International Conferences on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics

2010 - Fifth International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics

26 May 2010, 4:45 pm - 6:45 pm

New Methods to Remove Arsenic from Soils

R. N. Khare

Shri Rawatpura Sarkar Institute of Technology, India

Recommended Citation

Khare, R. N., "New Methods to Remove Arsenic from Soils" (2010). *International Conferences on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics*. 30.
https://scholarsmine.mst.edu/icrageesd/05icrageesd/session01b/30

Fifth International Conference on
Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics
and Symposium in Honor of Professor I.M. Idriss
May 24-29, 2010 • San Diego, California

NEW METHODS TO REMOVE ARSENIC FROM SOILS

Dr. R. N. Khare
Principal
Shri Rawatpura Sarkar Institute of Technology
Raipur (C.G.)-491006
India
rn_khare@rediffmail.com

ABSTRACT

In Chhattisgarh State, arsenic content in soil is usually moderate to high.. However, on some industrial sites like in Bhilai Steel Plant Bhilai, certain effluent discharges can lead to high concentrations of this chemical in the soil. After periods of rainfall and run-off, arsenic can also be found in water. In this context, Indian researchers investigated the potential of contaminations to remove arsenic from contaminated soils and waters. In addition, Electrokinetic model is developed in laboratory which has shown that, depending on soil conditions, these models are able to remove heavy metals in polluted soils by 85-90%. Overall, this research paper provides new insights into the decontamination and the bioremediation method of soils.

INTRODUCTION

This paper presents the results of an experimental investigation undertaken to evaluate different purging solutions to enhance the removal of contaminants, particularly arsenic from low buffering clay, specifically kaolin, during electrokinetic remediation. Experiments were conducted on kaolin spiked with As (III) and As (IV) in concentrations of 100, and 50mg/kg, respectively, which simulate typical electroplating waste contamination. A total of five different tests were performed to investigate the effect of different electrode purging solutions on the electrokinetic remedial efficiency. A constant DC voltage gradient of 1 V/cm was applied for all the tests. The removal of heavy metals from the soil using tap water as the purging solution was very low. When 1 M acetic acid was used as the purging solution in the cathode, the removal of arsenic was increased to 20%, respectively. Using 0.1 M ethylene diamine tetraacetic acid as the purging solution in the cathode, 83% of the initial As was removed.A sequentially enhanced electrokinetic remediation approach involving the use of water as a purging solution at both the anode and cathode initially, followed by the use of acetic acid as the cathode purging solution and a NaOH alkaline solution as the anode purging solution was tested. This sequential approach resulted in a maximum removal of As (III) and As (IV) 68–71, and 71–73%, respectively. This study shows that the sequential use of appropriate electrode purging solutions, rather than a single electrode purging solution, is necessary to remediate multiple heavy metals in soils using electrokinetics.

EXPERIMENTAL METHDOLOGY & TEST SETUP

The electrokinetic test setup (reactor) is used for the study. The setup consists of an electrokinetic cell, two electrode compartments, two electrode reservoirs, a power source, and a multimeter. The Plexiglas cell had an internal diameter of 6.2cm and a total length of 35cm. To control the flow into the cell each electrode compartment consists of a valve, a slotted graphite electrode, and a porous stone. The electrode compartments were connected to either end of the cell using screws. The electrode reservoirs were made of 3.8 cm inner diameter Plexiglas tubes and were connected to the electrode compartments using Tygon tubing. Exit ports were created in the electrode compartments, and the tubing was attached to these ports to allow the gases generated due to the electrolysis of water to escape. The other end of these gas tubes was connected to the reservoirs to collect any liquid that was removed along with the gases. A power source was used to apply a constant voltage to the electrodes, and a multimeter was used for monitoring.

OBSERVATIONS

Table 1 below shows the testing program and the variables used in the five different electrokinetic tests.

Table – 1
VARIATIONS OF CONTAMINANTS

TEST	DESIGNATION	CONTAMINANT CONCENTRATION	INITAIL MOISTURE CONTENT (%)
1.	RNK – I	As (III) – 100, As (IV) – 50.	30
2.	RNK – II	As (III) – 100, As (IV) – 50.	50
3.	RNK – III	As (III) – 100, As (IV) – 50.	70
4.	RNK – IV	As (III) – 100, As (IV) – 50.	30
5.	RNK – IV	As (III) – 100, As (IV) – 50.	30

Table - 2
COMPOSITION AND PROPERTIES OF ALLUVIAL SOIL OF KAUDIKASA SITE

PROPERTY	VALUE
Mineralogy	Kaolite: 100 %
Particle size distribution (ASTM D 422) Gravel Sand Silt Clay	78 % 12 % 08 % 02 %
Atterberg Limits (ASTM D 2487) Liquid limit Plastic limit Plasticity index Specific gravity (ASTM D 854)	56.00 % 30.40 % 25.6 % 2.60
Moisture – unit weight relationships Maximum dry unit weight Optimum moisture content Hydraulic conductivity Cation exchange capacity (ASTM D 9081) pH (ASTM D 4972) organic content (ASTM D 2974) USCS classification (ASTM D 2487)	15.4 KN/m^3 29 % 1.0 *10 $^{-8}$ cm/sec 1.0 – 1.6 meq/100 g 5.9 Near 0 % CL

TESTING PROCEDURE

Approximately 1100 gm of dry soil was used for each test. Arsenic as source of As (III) and As (IV). The amounts of chemicals to yield the desired concentration were weighed and dissolved separately in deionized water. These contaminant solutions were then added to the soil and mixed thoroughly with a stainless steel spatula in container. The amount of deionized water that was used was according to the testing program in table (1). The contaminated soil was then placed in the electrokinetic cell in layers and compacted uniformly using a hand compactor. The weight of soil required in the reactor was determined and the soil-water-contaminant mixture was equilibrated for 24 hours. The electrode compartments were then connected to the electrokinetic filter papers were inserted between the electrodes and the porous stone and soil. The electrode compartments were connected to the anode and cathode reservoir using Tygon tubing. The reservoirs were then filled with deionized water. Throughout the test duration, the elevation of water in both the reservoirs was monitored and adjusted to prevent a hydraulic gradient forming across the specimen. The electrokinetic cell was hen connected to the power supply and a voltage gradient of 1.0 VDC/cm was applied to the soil sample. The electric current and voltage across the soil sample as well as the water flow at the anode and cathode reservoir was measured different time periods throughout the duration of the experiment. Each test was terminated after operating for 120 hours.

At the completion of each test, aqueous solutions from the anode and cathode reservoirs and the electrode assemblies were collected and the volumes measured. Then, the reservoirs and the electrodes assemblies were disconnected, and the soil specimen was extruded from the cell using a mechanical extruder. The soil specimen was sectioned into five parts at distance of 0 to 4 cm (section 1), 4 to 8 cm (section 2), 8 to 12 cm (section 3), and 12 to 15.5 cm (section 4), and 15.5 to 19.1 cm (section 5), from the anode, respectively. Each part was weighted and preserved in a glass bottle.

CONCLUSIONS

This paper provides an overview of electrokinetic remediation and presents the result of five bench-scale electrokinetic experiments performed to investigate the effect of initial moisture contents and initial contaminant concentration on contaminant migration and removal in arsenic bearing soils. The first three experiments were conducted using different moisture contents of 30, 50 and 70, with same contaminants As (III) and As (IV) at contamination concentration of 100 and 50 mg/kg, respectively. Then two additional experiments were conducted at same contaminate concentration but with same moisture content. Overall, it was concluded that the initial moisture content affects the electrokinetic process but it does not significantly influence the migration and removal of heavy metal contamination, and the result indicates that the initial contaminant concentration affects the migration and removal, but the effect is dependent on the type and concentration of the heavy metal contaminants that are present.

REFERENCES

McKinney, R. E., (1962). Microbiology for Sanitary Engineers. McGraw-Hill Book Company, Inc., New York, 293:22

Strauss, E., (1999). A Symphony of Bacterial Voices. Science 284(5418): 1302-1304.