Technology Development Program:
ElectroKinetic Reclamation Dewatering Technology
(EKR-DT)

Process Optimisation Testing:

Overview of Research Design

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1 BACKGROUND

EKS is in the midst of an intensive process optimisation testing program; the results of which will allow the design and operation of commercial-scale installations of the EKR-DT process to be as economical and reliable as possible. This document provides an overview of the tests that are being conducted.

EKS has prepared a detailed research design document that lays out in detail for each test:

- The primary and secondary research questions/hypotheses,
- The experimental design,
- The test apparatus setup,
- Expected outcomes,
- Significance of findings, and
- Scheduling of steps.

EKS has developed a customised model (EKR_Mod) that is designed to assist with the engineering design of EKR-DT installations. The EKR_Mod is also essential for achieving the most efficient and reliable operation of EKR-DT systems. Version 2.1 of the EKR-Mod has been developed and tested. V2.1 is suitable for engineering design. However, V3.0 is being developed to provide the ability to operate EKR-DT systems most efficiently and reliably. The results from many of the tests being conducted as part of this program will feed directly into V3.0.

2 COMMISSIONING TEST

EKS conducted a commissioning test at the start of the process optimisation program. The purpose of this test was to gain experience with the test apparatus and the loading, dewatering and decommissioning procedures. A secondary purpose of the commissioning test was to conduct initial investigations into the dewatering behaviour of FFT as the density increases. Subsequent tests are planned to explore this dynamic in much greater detail.

The commissioning test has been completed and proved to be fruitful for refining the experimental procedures and protocols. Equally so, this test has yielded valuable insights into the dewatering behaviour of the process that will improve significantly the experimental design of future tests.

3 HIGH % SOLIDS

EKS has conducted previous tests with FFT having relatively low initial % solids (e.g. <40%) and dewatering to 50-55% solids. The EKR-DT process has the capability to dewater beyond this range. The high % solids tests are designed to confirm dewatering behaviour with higher % solids FFT.

More specifically, these tests are designed to address the following research questions:

- How does the rate of dewatering change with solids content?
- How does the energy required for dewatering change with solids content?
- Do the rate and energy requirements for dewatering FFT with different levels of solids content change with different voltage gradients?

4 POWER OPTIMISATION

The primary operating cost with the EKR-DT process is electricity. Increasing the energy efficiency of the process can yield major cost savings. These tests are designed to refine understanding of the functions that regulate energy efficiency. Of particular interest is confirming how these functions react as the dewatering process proceeds.

More specifically, these tests are designed to address the following research questions.

- How are dewatering rate and energy efficiency affected by:
  - Variations in the applied power?
  - Current intermittence? and
  - Polarity reversals?

5 SCALING FACTORS

The EKR_Mod is based on fundamental electrical, physical and chemical principles. The structure allows precise and accurate dewatering performance forecasts for EKR-DT systems having different dimensions, FFT characteristics and applied power schedules. This set of tests is designed to confirm the reliability and accuracy of the scaling factors on which the EKR_Mod is based.

More specifically, these tests are designed to address the following research questions.

- How are dewatering rate and energy efficiency affected by:
  - The vertical separation distance between the cathodes and anodes?
  - The horizontal separation between the cathodes and anodes?
  - The ratio of anodes to cathodes? and
  - The voltage gradient?

6 ANODE CONSERVATION

During the EKR-DT process, electrochemical reactions occur in the vicinity of the electrodes. A critical engineering design consideration is ensuring that the electrodes remain functional throughout the dewatering process. The functionality of the anodes can be compromised by:

- Corrosion due to electrolysis and the acidic environment that is produced by electrolytic reactions,
- Dehydration due to water being drawn away from the anodes toward the cathodes,
- Excessive local consolidation increasing the electrical resistance, and
- Gas formation impeding the movement of water and ions.

The purpose of this set of tests is to refine understanding of the factors regulating each of these reactions and their overall impact on the EKR-DT process.

More specifically, these tests are designed to address the following research questions.

- Is the rate of metal loss from the anodes affected by:
  - The applied power signature?
  - The total amount of current flowing through the anode?

  - The anode dimensions? and
  - Their composition?
- Is the rate of anode dehydration affected by:
  - The applied power signature?
  - The % solids of the underlying FFT? and
  - The initial % solids of the FFT?
- Is the rate of anode consolidation affected by:
  - The applied power signature?
  - The % solids of the underlying FFT? and
  - The initial % solids of the FFT?
- Is the rate of gas formation affected by:
  - The applied power signature?
  - The initial % solids of the FFT?
  - The stage in the dewatering process? and
  - The chemical nature of the FFT?

7 IMPACT OF FLOCCULANTS

Flocculation and centrifugation are currently being used to dewater FFT. One application of the EKR-DT process is to accelerate the dewatering of FFT that has been partially dewatered with current technologies. The purpose of this set of tests is to assess the impact of partial dewatering with flocculants on the dewatering performance of the EKR-DT process.

More specifically, these tests are designed to address the following research questions.

- How are dewatering rate and energy efficiency affected by:
  - The type of flocculants present?
  - The concentration of flocculant? and
  - The initial % solids of the FFT?

8 BOUNDARY EFFECTS

During the dewatering process, water moves upward from the material underlying the anodes. This movement occurs whether the underlying material is FFT or native overburden. One of the commercial deployment options for the EKR-DT process is to create a geotechnically stable cap over an FFT deposit. In this application, dewatering of the material below the anodes can provide a number of benefits and savings. The purpose of this set of tests is to determine the impact of the underlying boundary on the EKR-DT process.

More specifically, these tests are designed to address the following research questions.

- How are dewatering rate and energy efficiency affected by:
  - The presence of FFT below the dewatering zone?
  - The % solids of the underlying FFT? And
  - The applied power signature?