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After the fire: cleaning up Kuwait

Oil lake, bounded by typical aerial tailout contamination, reflects oil fires burning in the Kuwaiti desert.

Heavily contaminated desert soils pose massive remediation challenge

By Nader Al-Awadhi, Kenneth Williamson and Jonathan Isok

Of all the petroleum contaminated soil sites on earth, none is more notorious than images of the Kuwaiti desert at the end of the Iraqi occupation over a year ago. What remediation plan will be able to tackle such a massive project?

The destruction of Kuwait’s oil production facilities at the conclusion of the Iraqi occupation resulted in massive pollution of both the marine and terrestrial environment. While the marine environment has undergone significant natural removal of the oil contamination, the desert soils remain damaged with little or no change.

For the soils, two kinds of contamination has occurred: oil from the discharging oil wells, and oil and combustion products from the oil fires that burned for eight months. The volume of oil from the discharging oil wells is estimated at over 60 million
barrels and has collected in small depressions to form over 70 oil lakes with an area of over 2,300 hectares. The surface area of the aerial fallout is estimated at 1,400 square kilometers.

The greatest concern related to the oil is the potential migration into groundwater aquifers with subsequent exposure to humans through water or food. Much of the terrestrial oil contamination will have to be remediated with sophisticated treatment technologies to restore the potential of Kuwait’s land for plant and animal production and to reduce health risks for the human population. A large number of diverse technologies are available for such a remediation effort. The technologies must be evaluated for their efficiency and effectiveness of treatment, cost benefits related to risk reduction, applicability to the Kuwaiti environment and environmental impacts associated with application.

The density of the oil in the lakes after water extraction is near 1.0 kilograms per liter, with most values in the range of .93 to 1.01 kilograms per liter. The specific gravity of Kuwaiti oil is typically less than 0.94. The higher values in the lakes probably have resulted from selective evaporation of the volatile organic compounds. The volatile components of Kuwaiti oil has been reported to be about 8 percent. The quality of oil depends on the content of lower molecular weight hydrocarbons. As such, cost recovery estimates of the oil from the lakes and the contaminated soils cannot be based on market prices for oil directly from the oil fields.

Generalized maps of the locations of the oil lakes and groundwater aquifers are shown in Figures one and two, page 9. Important aquifers in the Al-Raudhatain and Umm Al-Aish areas and the Al-Wafra area are shown in Figure two. The area of the oil lakes can be estimated from existing maps. However, the size of other contaminated areas, such as from dried or burned oil lakes, and various forms of aerial fallout remain unknown. These data will be integral parts of the feasibility study of any plan for the remediation of the contaminated soils.

Typical soils have a void volume of about 40 percent. As such, one liter of soil with the voids saturated with oil contains about 400 grams of oil and 1,560 grams of soil. The resulting oil content, then, is about 20 percent and represents a maximum value. Soils contaminated to this level are referred to as heavily contaminated.

For a dry soil, the penetration of the oil into the soil can predicted, based upon equilibrium between capillary forces and static forces of the oil column. Equating these forces, the resulting height of oil is given by the Hobson Equation as:

$$ H = \frac{\Sigma \alpha_a}{2 \cdot r g \cdot j} $$

where:

- \( H \) = height of oil (penetration into the soil plus pool height)
- \( \Sigma \alpha_a \) = oil-air surface tension

Continues on page 8→

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deepth of about 50 to 100 meters. In the Raudhatain area, the gravelly soils have sufficient permeability to eventually allow deep migration into the aquifer.

In the Ahmadi and Burgan Fields, the soil is much less permeable, and is underlain with a gypsum-like layer near the surface. The only adjacent aquifer at Al-Abadaliyah contains brackish water and is already extensively polluted with oil.

Near these aquifers, oil migrates with each major storm as the water permeates the soil. The Raudhatain aquifer is thought to be an unconfined aquifer that is replenished from precipitation. Studies are required to determine the potential for storms to move the oil deeper into the soil.

The gypsum-like layer in Kuwaiti soils is fortunate because it provides a confining layer for the movement of the oil. As such, the worst case is that the oil will migrate to this layer and then spread laterally. In areas where the gypsum-like layer is continuous, more time can be taken to plan remediation programs.

However, if the oil penetrates the gypsum-like layer due to cracks or thin spots in the layer, remediation will be much more difficult because the oil will have to be extracted from beneath this layer. Ultimately, the oil contaminated soils above this layer will have to be removed or treated because of their narrowness and variation in thickness. Because of such natural variabilities, such a layer can only be considered as semi-impermeable under geologic time scales. Long term research must determine the migration of oil in the soil under the lakes. Such research will be difficult because of the complexities of sampling under the oil lakes.

Long term migration of oil—either as free product or in water—is typically predicted with hydrologic transport models. Inputs to such models require a variety of physical and chemical parameters for the soils—porosity, grain size distribution, hydraulic conductivity, oil conductivity, residual water saturation, residual oil saturation and depth to the gatch layer. Unfortunately, these data still need to be obtained for the soils under the oil lakes.

The technologies for heavily contaminated soils seek to alter the physical or chemical properties of the soil/oil matrix to overcome the capillary forces. Available technologies are based upon altering the surface tension, overcoming capillary forces or converting the oil to a gas by either evaporation or combustion.

The treatment technologies for heavily contaminated soils must be capable of reducing oil content from a maximum of 20 percent to less than 5 percent. It is estimated that about 25 percent of all the contaminated soil in Kuwait is heavily contaminated.

Containment is an attractive alternative for the heavily contaminated soils, considering the lack of rainfall in the Kuwait desert, low permeability of many soils and the lack of near surface aquifers in many areas. The volume of soil to be contained is estimated to be about 10
Figure one: Aquifer depths in the Raudhatain and Sabriyah oil fields are about 30 meters and overlain with permeable, gravelly soils.

Figure two: Originally, these lakes contained about 60 million barrels of oil.

millions cubic meters.
A site could be lined with an impervious soil layer, and any oil drainage could be collected by a series of sumps. Upon filling, the site would need to be sealed to eliminate percolation during heavy rainstorms.
Perhaps the most proven technology for treatment of contaminated soils is incineration. The advantages of incineration include immediate and complete destruction of the oil contamination, on site treatment and environmental safety. Because of the heat content of the oil, no additional fuel would be required for treatment of soil with an oil content greater than 5%

Continues on page 10→
After the fire, from page 9

percent.
While incineration is highly effective, its cost will probably limit its use for the remediation of Kuwaiti soils. At nearly $100 per cubic meter, the cost to incinerate the heavily contaminated soils there would probably exceed $1 billion.

Thermal treatment processes occur in two stages: primary volatilization followed by condensation or incineration. For thermal treatment of the Kuwaiti soil, it would be advantageous to recover the volatilized oil through condensation. Thermal processes require much lower temperatures than incineration. Typical operating temperatures for thermal treatments range from 200 to 700°C. At the higher temperature ranges, nearly all the oil components are volatilized except the asphaltenes.

Thermal treatment equipment uses material handling equipment similar to incin erators, except that the heating chamber and all associated equipment can be made of steel because of lower operating temperatures. If high turbulence is required for heat transfer, it is provided by rotary drums or fluidized beds. Heat can be provided by convection from fuel burning, radiation from electric heaters, or internal friction from agitation and abrasion of the soil. Single thermal units can treat up to 250 tons of soil per day.

Costs for the fuel and electric heated types of equipment operating at a temperature of 650°F are estimated to be about $80 per cubic meter. Costs for internal friction units are estimated at around $40 per ton. Thermal processes could be reserved for the most heavily contaminated soils. In all volatilization or desorption treatment operations, the removed oil can be condensed and recovered.

Surfactants have been widely used in the oil industry to enhance oil recovery of petroleum products. There are a wide variety of surfactants that are potential candidates to use in soil remediation. Of the five main types of surfactant (ethoxylated alcohols, ethoxylated nonylphenols, sulfates, sulfoates and biosurfactants) all have been used to successfully emulsify oils.

Surfactant leaching would probably involve mixing of the soil in ex situ reactors to facilitate oil recovery. After the oil has been emulsified with a surfactant, the mixture of water, oil and surfactant requires further treatment, often in several unit processes. The soil needs to be flushed with several pore volumes of water to fully extract the oil and the remaining surfactant. Large volumes of water would be required, which may be a serious constraint in the arid Kuwaiti climate.

Most of the contaminated soils have oil content in the range of zero to 5 percent. This soil is considered to be lightly contaminated. The sources of this material are the soil at depth under the oil lakes, the surface soils affected by aerial fallout of partially combusted oil and treated sand from soil leaching.
operations.

The most feasible technology for the treatment of the lightly contaminated soils is biodegradation. Three types of bioremediation schemes include land farming, soil piles and in situ treatment. Oil has been shown to be inhibitory to microorganisms in soils contaminated above about 5 percent. If concentrations are above 5 percent, the soil has to be diluted with clean soil to reduce the level for bioremediation.

Land farming involves stimulating the growth of aerobic bacteria within the top half meter of the soil surface. To encourage bacteria growth, the soil is continuously tilled to provide aeration. Water is added to maintain a reasonable content and nutrients are added as organic fertilizers.

Land farming of soils contaminated at about 5 percent can reduce the level of contamination by about 60 percent within three months, and greater than 90 percent within 24 months. The advantage of land farming is its relative simplicity and high effectiveness. The disadvantage is that it requires large land areas and relatively long treatment periods.

The Kuwait Institute of Scientific Research (KISR) is presently conducting field demonstrations of land farming and soil pile treatment of oil contaminated soils near the Purjan Oil Field. Experiments are determining the effects of tillage, irrigation, nutrient-addition and the addition of amendments.

Soil piles are a method of ex situ bioremediation which is relatively cheap and works faster than land farming. The soil is excavated and placed in piles over an impervious barrier with a series of drains and air vents. Water and nutrients are applied to the top of the pile and recirculated from the underdrain system. Oxygen is supplied either by natural ventilation or by blowers into the ventilation piping.

Soil piles allow control of water content, aeration, nutrients and soil pH. Runoff is recycled and off site contamination is minimized. Such systems are commonly used to degrade soils contaminated with gasoline from leaking underground storage tanks. The cost of soil piles is primarily in the excavation expense, and construction and operation of the treatment facility.

As a result of natural degradation processes, the amount and character of the deposited oily materials in Kuwait is changing continuously. This passive remediation is influenced by site specific factors—microbial strains, soil composition and density, climate and the like. Such biodegradation of oil in soil environments is a complex process that involves capillary trapping, sorption, transport by advection and competitive degradation by a series of receptors. Scientific knowledge is presently reaching the point that the complexity of this process can be modeled and applied to predict what will happen in the Kuwaiti desert.

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Write in 234  March 1993 Soils 11
Set a good sample example

Sample collection requires precision to assure accuracy

By Frank D'Addario

Soil samples must be collected for laboratory analysis at all petroleum release sites to document type, location and degree of soil contamination. Samples must adequately reflect the properties of the site. The consequences of improper sampling may result in a site that is later discovered to have additional contamination or in costly overkill cleanup activities. Here’s what to watch for to assure your site is getting effective sampling.

Soil gas and geophysical surveys are the first step to direct soil sampling into areas of greatest contamination. Soil characteristics, such as soil type and porosity should be determined to further define subsurface conditions and to assess chemical movement along various pathways.

There are two common classifications of soil sampling: grab samples and composite samples. A grab sample is a sample taken from one specific location, one time only. A composite sample is a combination of smaller samples taken at different locations or at different times. For the identification of hydrocarbon contamination, grab samples should be taken, as they are required for the analysis of volatiles.

There are several methods of collecting soil samples, depending on the depth of the samples to be taken and the soil characteristics of the site. Figure one, page 14, outlines each method and indicates the application of each.

It has become common practice to use organic vapor detectors to sample for soil contamination. Although this technique is a useful method to identify the presence of contamination, it is not good for quantitative measurements. The results are often quite different from those obtained from lab analysis. Organic vapor detectors may be used as site screening tools to determine the general location and degree of contamination, but sample collection for lab analysis is absolutely necessary.

All sampling equipment should be either stainless steel or polytetrafluoroethylene (like Teflon®). The equipment that actually takes the sample should not be the same as that used to advance the hole.

Personnel should wear clean gloves that should be changed before each new sample is collected. A different set of equipment should be used for each sample collection. When this is not possible, equipment should be cleaned between each sampling event. Each sample vial should be completely filled so no headspace exists to minimize aeration and air contact. Vials should be wrapped in aluminum foil and placed on ice in a covered cooler for transport. Samples should be kept around 40°F and out of light.

For test pits, boreholes and surface sampling, the location and number of samples required are site specific and depend on the type of contaminant, its mobility in the environment and the site’s physical features. The initial site assessment and site screening determine the appropriate number and location of samples to be taken.

The number of sampling locations must be sufficient to determine the horizontal and vertical extent of the contamination. The sampling density should be increased in areas of anomalies. If no information is available to predict the location of hot spots, a grid pattern can be used to identify sampling locations.

A sufficient number of samples should be collected from each sampling location to analyze for all

Information for this article was taken from Technical Assistance Bulletin (TAB) #4, prepared by Environment Canada, Ontario Region, under the supervision of Frank D'Addario, senior environmental officer.
parameters as well as soil characteristics. The soil sample should consist of soil particles not greater than two millimeters.

A clean stainless steel trowel, scoop or gloved hands should be used to collect the soil. If this is not possible, a backhoe may be used. To prevent loss of volatiles, samples should be gathered from freshly exposed soil and preserved as soon after the excavation as possible.

In the case of surface sampling, a soil punch may be used. The advantage of a soil punch is that it retains the sample with the soil core intact. For slightly deeper samples, a bucket auger may be used, but the sample is a combination of soil at the surface and at the greater depth.

To excavate a test pit, a clean backhoe should be used. All excavated material should be placed on a tarp. If free product is floating at the bottom of the pit, it should be pumped out before taking a soil sample.

Representative samples should be taken each time a different soil type is encountered. Samples should be taken from the areas where it is likely that the highest degree of contamination is present. The bottom sampling depth of a test pit depends on characteristics of the site and determined through prescreening methods.

In the installation of a borehole, soil borings should be advanced with a power auger drill. Borings should extend to the water table, or at least five feet below the base of the contamination.

Soil samples often exhibit geological variability. Soil is not a homogenous mass, but rather a heterogeneous body of material. Therefore, samples should be collected at least every five feet and at changes in lithology. Special consideration should be given to the sampling of the vadose zone, as it is an important transition area between the soil and the groundwater.

A split spoon sampler should be used to obtain depth specific samples. Samples for chemical analysis should be preserved immediately after the split spoon sampler is open.

When samples are being taken from a soil pile that has been sitting for a time, dig six to eight inches into the pile to get the sample.

In a tank pit situation, if free product is floating in the bottom, it should be pumped out. Samples should be taken from the areas where it is likely that the highest degree of contamination is present. A jar headspace test may help determine the areas of greatest contamination. Figure two, page 15, shows general sampling guidelines for tank pits.

A proper QA/QC (quality assurance

Continues on page 14→

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Write in 347

March 1993 Soils 13
quality control) program must be in place to ensure that data is accurate and representative of actual soil conditions. Quality control is the set of procedures followed to measure and, when necessary, to correct data quality. Quality assurance is the set of procedures followed to provide documentary assurance of the proper

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth of Collection</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface sampling</td>
<td>0 to 15 cm</td>
<td>• Recent spills</td>
</tr>
<tr>
<td>Test pit</td>
<td>0 to 5 m</td>
<td>• Low migration rates (clay)</td>
</tr>
<tr>
<td>Borehole</td>
<td>0 m to Bedrock</td>
<td>• Shallow contamination</td>
</tr>
<tr>
<td>Soil pile</td>
<td>NA</td>
<td>• Complex stratigraphy</td>
</tr>
<tr>
<td>Tank pit</td>
<td>NA</td>
<td>• Heterogeneous fill</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Deep contamination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dispersed spill</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prevents cross-contamination</td>
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<tr>
<td></td>
<td></td>
<td>• Best method to identify volatiles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• To find levels in a surface mound</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• After tank removal</td>
</tr>
</tbody>
</table>

application of quality control and of the data quality.

The first step in any sampling program is the development of a sampling protocol, a written description of the detailed procedures to be followed. It should contain:

- sample collection method(s)
- sampling locations (pinpointed on a map)
- equipment calibration and maintenance
- number of required field samples
- number and type of quality control samples
- designated lab and their QA/QC procedures
- order of sampling
- type, number and size of containers
- preservation instructions
- chain of custody procedures
- transportation plan
- field preparations
- field measurements

Quality control samples determine background levels of chemicals in the clean soil for comparison with the contaminated soil. One control site sample (sample blank) should be obtained and analyzed for each overall site being assessed. The control site should have common soil characteristics with the contaminated site, but should, obviously, not be contaminated. It should be located near the contaminated site, upgradient from the contamination. If there is no suitable sample blank location nearby, a site in the general region should be chosen. The control site sample should be taken just prior to the field samples.

The same sampling containers are used to prepare blanks as are used to
collect field samples. However, the blanks are prepared with contaminant-free (blank) water. Three types of quality control blanks are used during sampling.

Trip blanks verify if sample contamination occurred in the sample containers or as a result of sample cross contamination during sample transport and storage. They are prepared by filling sample containers prior to going into the field. These blanks are carried with the field samples in the sample cooler and are not opened in the field.

Field blanks verify if sample contamination occurred as a result of reagent or environmental contamination, such as from contaminated air at the sampling location. Field blanks are prepared by pouring blank water from a clean container into a clean sample container in the field at the same time of sample collection.

Equipment blanks are designed to check for contamination from sampling equipment. They are useful to evaluate the effectiveness of equipment decontamination procedures. They are prepared in the field by pouring blank water into the bailer of the well, and are processed as if they were field samples.

One blank of each of the three types should be prepared for every 20 samples.

Sample spikes are prepared in the field at the same time as sample collection to provide a quantitative measure of analyte loss by microbial degradation, volatilization, adsorption of sampling equipment and other mechanisms. To avoid cross-

contamination, spiked samples should not be carried in the same cooler as the field samples.

Sample spikes are prepared by adding a known mass of the target compounds or elements of interest to a known volume of contaminant-free soil. The concentration levels of target compounds should be about 10 times the analytical detection limit. The concentration of target compounds in

Continues on page 16→
Good sample example, from page 15

spiking solutions and their stability must be independently verified. Blanks and spikes should be available from the lab.

The collection of quality control duplicate samples provides for evaluation of the lab’s performance by comparing analytical results of two samples of the same location. A minimum of one set of duplicates should be collected for every 20 samples.

Obtaining duplicate samples in soil requires homogenization of the sample aliquot prior to filling sample containers. This should be accomplished by filling a properly decontaminated stainless steel tray or bowl and mixing it with a clean instrument. Once mixed, the sample should be divided in half and containers should be filled by scooping sample material alternatively from each half.

Record keeping is an integral part of the sampling procedure. If sampling is not adequately documented, sample results may be meaningless. Documentation can be grouped into three areas: sample identification, sample log record and chain of custody record.

Sample identification requires that each sample be assigned a number in the same sequence as the field samples were taken. The details of each sample should be recorded in a sample log record. To avoid lab bias during the analysis, the only information the lab should have is the sample number. A detailed sample log record should contain:

- sampling site name
- signature of sample collector(s)
- pit, surface or borehole identification number
- sample number
- whether the sample is a field sample, control site sample, QC duplicate, blank or spike
- sampling date and time
- type of analysis required for the sample
- if the sample is a composite or grab
- if a preservative was added to the sample and what type
- at what temperature the sample was preserved
- sampling equipment
- weather conditions at time of collection
- relevant sample site observations

The chain of custody form provides a record of all the personnel responsible for handling the samples. It must accompany the samples at all times. Samples should change hands as few times as possible on their way to the lab. Chain of custody helps ensure that data from the analysis of a sample is credible and defensible.

Chain of custody begins at the time and point of sample collection. After both field and blank samples have been filled, a signed and dated chain of custody seal should be sealed across the sample cap. Any transfer of custody should be recorded with both the signature of the person relinquishing the sample and the person taking over the sample, date and time. Chain of custody labels should be sealed over shipping containers. Chain of custody must be maintained until analysis is complete and results are reported.
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Write in 158
Radio frequency heat enhances contaminant removal

Accurate temperature control and thermal stirring in a mobile system

By Raymond Kasevich, Raymond Holmes, David Faust and Richard Beleski


In-situ radio frequency technology heats non-conducting materials with controlled electromagnetic energy much like a microwave oven heats food. This technology can provide controlled in-situ heating to a variety of soil contaminants—improving contaminant flow characteristics, thus facilitating their separation and removal from subsurface soils.

The technology is applied by inserting a flexible coaxial transmission line, connected to an antenna system, into one or more boreholes in the affected area. Radio frequency generators supply energy through these transmission lines to multiple electromagnetically-coupled downhole antennas, also known as radio frequency heating applicators. The subsurface material surrounding the antennas rises in...
Mobile system can be towed by a pickup truck and requires minimal setup.

temperature as it absorbs electromagnetic energy radiating from the antennas.
Properly configured, the system provides a steerable heating pattern that can be controlled by selection of the operating frequencies, electrical phase relationships, antenna element lengths and antenna locations. The selection of different applicators, operating frequencies and power levels allows the heat generation process to be tailored for each application.

Multiple heating applicators may be employed to provide large areas of uniform heating or highly focused thermal regions. This type of control is made possible by the application of phased array, beam steering technology, common in advanced military radar systems. With this capability, energy focusing can be controlled to heat regions dynamically in timed sequences. Slow, thermal stirring motions can be created within the heated medium by scanned heating sequences of multiple antennas.

Pumpable liquids or vapors created as a result of in-situ heat absorption may be extracted through the same boreholes used to apply the electromagnetic energy. Figure one, page 18, shows a schematic of a single borehole system.

The key elements of a radio frequency heating system are a subsurface borehole applicator, a transmission line and a radio frequency generator. Both the applicator and the impedance

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Radio frequency heat, from page 19

matching network of the generator are adjusted for optimum power transfer into the heating region surrounding the applicator. As underground areas are heated and liquids are extracted, the electrical properties of the soil change. As this change occurs, a diagnostic and control system re-tunes the applicator impedance matching network automatically to maintain the most efficient heating level.

Potential environmental candidates for the technology include in-situ remediation of soils contaminated with hazardous wastes and sludges containing coal tar and fuel oil. Other applications involve reduction of hydrocarbon viscosity in lagoons and tanks, enhanced oil recovery and separating nuclear and mixed wastes.

Compounds that can be effectively extracted with this method include gasoline, diesel fuel, hexane, benzene, toluene, ethylbenzene, carbon tetrachloride, chloroform, acetone, methanol and the like.

Figure two: Single applicator electric field distribution

In addition, the system can support other remediation technologies, such as in-situ bioremediation. Soils that have been infused with bacteria can be evenly heated by arrays of applicators. The radio frequency technology allows bioremediation to continue year-round, holding ground temperatures to an optimum range for bacterial action.

The radio frequency heating system’s control and generation equipment is typically housed in a portable shelter, powered from 3-phase 208 or 240 volt AC utility lines or a diesel-fueled generator. The coaxial transmission lines from the radio frequency generator can be rigid or flexible, with diameters of 7/8 inch or 1-5/8 inch used to feed the downhole applicator. Applicators range in diameter from one to six inches, with antenna radiating element spans from 50 to less than five feet.

Typical heating systems operate on authorized transmitting frequencies between six and 40 Mhz with radiated power levels of up to 25,000 watts per applicator.

Typical borehole diameters range from four to nine inches and often accommodate a non-metallic vapor or liquid extraction tube that can be co-located with the applicator. Individual boreholes may be spaced from 10 to 50 feet apart and placed at depths that may range to 1,000 feet. High power applicators operated close to the surface are shielded by flexible metallic grids. They contain electromagnetic fields for better heating efficiency and provide protection for the operators on the surface to safety and emission levels prescribed by OSHA (Occupational Safety and Health Administration) and the FCC (Federal Communications Commission).

The dielectric heating pattern
produced by the radio frequency antenna extends radially away from the antenna into the contaminated soil zone. The radial extent of the heating pattern from a single borehole apparatus varies as a function of the operating frequency, the length of the antenna and the effective electrical conductivity and dielectric constant of the soil and its contaminants.

Water converted to steam in the contaminated region by radio frequency energy significantly enhances the extent of the energy’s penetration from the borehole because of the attendant reduction in the material dielectric losses where steam is produced. Steam does not absorb radio frequency energy while water does. When the system produces steam, the diameter of the heating zone expands rapidly.

As the contaminated region heats from the absorption of radio frequency energy, liquids and vapors begin to flow toward the borehole if a positive pressure is maintained by the thermal gradient. Apertures or perforations in the applicator’s borehole liner, or an adjacent borehole, collect the hot liquids from the heated region. The heated liquids are then pumped to the surface to a collection system.

Certain hazardous materials are only found in a liquid state. In those instances, radio frequency energy increases the temperature of the hazardous material-containing volume and thereby volatilizes those hazardous materials. The resulting vapor by-products are transported from the soil to a storage facility via the production flow line of the antenna.

A 3-D cut of a subsurface electric field distribution pattern of a radio frequency heating applicator located deep below the surface within a homogenous soil is shown in Figure 2, page 20. In this plot, the applicator is horizontal and lying along the X axis 0.0 line within the X-Y plane. This pattern is truncated at the 100 volt per meter cut to outline a heating rate boundary of approximately one degree Centigrade per hour for a nominal conductivity of 40 milliSiemens per meter. Figure 3, above, is a plot of the theoretical heating rate (degrees Centigrade per hour) vs. the electric field intensity (volts per meter) for several soil conductivities. Figure 4, page 23, plots the soil conductivity in milliSiemens per meter, and relative dielectric constant as a function of frequency, for several volumetric water content levels and soil types. An example of a heating rate estimate for a 13.56 MHz vertical borehole applicator with 25 kilowatts of radiated power in soil, with a conductivity in the 10-20 milli/Siemens per meter range, is summarized as follows:

- Between a zero to one meter radius, heating rates will be as high as 12°C per hour at the applicator feed

Continues on page 22→
Radio frequency heat, from page 21

point within the first 24 hour period of high power application.

- At 10 feet radially away from the applicator, a maximum heating rate of 3°C per hour, after approximately two to three days of continuous heating at high power, will be achieved.
- At 20 feet radially away from the applicator, a maximum of 0.8°C per hour, in approximately one to two weeks of continuous heating at high power, will be achieved.
- At 30 feet radially away from the applicator, a maximum of 0.2°C per hour will be achieved after two to three weeks.

Near uniform heating over significant distances is achieved by using an array of borehole applicators spaced 10 to 20 feet apart.

The following energy input approximations can be used to estimate the requirements for a model site:

- To heat one cubic yard of sand from 20°C to 100°C requires approximately 25 kilowatt hours, or 25 kilowatts for a one hour duration.
- To heat one cubic yard of water from 20°C to 100°C requires approximately 100 kilowatt hours, or 25 kilowatts for four hours.
- To vaporize one cubic yard of water at 100°C requires approximately 750 kilowatt hours or 30 hours at 25 kilowatts (using 1,150 BTU per pound latent heat of vaporization).
- To heat one cubic yard of heavy oil from 20°C to 100°C requires approximately 1.75 times more heat energy than sand.

As an example, assuming 35 percent by volume water, 35 percent by volume oil and 30 percent sand, the total energy requirement per cubic yard is approximately 320 kilowatt hours, or 12.8 hours at 25 kilowatt power input for the material. In practice, it is reasonable to use a single 13.56 MHz applicator to treat between 200 and 600 cubic yards from a single borehole to achieve volume temperatures in excess of 100°C in time scales ranging from a few weeks to three months.

A realistic example can be estimated in a case where 1,2-dichloroethene is present in soil with traces of other organics. Heating the soil to a temperature at or below 100°C to vaporize the compound would make it easy to remove with standard soil vapor extraction methods. The energy required to heat the soil and the remedial time to boil the 1,2-dichloroethene is estimated at 15,160 kilowatt hours for 400 cubic yards. The system energy cost, estimated on the basis of 50 percent conversion efficiency from utility power to delivered radio frequency heat, is $1,500 (based on five cents per kilowatt hour). The total time requirement is about one month of continuous operation, based on the use of one radio frequency generator and a single applicator. The energy cost is on the order of $3.75 per cubic yard.

Radio frequency heating is also useful to remove thick crude oil sludges in storage tanks—in some cases, more economically than steam, hot water or manual shoveling. Crude oil storage tanks can have thick layers of unpumpable heavy crude oil sludge deposits that build up over a tank’s lifetime. These deposits, some up to 10 feet thick, have very low thermal conductivity and can take months to be melted away by hot water or steam cleaning systems. Radio frequency heating can penetrate deeply into the heavy crude sludge, lower its viscosity, and allow it to be pumped out of the tank as a hot liquid—possibly to be recovered for refining.

KAI Technologies, Inc., Woburn, Mass., developers of this system, currently estimate the cost of radio frequency processing of soils can be competitive with the cost of excavation and ex-situ incineration or thermal treatment. Radio frequency heating may provide cost advantages when the contaminants to be heated are more than 15 feet below the
surface. Similarly, radio frequency heating in combination with horizontal drilling techniques may be used to remove contaminants under buildings.

According to the company, this system requires less setup manpower and fewer construction resources than any other heating approach. Because the automated system is remotely monitored and controlled over a phone line or a cellular phone, it requires only minimal—or no field monitoring personnel—for many applications. KAI suggests that the entire system can function as simply and reliably on a job site as an electrical power utility substation.

The Westinghouse Savannah River Co. Technology Center, Aiken, S.C., has teamed with Westinghouse Environmental Systems and Services Division of Wallingford, Conn., the Westinghouse Electronics Systems Group of Baltimore, Md., the Westinghouse Science and Technology Center of Pittsburgh, Pa., and KAI Technologies to conduct a field demonstration to establish the effectiveness of radio frequency heating to raise the soil temperature of contaminated vadose zone clay deposits at the Savannah River Superfund site.

The purpose of raising the soil temperature is to shift transport rates and thermodynamic equilibria favorably (specifically for per- and trichloroethylene) to enhance vacuum extraction processing rates. To achieve this, the demonstration will integrate vacuum extraction with radio frequency heating and horizontal well drilling.

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Write in 263

March 1993 Soils 23
You’re covered!

Recent court decisions dramatically expand insurance coverage

By Jonathan Redding and Julia Nye

On July 21, 1992, the California Court of Appeals issued a decision of paramount importance to all persons and businesses who have ever paid premiums for insurance policies. The court held in the case, Montrose Chemical Corp. vs. Superior Court, that an insurance carrier must pay all costs and attorney fees incurred by the policyholder in defending lawsuits from third parties unless the insurance carrier can conclusively establish that there is no potential for insurance coverage under the policy provisions.

Under this decision, insurers have a virtually unqualified duty to defend their policyholders against liability from a third party lawsuit. And while this landmark decision was made in the context of third party claims for damages caused by pollution, the law established by the case is applicable to all types of insurance policies.

Montrose Chemical Corp. manufactured the pesticide DDT from about 1947 to 1982. Allegedly, contamination at two Superfund sites where Montrose disposed of the DDT began in 1947 and continues to the present. Montrose first learned of its potential liability for the contamination in August, 1982, when it was notified by the EPA that it may be named in an action to recover cleanup costs at these two Superfund sites. At that time, Montrose had ceased disposing of wastes at those sites. Following receipt of this notice, Montrose purchased CGL policies from Admiral Insurance Co. in October, 1982, and renewed the policies through March, 1986.

In February, 1985, Montrose tendered a claim to Admiral, asserting that Admiral had a duty to defend Montrose from the government’s claims under the property damage and personal injury provisions of the policies. Admiral refused to defend or indemnify Montrose for its defense costs. Admiral argued that the continuous pollution or damage did not “occur” during Admiral’s policy periods because Montrose discovered the pollution prior to purchasing the first Admiral policy. Admiral also argued that Montrose knew, prior to the purchase of the policies, that the pollution existed and an action for cleanup was inevitable, and therefore the claim should be barred pursuant to the “known loss” rule.

Montrose filed suit to compel defense and indemnification under its insurance policies. (Montrose Chemical Corp. vs. Admiral Insurance Co.) The insurance carriers were successful at the trial court level. However, in February, 1992, the Court of Appeals reversed, and rejected the carrier’s arguments, finding that only the effect of the injury or damage, rather than the timing of the cause, is to be considered in calculating an “occurrence.”

Furthermore, the “known loss” rule did not preclude coverage where a policyholder is under no legal obligation to pay and no lawsuits have been filed at the time the policies were purchased.

In a July 1992 Montrose decision, the court held that a carrier may not defeat its duty to defend its insured by introducing extrinsic evidence which merely disputes the facts on which the policyholder relies in making its claim for defense. Together, the February and July Montrose decisions dramatically expand insurance coverage. Now, an insurance carrier must defend a policyholder once the policyholder can demonstrate that a potential for indemnification exists, and carriers may no
longer rely on typical “continuous and progressive injury” or “known loss” arguments to deny potential coverage. The February Montrose decision has been granted review by the California Supreme Court. However, other courts in California, and in other states, have followed Montrose. Thus, these cases are authoritative and demonstrate the trend that California courts are expanding insurance coverage for defense and possibility for indemnification.

A person or business may have coverage under policies which expired many years before the contamination, defect or damage is discovered—and may have coverage under policies that were issued even after the damage is discovered. Insurance policies are like money in the bank, since they may provide expensive litigation defense and indemnification coverage in cases where there is continuous pollution. Insurance carriers usually destroy insurance policies and related documents five years after the expiration of each policy. For these reasons, it is very important that all policyholders immediately collect and retain complete insurance files in a safe place. Even if a policyholder cannot locate the original policy, secondary evidence of the policy, such as invoices, checks evidencing payments, and certificates of insurance—even correspondence with insurance brokers and agents, may suffice to prove coverage. Policyholders are strongly advised to prepare a chart of their various insurance policies. This chart should include the names of the carriers, overlapping, umbrella or excess policies, types of coverage, dates of coverage and policy limits. To construct complete records of insurance coverage, the policyholder should:

- Search all active files to locate all current and recent policies and all subsequent endorsements to these policies.
- Search all non-active files and archived company and personal records to locate old policies and endorsements.
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Write in 213
Reclaim metals to clean up soils

Acid leaching process pulls out valuable metals while it treat's sites

By Troy DuGuay

precipitate the metals. The precious metals would be reclaimed from the precipitate.

As the price of precious metals declined and the volume of high percentage ores was exhausted, the use of acid leaching faded. But, in recent years, this technology has been not understood that fixation only reduced ion mobility, and that mobility could later be reactivated by a number of biogenic or non-biogenic factors.

In May, 1992, the RCRA (Resource Conservation and Recovery Act) Third Third Land Ban went into effect—the option to dispose of heavy metal contaminated soils in landfills vanished. The states began promulgating strict compliance levels. For example, New Jersey recently enacted legislation requiring cleanup levels for chromium to 10 ppm in soil. Mercury cleanup levels in most states are based on total mercury concentrations ranging from 140 ppm to background. As these levels are pushed ever lower, industry needs to look to techniques that can remove low concentrations of metals economically.

The situation is similar to the problem once faced by the mining industry when evaluating the economics of micron mining, the reclamation of less than 1 percent metals. Only when the price per ounce of precious metals started its steep upward climb in the late 1970s did the feasibility of micron mining gain serious consideration.

This resembles the situation faced by the remediation industry, because the mining industry needed to develop

Continues on page 28→

T here’s gold in them thar hills!” Over 150 years ago, little did the prospectors know that their quest for gold would someday lead to a solution for the remediation of soils contaminated with metals. Acid leaching technology can be the solution for many sites contaminated with metals.

After the earliest prospectors exhausted the easily accessible supply of precious metals, a new and more technically advanced “prospector” came into the picture. This new breed believed that with the science of chemistry, they could remove precious metals with acid solutions from the discarded ores of their predecessors.

In the early days of acid leaching, the preferred method was called “heap leaching.” This involved building earthen lagoons around stockpiles of ore containing sizable amounts of precious metals. Large volumes of an acid solution would be pumped into the lagoon and left to react with metals entrained in the ore. The soluble metal solution would be pumped into holding tanks where chemicals would be added to

Troy DuGuay is environmental manager for Coastal Remediation Co., King of Prussia, Pa. Extraction technology data provided by Michael Hobby in association with John Pease

26 March 1993 Soils
SPI thermal remediation plants get stamps of approval

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Reclaim metals, from page 26

Technologies that could economically recover low concentrations of metals contained in larger volumes of material—just as today's remediation industry needs to do.

This effort gave birth to many technologies, one of which is acid leaching. If the treatment of contaminated soil is viewed as a reclamation process versus a treatment process, economics will drive the development. Unfortunately many of today's remedial technologies were developed as treatment processes—thus their high costs. To make acid leaching a practical option for environmental remediation, several modifications to the mining industry's technology were necessary.

Acid leaching works on the principle of the solubility of metals: the transformation of a solid to a liquid, then back to a solid by means of chemical processes. The acid leaching solution concentration and type is determined by the type of metal causing the contamination. The concentration is typically determined by the level of concentration of the metal and soil type. A feasibility study sorts out the various metals, soil types, site factors and establishes cost per ton.

Adjustments to the leaching solution affect retention times. At first, it might appear reasonable to use the highest concentration of acid solution available. But, increases in material and handling costs require planners to find the point of efficiency where the incremental recovery of metals can be justified against incremental increases in the concentrations of the leaching solution over time.

The determination of that point is a key goal of the feasibility study. The optimum leaching solution combines various proprietary agents to keep the percent concentration of acid low, accelerate the reaction and achieve desired reclamation levels. Each metal has its own recipe that can be adjusted for various concentration levels of the metal. The leaching solution may contain any combination of inorganic or organic acids along with proprietary agents.

After the chemical reaction is completed, the leaching solution is physically separated. Then, it is moved to a tank where target metals are removed using various forms of precipitation or ion recovery, including organic reducing agents. Finally, the soil is washed with a solution to neutralize any residual leaching solution or soluble metals.

Retention time in the system is critical, because extracted ions normally begin to reabsorb after a certain period of time. Any soil exposed to the solution too long begins to reabsorb the very ions previously extracted. That is why an acid rinse is normally required as a standard step. In actual fact, ions are always moving in two directions, because extraction is a dynamic process.

Feasibility study data indicate that after a certain period, the dynamics change such that more ions are being readsorbed than are entering the solution. This is critical because the first soil in gets different process

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28 March 1993 Soils
results than the last soil in. Pumping in wet-sieved material with a grout pump in a short time limits the standard deviation to insignificant levels, so that the reversal is limited to the time required to pump the material through a filter press. But this effect is easily reversed with an immediate hot acidic rinse while the material is in the press.

For this technology to work with high efficiency, particle size must be limited—both to directly address the largest possible initial contact surface of the soil, and to restrict the admission of organics into the system. Particle size affects the rate at which the leaching solution works. This means that 100 percent of the contaminated soil feed must pass through a ten mesh screen.

A filter press is more economical in this process than a centrifuge because several additional steps can be applied while the soil is in the press, requiring only small volumes of additional treatment solutions—instead of the larger amount that would be required to refill entire basins or mixing systems. In addition, in the press, the soil is stationary and the fluid is moving.

Special considerations apply to handling of clays. Unlike sands or loams, if the clayey soil is dry, in order for it to be processed, some form of milling to reduce particle size to equal that of sand or smaller is necessary. Such a particle size allows for rapid penetration and leaching, but the soil must be agitated vigorously to prevent compaction or balling. Larger particle sizes result in incomplete treatment and need additional handling.

Clayey soils must be kept suspended during leaching and rinsing, or stratification and compaction negate the effort to produce a metal-free product.

Successful pretreatment consists of trommel sizing, screening or crushing soils to sand-size or smaller. Balling occurs if large masses of soils are added too rapidly to the mixing system for thorough wetting to occur.

Continues on page 30→
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Reclaim metals, from page 29

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This can impair penetration into the body of the mass or prolong the required residence time in the mixing system.

The mixing system design achieves accelerated leaching and virtually eliminates balling. The addition of oxygen also enhances leaching. For this reason, air sparging is the preferred means of agitation, sometimes in combination with mechanical mixing. Variability of mixing results if the soil contains sand, oil, grease, wax or organics.

Heat also plays a major role in the technology, because it aids in the reduction of surface tension as the acid modifies the charge on clay particles. The settling may be enhanced by positively charged electrolytes, but only after acid soluble metals are removed. Settling and decanting is effective if surface agitation is minimal. For this reason, a preferred dewatering approach is to pump the colloidal suspension from the mixing system to a basin for settling, liquid pump-off and decanting. Dewatering in a plate and frame filter press can also be used when combined with polymer additions and filtration.

Treating only solutions having metals of a single valence state is of utmost importance. The hexavalent state of chromium does not incorporate into organic-metallic readily, although tri-, ter- or pentavalent complexes more readily form organo-metallics. Other metal ions behave in other ways—each species-specific. Polymer concentration and preparation are critical, and the processes developed

Continues on page 33→
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Write in 310
Reclaim metals, from page 30

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Write in 333

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during the feasibility study must be strictly followed for complexation to occur.

Recirculation may be necessary in order to remove the specific ion in question. Additional treatment with metal reducing agents, pH corrections and polymer additions can remove a specifically targeted ion.

For final polishing, the treated solution is run through an ion-exchange filtration medium after elevating the pH to reduce residual metal concentrations to less than drinking water standards.

In one case, total lead concentrations up to 44,000 ppm were reduced to several hundred ppm. Chromium concentrations as high as 15,000 ppm were reduced to less than 100 ppm, and were non-detectable by TCLP (Toxicity Characteristic Leaching Procedure). Cadmium, lead and arsenic all attained TCLP standards. Total mercury of over 18,000 ppm was reduced to 6.9 ppm. TCLP results of less than .15 ppm were achieved.

Costs of the process vary. Key variables are soil volumes, metals to be recovered, concentrations of the metals, state regulations and soil types. Typically, costs range between $175-$475 per ton of processed soil. Credits from the resale of recovered metals can offset a portion of the costs per ton.

There is “gold in them there hills,” but with the recent disposal restrictions for contaminated soils, industry needs to find a gold mine in order to pay for the compliance tab.
Globally speaking

Fast takes on some firms’ international activities

BioGenesis Enterprises, Inc., of Milwaukee, Wis. has agreed to test an extension of their soil washing technology to remediate contaminated harbor sediments in Thunder Bay, Ontario. The contract, with Environment Canada’s Wastewater Technology Centre, calls for BioGenesis to test a high-pressure, closed chamber wash process. The process is being evaluated under the EPA’s SITE (Superfund Innovative Technology Evaluation) program. Their report is expected to be issued later this year. The company has formed a joint venture with CEDA, Inc., of Minneapolis, Minn. for the test.

The first Mexico/U.S. Industrial Environmental Conference will be in Mexico City, March 30-31. The conference is sponsored by the Industrial Environmental Association (IEA), San Diego, Calif., and Consejo Nacional de Industriales Ecologistas (CONIECO) of Mexico City. Both associations were formed to provide technical input to the environmental regulatory development process. U.S. presenters at the event include Vice President Gore, EPA administrator, Carol Browner and chairman of the Environmental Technology Export Council, Thomas Page.

J. Amerika, the Dutch environmental services subsidiary of Thermo Process Systems, Inc., Waltham, Mass., has begun processing soil for Amsterdam under a six month permit issued by the city. The company’s soil remediation unit has been transported to an industrial site on Amsterdam harbor.

McLaren/Hart Environmental Engineering Corp., Rancho Cordova, Calif., recently completed the first comprehensive process safety risk audit in Mexico using the new Mexican EPA (SEDESOL) risk assessment guidelines at a chemical manufacturing complex in Monterrey, Mexico. Industry throughout Mexico will be required to perform a risk audit, including a hazards review and consequence analysis, of any plant that processes or uses hazardous chemicals.

Radian Corp., Austin, Texas, has entered into an agreement with Vnizarubezhgeologia (VZG), a geological institute headquartered in Moscow, Russia. VZG’s specialties include investigation and analysis of geology and mineral resources. The groups plan to develop environmental assessments for targeted industries in the Commonwealth of Independent States and Eastern Europe, health risk assessment studies and computer software development for environmental information management.

Radian has also purchased an interest in Environment Transport & Planning, an environmental engineering firm in Madrid, Spain. The operation will be known as ET&P-Radian. And, Radian has opened an office in Hannover, Germany, Radian GmbH.

Weston, Inc., West Chester, Pa., and Silec, S.p.A. of Torino, Italy, have joined to form Weston Italia s.r.l. to provide environmental engineering, consulting, remediation and construction services throughout Italy. They will specialize in the industrial waste area.

Zimpro Environmental Inc., Rohrschild, Wis., has received an order for over $10 million for wastewater treatment equipment for a refinery in Taiwan, Republic of China. The order is for two of the company’s wet air oxidation systems, to be installed at the Lin Yuan Refinery of Chinese Petroleum Corp., Kaohsiung, Taiwan.

United Nations Publications has published the fourth edition of, Consolidated List of Products Whose Consumption and/or Sale have been Banned, Withdrawn, Severely Restricted or not approved by Governments. The Consolidated List is a reference to products determined harmful to human health and/or the environment by governments worldwide. Prepared by the U.N., in collaboration with the World Health Organization and the U.N. Environment Programme, the 770 page book covers over 600 products and costs $95. U.N. sales number E.91.IV.4. Call 800-253-9646 to order.
Enviro Products now offers carbon systems

Enviro Products, Inc., Lansing, Mich., now offers sales and service of carbon systems for removal of contaminants from liquid and vapor streams, along with on site carbon change out services for spent carbon.

EPI, which provides remediation equipment says they can assist with customizing site specific tanks to fit almost any contaminant level and flow rate.

Write in 680

Carbon systems

ORS Equipment says Interface Probe system easier to use

ORS Equipment, Greenville, N.H., announces improvements to its Interface Probe™ Well Monitoring System, which measures depths to oil and water in monitoring wells.

New units now have visual and audible alarms to indicate whether the probe is in air, water or petroleum products.

Write in 674

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March 1993 Soils 35
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What’s new

In-Situ offers new 1000C data logger

In-Situ, Inc., Laramie, Wyo., introduces the Hermit 1000C, the new version of the 1000B Data Logger.

The 1000C features a two-channel design for monitoring two locations simultaneously with stand-alone operation over a wide temperature range, the company says.

Write in 676

Enmet Corp.’s CGS-9OR

Detectors made for tight areas

Enmet Corp., Ann Arbor, Mich., introduces the CGS-90R, the newest addition to their line of portable gas detectors for confined space entry.

The instrument features a detachable sensor head and a 20 foot sensor cable for remote pre-entry testing, separate toxic and combustible bar graphs and separate digital oxygen display with low/high alarms.

Write in 677

Steel Tank’s cathodic system protects USTs from corrosion

Steel Tank Institute, Lake Zurich, Ill., introduces a cathodic protection testing system for sti-P3® underground storage tanks. The new system, called Protection Prover-4 (PP4), will result in a policy change for these tanks. Cathodic protection is a corrosion control technology that can extend the life of USTs.

Write in 678

Consolidated Resources has software for remediation plants

Consolidated Resources, Inc., Columbia, Md., offers a software system that tracks contaminated soil in a remediation plant. It produces tracking reports at each stage of remediation: receiving, screening and treatment.

Write in 679
Columbus Instrument's Iso-Thermex

Thermometer measures soil

Columbus Instruments, Columbus, Ohio, introduces the Iso-Thermex, a computerized thermometer capable of monitoring the temperature of compost, soil or water with an accuracy of 0.1°C and a resolution of 0.015°C.

The thermometer is a multi-channel thermocouple interface to IBM-PC compatible computers. It is supplied with software for printing, storing and graphing the results of the measurements. Optional temperature sensors in a variety of designs are also available.

Write in 672

Serfilco

updates

filter system

Serfilco, Ltd., Northbrook, Ill., is offering new, larger models of their Sub-Admiral in-tank suction filtration systems.

The new model features a discharge eductor that provides up to 9600 GPH agitation. This permits the use of lower horsepower pumps to circulate larger volumes of liquid in the tank, which prevents stratification of liquids or the settling of solids.

The system uses either a twin or triple column filter cartridge adapter for increased flow capacity, and a screw-in suction extension to convert the system to a transfer pump, Serfilco says. It accepts 2-3/8" or 2-1/2" diameter pleated wound depth filter cartridges, carbon cartridges and mini-canisters.

Write in 673

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Write in 081
State-by-state summary of cleanup standards

Corrections and update information

Note the following corrections to the State-by-state summary of cleanup standards, Soils, December, 1992, starting on page 14. Delaware reports that any amount of gasoline or diesel in soil must be reported. Action level and recommended cleanup level are site specific. Montana reports that recommended cleanup levels are slb ≥ ppm. New Jersey’s action level for benzene is 1 mg/kg according to

Proposed Technical Requirements for Site Remediation (N.J.A.C. 7-26E) and the Proposed Cleanup Standards for Contaminated Sites (N.J.A.C. 7-26D). Tennessee reports lab tests are Gasoline and Diesel Range Organics Methods and a change in their telephone number to 615-532-0956. Exponents were missing from the New York report, which should have read as follows:

In addition...

In the January-February issue of Soils, in the article on page 18, “Synthetic Soil Promises to Enhance Bioremediation,” general counts increased from a baseline concentration of 10^6 cells per milliliter of water to greater than 10^7 cells per milliliter after 48 hours. During this same time period, selective counts rose from approximately 10^2 cells per milliliter to greater than 10^6 cells per milliliter.

In the November issue, in the article, “Budget the First Step,” beginning on page 22, all the equations to develop cost estimating relationship should have read, “hours per acre or dollars per acre divided by number of acres.” Soils regrets these errors.

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Moving is not solving
Survey says landfilling is still number one
By Susan Parker

How do you feel when you tell someone what to do—and they don’t do it? That seems to be happening to me, and I am pouting.

Recently, AEHS (Association for the Environmental Health of Soils), Amherst, Mass., completed a survey of states. One of the things they asked states was to rank the popularity of various remediation methods. The overwhelming, number one, most popular method reported was excavation and landflling.

So, yes, I am pouting. Each issue of this magazine contains creative, environmentally responsible, on site ideas for cleaning up contaminated soils. Thermal treatments, vapor extractions, washing, air sparging—we explain them all. This issue, for example, contains an article about the use of radio frequency to heat subsurface soils for remediation (page 18).

Twenty-two states “rarely” or “occasionally” use bioremediation. Only eight states report that they “frequently” use bioremediation for contaminated sites. Twenty-eight states “never” or “rarely” use soil flushing.

What is going on out there? I am taking this very personally that, apparently, people are reading Soils magazine articles, then tossing the magazine on their desks to rush out and oversee the loading of tons of petroleum contaminated soils onto trucks to be hauled off to landfills!

I am surprised at these reports. I can’t help but wonder what is behind this phenomenon...and my first suspect is Mr. Dollar. In spite of the huge increases in fees landfills charge to accept petroleum contaminated soils, apparently, landflling is still perceived as cheaper than other cleanup technologies.

And, since time is money, I suspect quite a few clients are in too big a hurry to wait for bioremediation, or to take the time to set up soil vapor extraction systems or schedule a thermal unit or other on site treatment process.

Perhaps lots of sites are contaminated with such tiny quantities of petroleum contaminated soils, that they just sprinkle it into an envelope and mail it out to the landfill.

The landfill choice eliminates all that confusing consideration of determining what is clean, what levels of what compounds do we need to hit—no pesky monitoring or explanations to the neighbors. There is a lot of uncertainty in a remediation effort. The regulations are confusing. The remediation choices are confusing, difficult to explain and understand. After all, the problem and the solutions are, for the most part, hidden away underground.

But, can’t we all agree that landflling does not solve the problem of petroleum contaminated soils?

I am amazed so many people are willing to sign up for cradle to grave liability. This country has a reckless tendency to cheerfully gamble against its own future. Perhaps we expect continuous advances in science and technology to take care of whatever consequences our present behavior might bring. Maybe that’s what they were hoping back in the 1960s when they were burying plutonium wastes in cardboard boxes at weapons manufacturing sites.

Indeed, landfill technology is not standing still. I know of at least one landfill, in Collier County, Florida, that is continuously being recycled. They have set up a conveyor system that cleverly sorts and screens out glass, aluminum and plastic for reuse. Their goal is to eventually reclaim waste as fast as they receive it. Officials in Laketop Pinehurst, Ariz., have set up a big digester system to compost biosolids—diverting consumer trash headed for the landfill as the bulking agent in the process.

As landfill technology advances, it is unclear whether petroleum contaminated soils will continue to be welcome.

Generally, landfill managers who are paying to have virgin clay mined and transported in for landfill caps listen with great interest to plans whereby they can accept petroleum contaminated soils, then mix them with asphalt for their caps. But, in the final analysis, I expect there is a lot more petroleum contaminated soil than the landfills can use for this purpose.

Back in the 60s, we used to say, “Can you dig it?” On the other hand, we were idiots back in the 60s.
Of the huge quantities of petroleum contaminated soils in need of cleanup, a great deal falls into one of two categories: the "light" hydrocarbons such as gasoline and the "heavy" hydrocarbons, which include fuel oils, motor oils, lubricating oils and coal tars. Effective thermal process design is critical depending on which type of contaminant is targeted. There is a significant difference in design and arrangement of components of a thermal process system designed for heavy hydrocarbon contaminated soils as compared to the basic sand drying system currently being used on gasoline cleanups. There is a need for higher processing temperatures and extended retention times to properly clean the heavier contaminants. The two main process differences, as illustrated above, are in the arrangement of the rotary drum, parallel-flow or counterflow, and the location of the baghouse with respect to the afterburner. For lighter, gasoline cleanups, equipment consists of a counterflow drum and baghouse with afterburner located between the two. Soils enter the drum at the opposite end of the burner and exit at the burner end. Gas stream temperature leaving the drum is lower than soil discharge temperature, which means the lightest airborne particles exit the drum at lower temperatures than the targeted operational temperature for cleaning the soils. Contaminated fines must be treated. In parallel flow, soils enter at the burner end. Gas temperatures exiting the drum are slightly higher than soil discharge temperatures. Higher drum gas temperatures are achieved in a parallel flow, and fines always exit at or above target temperature for removing the contaminant. The parallel flow system is more effective in treating the heavier hydrocarbons because it achieves the higher gas temperatures necessary to vaporize these contaminants from the fines.

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The carriage pontoons house the track drive assemblies. Rubber or metal tracks are available, depending on what type of traction is needed. The tracks are driven by a roller chain and sprocket system. Automotive power for the tracks is provided by hydraulic operation in forward and reverse, as well as pivot-type steering for maneuverability inside restrictive spaces. The power unit is trailer mounted and equipped with all controls to operate the motive system and pumping system—including steering, forward/reverse, pump speed and cutterhead speed. It can be located up to 200 feet away from the Trac Pump work area. The system enables sludge removal from tanks or other closed equipment by venting emissions back to the tank. It can pump sludge (biosolids), water, crude oil, chemicals and sewerage. The unit requires four inch flexible discharge tubing.  

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