

**Assessment, Evaluation,
and Testing of Technologies for
Environmental Restoration, Decontamination,
and Decommissioning,
and High Level Waste Management**

DOE/SR/18925--T2

Progress Report To

**United States Department of Energy
Savannah River Site
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Submitted By

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- List of technologies
- Student participants
- Sample Project

INTRODUCTION

North Carolina Agricultural and Technical State University (NCA&TSU) is a comprehensive State University with more than 90 academic programs (Certificate, B.A., B.S., M.A., M.S., and Ph.D.) offered through the Schools of Agriculture, Business and Economics, Education, Nursing, Technology, College of Engineering, and the College of Arts and Sciences. The University enrolls nearly 8,000 students from 62 foreign countries. Faculty and staff number nearly 1,300.

TECHNOLOGY ASSESSMENT AND EVALUATION

Nuclear and commercial non-nuclear technologies that have the potential of meeting the environmental restoration, decontamination and decommissioning, and high level waste management objectives are being assessed and evaluated. A detailed comparison of innovative technologies available will be performed to determine the safest and most economical technology for meeting these objectives. Information derived from this effort will be matched with the multiobjectives of the environmental restoration, decontamination and decommissioning, and high level waste management effort to ensure that the best, most economical, and the safest technologies are used in decision making at USDOE-SRS. Technology-related variables will be developed and the resulting data formatted and computerized for multimedia systems. The multimedia system will be made available to technology developers and evaluators to ensure that the safest and most economical technologies are developed for use at SRS and other DOE sites.

PROJECT ACCOMPLISHMENTS

Identification, Assessment, and Evaluation of Technologies

The attached 300 nuclear and commercial non-nuclear technologies for environmental restoration, decontamination and decommissioning, and high level waste management have been identified from various sources. Thirteen undergraduate students are participating in this project. They were awarded scholarships ranging from \$500 - \$900 based on quality of work performed. A list of student participants and an example of their contribution to the project are attached.

Development of Ecological Database and Analysis of Soils at SRS

Acquisition of FIA data through SRS is in progress. FIA results are reported as aggregate summaries on a county basis. With such summarization and the use of political boundaries as scale, essential details and the spatial variability of the ecological variables are lost. The unsummarized data and especially the “non-forestry” information (soil chemistry data, geographic coordinates, etc.) are computer coded in a format that discourages and/or prohibits their further use, and stored away from accessibility.

National Environmental Technology Conference

The University plans to host a national environmental technology conference in early september 1998 that will address SRS technologies. The conference will be sponsored by DOE-SRS, DOE-Oak Ridge, DOE-Chicago Office, US Army Corp of Engineers and IOC, and USEPA. Participants will include Colleges and Universities and Environmental Technology Vendors. The theme for the conference will be developed from information obtained from technology vendors and SRS. The University has formed a technology conference committee. The committee has met twice to outline the conference objectives and scope.

Attachments

List of Technologies

Student participants

Sample Project

IDENTIFIED TECHNOLOGIES

Acid Extraction	Lockheed Martin Corporation
Acid Extraction Treatment System (AETS)	Center for Hazardous Materials Research (CHMR)
Acidification-Volatilization & Recovery	Viking Industries, Inc.
Acoustic-Enhanced Remediation	Weiss Associates
ACT*DE*CON	Selective Environmental Technologies, Inc.
Activated Alumina	
Advanced Chemical Treatment	MARCOR Remediation, Inc.
Advanced Integrated Solvent Extraction and- Ion Exchange Systems	Argonne National Laboratory
Air-Sparged Hydrocyclone	Advanced Processing Technologies, Inc.
Alternating Current Electrolysis	Water and Slurry Purification Process (WASPP) Corporation
Aminoplast Capillary Technology	Landmark Environmental, Inc.
Anaerobic Biotransformation with Steam Injection	ENSR Consulting and Engineering
APEG-PLUS Process	Galson Remediation Corporation
Aquathermolysis	
Aqueous Biphasic Extraction System	Argonne National Laboratory
Barrier System	International Environmental Technologies (IET)
Batch Steam Distillation & Metals Extraction	IT Corporation
Biocat	Yellowstone Environmental Science, Inc., (YES)
Biochemical Recovery of Radionuclides and Heavy Metals	Brookhaven National Laboratory
Biodrain	International Environmental Technologies, Inc.
Bioinjection	Keller Environmental, Inc.
Biological Air Treatment (BAT) System	Allied Signal Environmental Systems & Services, Inc.
Biopurge	Enviro FX, Inc.
Bioreactors	Environsystems, Inc.
Bioremediation of Explosives-Contaminated Soil	
Bioremediation-Soil and Groundwater	KEMRON Environmental Services, Inc.
Bioremediation-Solid Phase	Arctech Inc.
Bioremediation-Solid Phase	Earth Tech
Bioslurping	
Bio-Solution	Cherokee Environmental Group
Biosorption	
BioSparge System	Enviro FX, Inc.
Biosurfactants	
Biovac	Terra Vac, Inc.
Bioventing	
BTS Method	Bioremediation Technology Services, Inc
Campbell Centrifugal Jig	Montana Tech of the University of Montana
Carbon Aerogel Capacitive Deionization of Water	Lawrence Livermore National Laboratory
Carbon Dioxide Blasting	Alpheus Cleaning Technologies
Carbon Dioxide Pellet Surface Cleaning	
Catalytic Extraction Process	M4 Environmental, L.P.
Catalyzed Decomposition	U.S. EPA National Risk Management Research Laboratory
Ceramic Immobilization of Radioactive Wastes	
Ceramic Silicone Foam Encapsulation	Orbit Technologies, Inc.

IDENTIFIED TECHNOLOGIES

TECHNOLOGIES	VENDORS
ChemChar Process	University of Missouri
Chemfix	Chemfix Technologies, Inc.
CHEMIC Ultrafiltration of Toxic Metals in Wastewater	Atomic Energy of Canada Limited (AECL)
Chemical Oxidation	
Chemical Treatment	G E M , Inc
Chemically-Enhanced Solubilization for Aquifer Remediation (CESAR)	INTERA, Inc
Chitosan Derivative	Humboldt State University
Clean Soil Process (CSP)	Thermo Design Engineering, Ltd
Coaxial Groundwater Ventilation (KGB)	IEG Technologies Corporation
Co-Burning Technology	Barr Engineering Company
Colloid Polishing Filter Method	Filter Flow Technology, Inc.
Compact Processing Unit (CPU)	Battelle Pacific Northwest Laboratory
Composting	
Corpex Technology	Corpex Technologies, Inc.
Countercurrent Decanting	Westinghouse Savannah River Company
Cryofracture	General Atomics
Cryogenesis Surface Decontamination System	CryoGenesis
Cryogenic Retrieval	Sonsub, Inc
CURE Electrocoagulation Wastewater Treatment System	CURE International, Inc.
Cyclone Furnace Vitrification	Babcock & Wilco Nuclear Environmental Services, Inc.
Cyclone Melting System (CMS)	Vortec Corporation
Cyclone Furnace Vitrification	Babcock & Wilcox Nuclear Environmental Services, Inc.
DC Graphite Arc Furnace	Electro-Pyrolysis, Inc
Deact Soil Washing	Advanced Recovery Systems, Inc.
Debris Washing System	U S EPA and IT Corporation
DeCaF	Advanced Recovery Systms, Inc.
DeHg	Advanced Recovery Systems, Inc.
Density-Driven Convection (DDC)	Wasatch Environmental, Inc.
Depocrete	Cancrete Environmental Solutions, Inc
DETOX	Delphi Research, Inc.
Detoxifier In Situ Steam/Hot-Air Stripping Unit	Alternative Technologies for Waste, Inc.
Diatomite	Landmark Environmental, Inc.
Diphonix	Eichrom Industires, Inc.
Dispersion by Chemical Reaction (DCR) Technology	SOUND Environmental Services, Inc.
Distillation	
DOWEX Ion Exchange Resins	Dow Chemical Company
Dual Auger System	In-Situ Fixation, Inc
Dual Phase Extraction	
Dual Vacuum Extraction	Terra Vac, Inc
DUCRETE Shielding	Starmet Corporation
DuraMelter	GTS Duratek
Dynamic Underground Stripping (DUS)	Lawrence Livermore National Laboratory
Ecolotree Buffer	Ecolotree Inc.
Ecolotree Cap	Ecolotree Inc.

IDENTIFIED TECHNOLOGIES

TECHNOLOGIES	VENDORS
Electroacoustic Dewatering	Battelle Memorial Institute
ElectroChemical GeoOxidation (ECGO)	ManTechn International Corporation
Electrode Assisted Soil Washing	Toxic Environmental Control Systems, Inc.
Electrofrac Detoxification System	Bio-Electrics, Inc.
Electrokinetic Decontamination Process	ISOTRON Corporation
Electrokinetic Remediation	Massachusetts Institute of Technology
Electrokinetic Remediation	Sandia National Laboratories
Electrokinetic Remediation	
Electrokinetic Remediation of Contaminated Soil	Lynntech, Inc.
Electrokinetic Transport	Envirogen, Inc.
Electrokinetic Treatment	Electro-Petroleum, Inc.
Electrokinetically Enhanced Bioremediation	
Electro-Klean Electrokinetic Soil Processing	Electrokinetics, Inc.
Electroreclamation	Geokinetics International, Inc.
Enviroglass	Molten Metal Technology
EnviroMech Gold Biocatalytic Contaminant Degradation	ECO-TEC, Inc.
Enzymatic Reduction of Uranium	U.S. Geologic Survey
FE-ACTIVE	First Environment, Inc.
Forced Aeration Contaminant Treatment (FACT)	ABB Environmental Services, Inc.
Fungal Composting	Environmental BioTechnologies, Inc.
Geo-Cleanse Process	Geo-Care, Inc.
Glass Material Oxidation & Dissolution System	Oak Ridge National Laboratory
Heap Leaching	Geochem Division of Terra Vac
High-Energy Electron Beam Irradiation	High Voltage Environmental Applications, Inc.
High-Force Magnetic Separators	International Process Systems, Inc.
High-Gradient Magnetic Separation for Radioactive Soils and P	Los Alamos National Laboratory
High-Temperature Joule-Heated Vitrification	EnVitCo, Inc.
Horizontal Drilling	Drillex System, Inc.
Horizontal Drilling	
Hot-Recycled-Solid (HRS) Retorting Process	Lawrence Livermore National Laboratory
Houdini	RedZone Robotics, Inc.
Humasorb	Arctech, Inc.
Hydraulic Fracturing	FRX, Inc.,
Hydraulic Fracturing	
Hydraulic Fracturing/FracTool	Golder Applied Technologies, Inc.
Hydrolytic Terrestrial Dissipation	HyroScience, Inc.
ID-20 Chemical Neutralization Process	Cunningham-Davis Environmental (CDE Resources, Inc.)
IE-911 Ion Exchange Resins	UOP Ionsiv
Imbiber Beads	Imbibitive Technologies Corporation (IMTECH)
In Situ Air Atripping	Westinghouse Savannah River Company
In Situ Grouting and Retrieval	Idaho National Engineering Laboratory
In Situ Plasma Vitrification	Georgia Institute of Technology Construction Research Ce
In Situ Saturated Zone Treatment	Oak Hill Company, Ltd.
In Situ Solidification/Stabilization Technology	Geo-Con, Inc.

IDENTIFIED TECHNOLOGIES

TECHNOLOGIES	VENDORS
In Situ Vitrification	Geosafe Corporation
In Situ Waste Destruction & Vitrification	Teton Technologies, Inc
In-Situ Air Stripping	Westinghouse Savannah River Company
In-Situ Bioremediation of Chlorinated Solvents with Natural Gas	Westinghouse Savannah River Company
InSitu Bioremediation Treatment System	R E Wright Environmental Inc
In-Situ Bioremediation(ISB)	Terra Systems, Inc
In-Situ Corona	Battelle Pacific Northwest Laboratory
InSitu Soil Vapor Extraction (SVE)	
ISOTEC	In-Situ Oxidative Technologies, Inc (ISOTEC Inc)
Joule-Heated Vitrification	
KPEG	SDTX Technologies, Inc
Lasagne	Monsanto Company
LEADX	Proactive Environmental Research & Development, Inc
Light Activated Reduction of Chemicals (LARC)	Arctech, Inc
Light Duty Utility Arm	Spar Aerospace, Ltd
Linear Containment Remediation System	Horizontal Technologies, Inc
LLC, Aeration Curtain	Radian International
LLC, Aquadetox/Soil Vapor Extraction (SVE)	Radian International
LLC, CRYOCELL	RKK-SoilFreeze Technologies
LLC, CRYOSWEEP	RKK-SoilFreeze Technologies
LLC, ISOCELL	RKK-SoilFreeze Technologies
LLC, Supercritical Carbon Dioxide Extraction	Kaiser-Hill Company
LLCX, CRYOCELL	RKK-SoilFreeze Technologies
MAECTITE Chemical Treatment Process	Sevenson Environmental Services, Inc
MAG*SEP	Selective Environmental Technologies, Inc
Magnetic Barrier Separation	S G Frantz Company, Inc
Magnetically Assisted Chemical Separation (MACS)	Argonne National Laboratory
Mechanical Volatilization Screening	O'Brien & Gere Engineers, Inc
MecTool Remediation System	Millgard Environmental Corporation
Mediated Electrochemical Oxidation (MEO)	EOSystems, Inc
Mercon	Solucorp Industries
Mercrobes Mercury Reduction Technology	AP Technologies, Inc
Metal Separation by Liquid Ion Exchange	Met-Tech Systems, Ltd
Metal Treatment Technology	RMT, Inc
Meta-Lock	Klean Earth Environmental Company (KEECO, Inc)
Metals Recovery and Recycling System	International Environmental Trading Company, Inc
Methanol Extraction Process	Environmental Treatment and Technologies Corporation
METLCAP Chemical Cement	Stark Encapsulation, Inc
Metrax	Integrated Chemistries, Inc
Microfiltration Technology	DuPont/Oberlin
Microwaste Solidification	EET Corporation
Microwaste Waste Solidification	EET Corporation
Mini-Miser	Recre Environmental, Inc
Modular Integrated Treatment System (MITS)	On-Site Technologies

IDENTIFIED TECHNOLOGIES

TECHNOLOGIES	VENDORS
Molten Salt Oxidation	Lawrence Livermore National Laboratory
Montan Wax Barrier	Golder Associates Corporation
MSRDI Combination Technology Mercury Treatment System	Mountain States R&D International, Inc.
National Laboratory Modified Sulfur Cement Encapsulation	Idaho National Engineering Laboratory/Brookhaven
Oclansorb	Hi-Point Industries, Ltd.
Oil Gator	Product Services Company
OptiSorb Encapsulate	Aqualogy BioRemedics
OW*WW*ER Wastewater Treatment System	Wheelabrator Clean Air Systems, Inc.
Oxy Vac	Terra Vac, Inc.
Oxygen Release Compound (ORC)	Regenesis Bioremediation Products, Inc.
Palladium-Iron Dechlorination of Organic Compounds	Research Corporation Technologies, Inc.
Perma-Fix Process	Perma-Fix Environmental Services, Inc.
Phosphate-Induced Metal Stabilization (PIMS)	UFA Ventures, Inc.
PHOSter	Freemean & Vaughn Engineering, Inc.
Photolytic and Biological Soil Detoxification	IT Corporation
Phytoremediation	
Phytoremediation/Hyperaccumulation	
Pile Biodegradation (Biopile)	
Plasma Arc Centrifugal Treatment (PACT) System	Retech, Inc.
Plasma Energy Recycle and Conversion (PERC)	Thermo Conversion Corporation
Plasma Hearth Process	Science Applications International Corporation
Plasma Vitrification	
Plasma Waste Converter	Startech Environmental Corporation
Pneumatic Fracturing Extraction	Accutech Remedial Systems
Pneumatic Soil Fracturing (PSF)	Terra Vac, Inc.
PneumaticFractureing Extraction	Accutech Remedial Systems
Polyethylene Encapsulation	Envirocare of Utah, inc.
Polymer-Based Solidification/Stabilization	
Polywall Barrier System	Horizontal Technologies, Inc.
Pozzolanic Solidification/Stabilization	
Pressure Dewatering	
Pyretron Thermal Destruction System	American Combusion, Inc.
Pyrodigestion	Clean Technologies
Pyrolysis	
Quantum Catalytic Extraction Process (Q-CEP)	Molten Metal Technology, Inc.
Quick-Purge	Integrated Environmental Solutions, Inc.
RadAway	The Molecular Company, Inc.
RaDFix Harmonic Compaction	Ryan-Murphy, Inc.
Radio Frequency Heating	IIT Research Institute
Radionuclide Separation Process (RASEP)	ADTECHS Corporation
Relclaim	Environmental Fuel Systems, Inc.
Remediation Using Foam Technology	Argonne National Laboratory
Resin-in-Pulp/Carbon-in-Pulp	Kvaerner Metals
RHM-10000 Process	TechTran Environmental, Inc.

IDENTIFIED TECHNOLOGIES

TECHNOLOGIES	VENDORS
RocTec Stabilization	Starmet Corporation
Rosie II	RedZone Robotics, Inc
ROVCO2	Oceaneering International, Inc
SAREX Chemical Fixation Process	Separation & Recovery Systems, Inc
Segmented Gate System (SGS)	Thermo NUClean
Self-Sealing/Self-Healing Barrier (SS/SH)	Water Technology International Corporation
Sepor System	U S Naval Academy
Shallow Soil Mixing	Geo-Con, Inc
Soil Leaching and Enviro-Clean Technologies	Lewis Environmental Services, Inc
Soil Recycle Treatment Train	Toronto Harbour Commissioners
Soil Remediation and Cleaning Products	BioGenesis Enterprises, Inc
Soil Washing	TVIES, Inc
Soil Washing System (BSWS)	Brice Environmental Services Corporation (BESCORP)
Soil Washing Technology	ARCADIS Geraghty & Miller, Inc
Soil Washing Technology	GHEA Associates
SOIL*EX	Rust Federal Services
Soil/Sediment Washing Technology	Bergmann USA
Solid Organic Phase Extraction (SoPE)	Envirogen, Inc
Solidification & Immobilization of Radioactive Wastes in Cement	
Solidification and Stabilization	WASTECH, Inc
Solidification/Stabilization	
Solidification/Stabilization Technology	STC Remediation, Inc
Solvated Electron Technology (SET)	Commodore Environmental Services, Inc
Sonic Reactor (or Sonic Grinder)	ARC Sonics, Inc
Sparge VAC	Terra VAc, Inc
SpargePurge	NEPCCO Environmental Systems
SpinTek	SpinTek Systems
Spray Aeration Vacuum Extraction (SAVE) System	Remediation Service Interational
SRTALK Process for Technetium Extraction	Oak RidgeNational Laboratory
Stabilization of Lead Bearing Waste	Forrester Environmental Services, Inc
Steam Enhanced Recovery	R E Wright Environmental, Inc
Steam Reforming-Synthetic Technologies Detoxifier (STD)	Scientific Ecology Group (SEG)
Str-Melter	Str-Melter Inc
STRATEX (Stratified Temperature Extractor)	ARCADIS Geraghty and Miller, Inc
Subsurface Volatilization and Ventilation System	Billings and Associates, Inc
Super All #38	Solution Distributors
Supercritical Carbon Dioxide Extraction	Kaiser-Hill Company
Supercritical Water Oxidation	Summit Research Corporation
SuperLig Ion Exchange Resins	IBC Advanced Technologies, Inc
Supported Liquid Membrane	Commodore Separation Technologies, Inc
Surfactant Remediation	Surtek, Inc
TechXtract	EET, Inc
Terra Wash Soil Washing	Terra Resources, Ltd
TERRAMET Heavy Metal Removal Technology	Doe Run Company

IDENTIFIED TECHNOLOGIES

TerraSure (TM)	Terranalysis Corporation
Terra-VIT Vitrification Technology	Battelle Pacific Northwest National Laboratory
The Ultimate Solution	MeltTran, Inc.
Thermal Distillation and Recovery	Caswan Environmental Services, Ltd.
Thermex	Chem-Nuclear Systems, Inc.
Thermoplastic Stabilization/Solidification	
TIE-96 Ion Exchange Resins	UOP
Transuranium Extraction (TRUEX) Process	Argonne National Laboratory
TR-Detox	Environmental Technology (U.S.), Inc.
Treatment Walls	
Truclean Soil Washing System	Lockheed Martin Corporation
Two-Phase Extraction system	Xerox Corporation
Two-Phase Vacuum Extraction	Dames and Moore
Two-Phase Vacuum Extraction	Smith Technology Corporation
Ultrasound-Enhanced Soil Washing	New Jersey Institute of Technology
Uranium Heap Leaching Technology	Los Alamos National Laboratory
VAC*TRAX Thermal Desorption	Rust Federal Services, Inc.
VaporPurge	NEPCCO Environmental Systems
Vegetable Oil Remediation	Battelle Pacific Northwest Laboratory
VESTRIP	Ejector Systems, Inc.
Waste Acid Detoxification and Reclamation	Viatec Recovery Systems, Inc.
Wet Oxidation	
Wet Oxidation (WetOx) Process	ADTECHS Corporation
WR2	Alternative Biowaste Elimination Technologies (ABET), Ltd
XeChlor Process	Xetex Corporation
X-Ray Treatment	Pulse Sciences, Inc.

1998 WMI UNDERGRADUATE SCHOLARSHIP AWARDS

NAME	MAJOR	CLASS	GPA	AMOUNT
Bell, Damasi [REDACTED]	[REDACTED]	Sophomore	[REDACTED]	\$700
Brice, Angela [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Brooks, Lakeeva Myrica [REDACTED]	[REDACTED]	Junior	[REDACTED]	\$900
Crump, Tommie Curtis [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Epps, Torrey Andre [REDACTED]	[REDACTED]	Junior	[REDACTED]	\$500
Farr, Elizabeth A. [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Holley, LaKeshia Michelle [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Lee, Chris Siu-Ling [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Lynch, Sean [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$900
Newell, Darrell Anthony [REDACTED]	[REDACTED]	Junior	[REDACTED]	\$500

NAME	MAJOR	CLASS	GPA	
Strickland, Tanyetta K. [REDACTED] [REDACTED]	[REDACTED]	Senior	[REDACTED]	\$500
Wells, Christopher M. [REDACTED] [REDACTED]	[REDACTED]	Junior	[REDACTED]	\$500
Whitaker, Dianna T. [REDACTED] [REDACTED]	[REDACTED]	Junior	[REDACTED]	\$700
TOTAL				\$9700

Black Females 5
 Black Males 5
 White Females 1
 White Males 1
 Asian Males 1

Application Ratings By Committee

* = A
 ** = B
 *** = C

Total 13

CHRIS S. LEE
UNDERGRADUATE SCHOLARSHIP APPLICATION

Ten Non-nuclear Technologies Used for Environmental Restoration

I. Using Sunlight and Anaerobic Treatment To Clean Up Organic Contaminants In Groundwater

The technology uses the photocatalyst titanium dioxide to decompose organic contaminant in groundwater. The contaminated water contains large quantities of trichloroethylene (TCE) and other chemical used to clean engine parts. In this process, sunlight illuminates the contaminated water contained in a transparent receiver. Modeling estimates obtained from 30 minutes batch experiments projected that approximately 3 minutes of exposure is necessary in a continuous mode to reduce TCE from 200 to 5 ppb, the EPA standard for drinking water. Contaminants are oxidized to CO₂, H₂O, and HCl (for chlorocarbons). These intermediates are not toxic but if they are hazardous more exposure is required to destroy them. The treated water is sent to a holding tank where the suspended catalyst is settled. The clean water is decanted, pumped to a treatment unit and eventually discharged to an arroyo.

Solar photocatalytic process was designed by the National Renewable Energy Laboratory and Lawrence Livermore National laboratory, Livermore, CA. [1]

II. Fiber Reinforced Plastic Reuse

Mazada Motor Corp., Hiroshima, Japan has developed a fiber-reinforced plastic (FRP) that can be recycled up to five times. Mazada uses liquid crystal polymers made from polyester resins that can combined with conventional thermoplastics such as polypropylene. The composite, still in precommercial production, will be used as a structural material for automobile frames, and can be recycled as original material at least five times. When the material is recycled, the liquid crystal polymers – even if ground – rebind after melting into fibrous structures of the original strength. [2]

III. Getting Lead out from Lead Soil

A concentrated chloride extraction process has been designed to remove high concentrations (typically 5-10%) of lead from soils, particularly at lead battery waste sites, while producing a treated soil usable as backfill and a recyclable, concentrated lead soil. These continuous 3-stages countercurrent extraction process produces treated soil suitable for replacement on-site, and lead hydroxide, which can be reprocessed to recover lead. The ease of solvent regeneration minimizes waste disposal. Solvent recycling has been very successful and pilot-plant tests have required little salt or water makeup. Moreover, this process uses less expensive extractant, and lead is readily recovered by a modest pH increase. The University of Houston, TX designed the extraction process. [3]

IV. HCl Extraction

Concurrent Technologies Corp., Pittsburgh, PA, has developed an acid extraction treatment system (AETS) to remove heavy metal contaminants (ex. Arsenic, chromium, cadmium, copper, nickel, lead, and Zinc) from soils. Following the treatment, clean soil may be returned to the site or used as fill. The heavy metals, which extracted from the process, are concentrated in a form potentially suitable for recovery and reuse. The soil is mixed with lime and fertilizer to neutralize any residual acid. No wastewater streams are generated by the process. Treatment capacity is expected to range up to 30 ton/h, which met the regulatory levels. Cost ranges from \$120/yd³ to \$180/ yd³ of soil depending on the site size, soil type, and contaminant condition. [4]

V. Warming Of Frozen Soil Speeds Decontamination

ENSR Consulting and Engineering, Acton, MA, has developed a new technique to bioremediate contaminated soils in subfreezing temperature. Cold weather has proved to be a stubborn barrier in the use of bioremediation to clean up contaminated soils. ENSR has built on-site bioremediation cells equipped with portable vapor extraction systems (VES) that raise and maintain the temperature to the degree required for natural biological degradation. In a 1992 diesel spill in AK, approximately 600 yds³ of soil were contaminated by a leaking underground storage tank. ENSR graded an area adjacent to the site and fitted it with a leachate collection system and Permalon liner. A sand base was placed over this, followed by vent pipes. The contaminated soil was excavated and placed atop the pipes. Finally, The pile was equipped with soaker hoses and covered in black plastic. Nutrients then were injected into the contaminated soil along with water. By pumping in warm air and drawing it through the pile via the VES during cold weather, the technicians were able to maintain the optimum condition for biological degradation. [5]

VI. Phytoextraction Toxic metals in the Soils

Phytotech, Inc., Monmouth Junction, NJ, uses phytoextraction (extracting toxic metals using specially selected quick-growing plants that incorporate toxic in their roots and stems) to clean heavy metals in soils. The tall, fast growing crop plants are grown on contaminated soil and harvested after metals accumulate in the plant tissues. The degree of accumulation can be as high as 2% of the plants' aboveground dry weight, leaving clean soil in place that meets or exceeds regulatory clean-up levels. After accumulation in the plant tissue, the contaminant metal must be disposed of but the amount of disposable biomass is a small fraction of the amount of soil treated. For example, phytoextraction of a typical 10acre site to remove 400ppm of lead from the top 1 ft would require disposal of only about 300 tons of biomass. This just needed 6 to 8 crops, with 3 or 4 crops required per growing season. This process can be used to clean soils or sediments contaminated with lead, cadmium, chromium, and radioactive materials such as cesium/strontium and uranium. [6]

VII. Exhaust Gas Put To Good Use

The BOC Group, Murray Hill, NJ has developed a technique to capture Carbon dioxide, nitrogen, and argon efficiently and economically from exhaust gas. The gas is treated to remove particular matter and then compressed to between 1 and 15 psig. The gas is purified to remove trace contaminants, and then separated to produce fractions that are rich in carbon dioxide and nitrogen. The fraction rich in carbon dioxide is liquefied and distilled to remove volatile contaminants, producing pure CO₂. The nitrogen-rich fraction is purified and cryogenically distilled to produce pure nitrogen and argon. [7]

VIII. Skidmounted, Aboveground Soil Washing Technology

Brice Environmental Services Corp. (BESCORP), Fairbanks, AK, has developed a skidmounted, aboveground soil washing process that reduces the overall volume of heavy metals-contaminated even after washing. Soil is cleaned by intensive scrubbing, followed by density, magnetic, and size separations. This technology remediates soils at rates of 10 to 40ton/h, depending on the contaminants and soil. This technology combined with the acid leaching process on a small-arms range operated by the Department of Defense in Fort Polk, LA. The result from Fort Polk showed the combination process consistently removed more than 99% of the lead in the soil. The processed soil averaged less than 200 mg/kg total lead after treatment with average Toxicity Characteristic Leaching Procedure levels below 2mg/L. Soil washing allows both unrestricted reuse of treated soil on-site and recycling of recovered metals, which are not possible with stabilization or disposal options.[8]

IX. New Catalyst Decomposes Oil

Mazada Motor Corp., Hiroshima, Japan has developed a decomposition catalyst capable of recovering oil from all type of plastic, including thermosets and composites such as fiber reinforced plastics. Plastic is heated in a furnace and vaporized. Then, the gas is transferred to the decomposition catalyst chamber, where it comes into contact with the catalyst. The plastics decompose into oil-based products as gasoline and kerosene. The catalyst can also decompose chlorinated plastics, including polychlorinated vinyl, eliminating the need to pre-sort plastics for recycling. Moreover, the catalyst is capable of breaking down the shredded plastics remaining from scrapped vehicles. The catalyst proved that more than 60 % by weight of shredded plastic from cars could be recovered as oil. [9]

X. Electrokinetic Extraction Metals and Organic Contaminants From Soils

Lockheed Martin Missiles and Space Co., Palo Alto, CA, and Geokinetics International, Inc., Seattle, WA has designed an Electrokinetic Remediation (ER) process for removing metals and organic contaminants from soil, mud, and sludge. Treatment concentrations range from a few to tens of thousands of parts per million. This technology is most appropriate for sites with contaminated estuaries, river mud, sewage and processing sludge, and fines remaining after soil washing. The process can be used with virtually any substrate but its effectiveness is sharply reduced for wastes with moisture content of less than 10%. It can remove over 99.9% of contaminants in the substrate. [10]

REFERENCES

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