# Soil Remediation for Contaminated Soil from Heavy Metals by Electrokinetic Process

**RESEARCH MANAGEMENT INSTITUTE (RMI)**
**UNIVERSITI TEKNOLOGI MARA**
**40450 SHAH ALAM, SELANGOR**
**MALAYSIA**

**BY :**

**Sabariah binti Arbai**
**Haryati binti Awang (Ph.D)**
**Sabiha Hanim bt Salleh**
**Azinoor Azida Abu Bakar**
**Zainab binti Mohamed (Ph.D)**

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## Contents

## 2. Letter of Offer (Research Grant)

UNIVERSITI TEKNOLOGI MARA

PEMENANG Anugerah Kualiti Perdana Menteri 2008

Surat Kami : 600-RMI/ST/FRGS 5/3/Fst (278/2010)
Tarikh : 30 Disember 2010

**Pn Sabariah Arbai**
Fakulti Kejuruteraan Awam
Universiti Teknologi MARA
**40450 Shah Alam**

Y. Brs. Prof/Tuan/Puan

**KELULUSAN SKIM GERAN PENYELIDIKAN FRGS FASA 2/2010**

| | | |
|---|---|---|
| Tajuk Projek | : | pH Performance to Temperature Controlled for Heavy Metals Desorption Capacity from Contaminated Site |
| Kod Projek | : | 600-RMI/ST/FRGS 5/3/Fst (278/2010) |
| Bidang | : | Sains Tabii dan Warisan Negara |
| Tempoh | : | 27 Disember 2010 – 26 Disember 2012 (24 bulan) |
| Jumlah Peruntukan | : | RM 50,000.00 |
| Ketua Projek | : | Pn Sabariah Arbai |

Dengan hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan pihak Kementerian Pengajian Tinggi melalui surat JPT.S(BPKI) 2000/011/010 Jilid. 5 (54) telah meluluskan cadangan penyelidikan Y. Brs. Prof./tuan/puan untuk di biayai di bawah Skim Geran Penyelidikan Fundamental (FRGS) Fasa 2/2010.

3. Bagi pihak Universiti kami mengucapkan tahniah kepada Y. Brs. Prof./tuan/puan kerana kejayaan ini dan seterusnya diharapkan berjaya menyiapkan projek ini dengan cemerlang.

4. Peruntukan kewangan akan disalurkan melalui tiga (3) peringkat berdasarkan kepada laporan kemajuan serta kewangan yang mencapai perbelanjaan lebih kurang 50% dari peruntukan yang diterima.

| | |
|---|---|
| Peringkat Pertama | 20% |
| Peringkat Kedua | 40% |
| Peringkat Ketiga | 40% |

5. Untuk tujuan mengemaskini, pihak Prof./tuan/puan adalah diminta untuk melengkapkan semula kertas cadangan penyelidikan sekiranya perlu, mengisi borang setuju terima projek penyelidikan dan menyusun perancangan semula bajet yang baru seperti yang diluluskan. Sila lihat lampiran bagi tatacara tambahan untuk pengurusan projek.

Sekian, harap maklum.

**"SELAMAT MENJALANKAN PENYELIDIKAN DENGAN JAYANYA"**

Yang benar

**MUSTAFAR KAMAL HAMZAH**
Ketua Penyelidikan (Sains dan Teknologi)

Penolong Naib Canselor (Penyelidikan) : 603-5544 2094/2095
Bahagian Penyelidikan : 603-5544 2090/2091/2101/5521 1462
Bahagian Penerbitan : 603-5544 1403/2785
Bahagian Sokongan ICT : 603-5544 3097/2104/5521 1461
Bahagian Kalira : 603-5544 2098/5521 1463
Pejabat Am : 603-5544 2559/2057/5521 1636
Penolong Pentadbiran : 603-5544 2090
Fax : 603-5544 2096 / 2767
Unit Kewangan Zon 17 : 603-5544 3434
: 603-5521 1386
Research Management Institute (RMI) Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
http://www.rmi.uitm.edu.my

# 5. Report

## 5.1 Proposed Executive Summary

Contaminated sites with heavy metals, organic compounds and hazardous materials added with inefficient waste handling techniques, leakages and untreated abandoned mines made enormous impact to groundwater quality, soils and ecosystems. Electro-chemical principle, known as electrokinetic method is a greatly potential treatment of heavy metal in contaminated soils, including soils of low permeable clays (Rutigliano et.al 2008); and groundwater (Cherifi et.al., 2009). (Colletta et.al., 1997) stated that purging liquids of certain pH is important for heavy metal migration and molar concentration, while Fabienne et.al. (1999) stated that temperature mainly influences the ionic velocities with changes in partitioning of heavy metals.

The study will identify and evaluate the amount of heavy metals in the collected contaminated soil samples, investigate physical characteristics of soils and relate to the chemical concentration levels of heavy metals, thus recommending the optimum temperature for efficient removal of heavy metals with appropriate pH. In this study, there are two types of specimen, i) site specimen, and ii) prepared specimen. For the site specimen, the physical characteristics and chemical concentration will be identified. For chemical concentration of both site and prepared samples, samples are digested and analyzed using ICP-MS equipment. For the prepared specimen, fresh clay specimen are spiked, compacted of low concentration heavy metals and will be run using electrokinetic under controlled pH and temperature. The purging liquids will be prepared in the electrode reservoirs to provide an appropriately-controlled pH for heavy metals adsorption. The electrokinetic tests will be performed onto 80 prepared spiked samples with initial concentration to a final concentration, each set of 240 hrs duration, temperature set and observed with daily pH monitored and recorded. The removal efficiency for optimal heavy-metal desorption, initial and final pH of the slurry specimen at 5 positions on the test-cell will be recorded, computed and analyzed.

## 5.2 Enhanced Executive Summary

The application of electrokinetic method to drive the elements of heavy metal has a great potential for contaminated soil remediation. An experimental model of electrokinetic setup was developed to investigate the performance of electroosmosis and ion migration thus lead for removal of four most significant heavy metal elements such as copper (Cu), iron (Fe), aluminum (Al) and zinc (Zn). The concentration and characteristics of heavy metal elements from the electrokinetic process was determined from laboratory testing by using DR 5000 Spectrophotometer. The efficiency of electrokinetic method for remediation of contaminated soil has introduced by the performance of electroosmotic flow and hydraulic flow by applying the Helmholtz-Smoluchowski equation and Poiseuille's law equation respectively. Significantly, the average flow rate of electroosmotic flow is higher up to 20 % compared to hydraulic flow. Besides contributed by electrical properties of soil such zeta potential and dielectric constant, the electroosmosis flow is highly influenced by the permeability characteristic of contaminated soil that measured by the rate of speed water passing through. The influence of soil permeability in electrokinetic method was presented by comparative analysis results from falling head test. Determination for coefficient of permeability in electroosmotic, $k_e$ introduces 70 % higher compared to the hydraulic coefficient of permeability, $k_h$. For higher efficiency of heavy metal removal in electrokinetic process, temperature was recognized as an important factor to affect the rate at which chemicals dissolve and react. The temperature effect was observed and found the optimum temperature is 30°C to 35°C can gives the higher efficiency of heavy metals removal in electrokinetic process. The temperature effect from the electrokinetic process was evaluated from the remediation of lead (Pb) and zinc (Zn) in contaminated soil sample. Additional indicator for heavy metal removal efficiency is also represented by acidic concentration at anode and cathode. The changes value of pH in anode and cathode was related with the movement of ion migration as the heavy metal's ions passing through the electrokinetic cell in soil decontamination. As the process of electrokinetic happen within seven days, the pH value at anode was decreased while the pH value at cathode was increased.