the liquid which is hard to remove using conventional methods.

Scale model of a filter-belt device, in combination with electroosmotic dewatering was developed and partly built. It was found that the

experimental results support the preceding laboratory results. It seems that EO can be particularly effective in dewatering of biological or chemical gelatinous and fine-particle sludges too difficult for mechanical dewatering.

Significant advantage of EO can be observed when applied in filtration processes. Blinding of the filter media, which is recognised as a major drawback of filtration, is markedly reduced by EO.

Upon completion of the electroosmotic two stage scale model and experimental trials the preceding findings were confirmed.

The uniqueness of the concept has been proven in the following respects:

1. The operational criteria can be tailored to each type of sludge which will provide greater flexibility in practical dewatering applications.

2. During electroosmotic dewatering major changes in cake structure take place which produce crumbly cake consistency, suitable for beneficial re-use or safe and cost-effective final disposal. This specific sludge cake consistency cannot apparently be achieved by conventional dewatering methods.

3. The success of electroosmotic dewatering depends on electrical characteristics of the sludge. It is found that all investigated samples of waste activated sludges could be dewatered to an average solids concentration of 15% and consistency of a crumbly sludge cake which can be stacked for further air drying or easier and cheaper transport.

4. Efficiency of electroosmotic dewatering improves with the increase in initial sludge solids concentration. Therefore, sludge needs to be prethickened to a highest possible solids concentration, prior subjecting it to EO dewatering. Because there is large installed capacity of centrifuges and vacuum filters, EO filter-belt press can be used to reduce moisture content of previously formed sludge cake.

5. Significant reduction in polyelectrolyte use is attributed to electroosmotic dewatering. Minimum dosage of 0,5 to 2,0 kg/Tds is recommended to be used for activated and anaerobically digested sludges respectively.

6. The comparison of energy consumption of the three commercially available dewatering machines, i.e. centrifuge, filter press and filter-belt press, with electroosmotic scale model of filter-belt press illustrates that the range of 0,08 to 0,13 kWh/kgds attributed to the EO dewatering does not exceed the values reported for the full-scale equipment.

7. The most recent experimental trials proved that the EO filter-belt can produce sludge cake of solids concentration reaching 45 percent which complies with a most stringent world standards.

8. The EO experimental filter-press, being a scale model of the full-scale plant, can supply only general criteria to be used in the final design of a prototype pilot-plant due to it's practical limitation which preclude valid insight into variables such as throughput, belt speed, voltage, gap between belts, etc. The trials of the proposed technical scale pilot-plant will be the occasion when questions regarding operational variables can be investigated and answered.

The above findings are sufficient to justify the investment in a prototype pilot-plant which, upon incorporation of structural and mechanical improvements, can be optimised for factory production and sales as a proven unit.

Since this report was first written, further developments concerned with design and construction of the prototype pilot-plant have taken place.

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* The members of the Steering Committee of the project:

Dr S A Mitchell	-	Water Research Commission (Chairman)
Mr H G J Beekman	-	Cape Town City Council
Prof G Ekama	-	University of Cape Town
Mr F P Marais	-	Water Research Commission (Committee Secretary)
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FINAL REPORT to the WATER RESEARCH COMMISSION
on a two year exploratory study on the
DEVELOPMENT of ELECTROOSMOTIC SLUDGE DEWATERING TECHNOLOGY

(1992 - 1993)

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LIST OF SYMBOLS

Symbol	
A	Ampere
AD (1)	Anaerobic Digestion (primary sludge)
AD (2)	Anaerobic Digestion (mixture primary & activated)
AeD	Aerobic Digestion
BF	Biological Filter
CST	Capillary Suction Time (s)
DAF	Dissolved Air Flotation
E	Potential drop between the electrodes (V)
E_w	Energy requirement ($kWh.m^{-3}$)
e	Dielectric constant of the interstitial liquid
EO	Electroosmosis
G	Centrifugal acceleration in gravities
K_o	Electroosmotic coefficient
L	Distance between electrodes (m)
P	Pressure drop - Poisseuille's equation (Pa)
Q	Volume of filtrate removed by electroosmosis (m^3)
Q_o	Initial volume of sludge to be dewatered (m^3)
R	Specific electric resistance ($\Omega m^2.m^{-1}$)
R_h	Hydraulic retention time in digester (d)
R_s	Solids retention time - sludge age (d)

SRF	Specific resistance to filtration ($m.kg^{-1}$)
t	Time of electroosmosis (min)
V	Applied voltage (V)
W	Watt
WAS	Waste activated sludge
WAS (1)	Waste activated sludge (N removal)
WAS (2)	Waste activated sludge (P & N removal)
η	Viscosity of the suspension at the ambient temperature (Pa.s)
λ	Specific conductivity (mS)
ξ	Zeta potential (mV)
Z	Zimpro sludge (heat treated primary sludge)