MOBILE SOILS WASHING TREATABILITY SYSTEM

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ABSTRACT

Recently, both government and commercial entities are displaying an increasing interest in soils washing for volume reduction of contaminated soil. This interest is driven by the continuing increases in transportation and disposal costs for both radioactive and hazardous soil. To address the applicability of soils washing at various sites, RUST Remedial Services, Inc. (RUST) has developed and procured a mobile soils washing treatability test plant for on-site volume reduction of radioactive, hazardous, and mixed waste contaminated soils using physical separation. RUST has also evaluated and integrated chemical treatment processing for additional volume reduction.

The integrated RUST soils washing system is a water based volume reduction process whereby hazardous contaminants are extracted and concentrated into a small residual portion of the original volume using physical and chemical methods. The mobile soils washing treatability test system was designed after years of laboratory and field testing and on-site projects. The mobile test system was fabricated by Bergmann USA, an international supplier in physical soil separation technology. The test system consists of all the necessary test components required to provide a complete pilot-scale physical separation testing program on one trailer.

RUST's soil process also incorporates a chemical process, the ACT*DE*CON^{SM} process, in conjunction with soils washing for the purpose of providing significant volume reduction beyond that achievable with soils washing only. The ACT*DE*CON^{SM} process (patent pending) selectively dissolves radionuclides and some heavy metals from soils. The contaminated materials are recovered from the ACT*DE*CON^{SM} solution and the ACT*DE*CON^{SM} solution is recycled. The process can be applied to a variety of soil materials contaminated with uranium, thorium, cesium, strontium, technetium, radium, barium, TRU elements, lead and mercury. The combination of both physical and chemical separation processes provide a significant volume reduction potential.

INTRODUCTION

In order to determine the applicability of soils washing on various contaminated soils, a treatability study is required to help ensure success during performance of the full-scale remediation phase of the project. The treatability studies required for soils washing include site characterization, laboratory screening, bench-scale testing, and pilot-scale testing.

Site characterization is the first phase of testing and will provide information concerning the physical and chemical charateristics of the soil. If the characteristics of the soil indicate soils washing is a candidate process, laboratory screening is the next phase of testing to be performed. Laboratory screening for soils washing consists of separation of the soil by particle size, inspection of the separated fractions and determination of the concentrations of contaminants in each separated fraction. If results of laboratory screening indicate the majority of contamination resides with a particular size fraction, then the next phase of testing required is bench-scale. Bench-scale testing will generate needed performance data for verification that cleanup goals can be obtained. During bench-scale testing, various separation technologies would be investigated to determine the optimum treatment scheme.

Following successful bench-scale testing, the final phase of treatability testing required is pilot-scale. Pilot-scale testing will provide quantitative performance, cost, and design information prior to committing dollars to full-scale equipment design and fabrication. Pilot-scale testing may also identify waste characteristics that may negatively impact full-scale operations.

To address the pilot-scale phase of treatability testing for soils washing, a trailer mounted test plant was fabricated to perform on-site treatability testing.

TREATABILITY TEST PROGRAM

The physical and chemical soil separation system combines a Bergmann USA designed and fabricated mobile pilot-scale physical separation plant combined with the demonstrated ACT*DE*CON^{SM} actinide dissolution and surfactant chemistry for decontamination of the separated waste streams. The integrated treatment system offers the following technical advantages:

- Easily transported to site, the process equipment is mounted on a single mobile trailer
- Only one power supply connection is required for operation of the entire system
- Pilot-scale plant components are scaled down from existing, proven full-scale processing equipment
- Based on current full-scale systems in operation for physical separation of soils
- Simple, easy to operate, and cost-effective
- Achieves significant volume reduction (>95%)
- Uses only benign chemicals to selectively remove contaminants
- Does not generate secondary waste
- Requires minimum amount of make-up water
- Can process up to 250 Kg per day of mixed waste soil meeting EPA exclusionary criteria

Soil Classification Equipment

The mobile bench-scale plant was designed and fabricated by Bergmann USA. Bergmann is a leader in physical soil separation technology, and has provided equipment for over 20 successful full scale installations, ranging in size from 10 to 350 tons per hour. In addition, the Bergmann designed equipment can achieve very efficient separation of the contaminated fines.

The components mounted on the plant are scaled down from proven physical separation technologies for pilot-scale testing applications.

ACT*DE*CON^{SM}, Actinide Dissolution Chemistry

In addition to physical soils washing, RUST has the capability of enhancing the technology with selective removal of contaminants using the exclusive ACT*DE*CON^{SM} process. This is a dilute chemical process developed by Bradtec and licensed exclusively by RUST. This technology uses benign chemicals to selectively remove plutonium, uranium and other contaminants, and has been shown to be effective on a wide range of contaminated soils. Based on the information generated at various tests, the process can reduce the overall waste volume to <5% of the original volume, rather than the 10% through 30% obtained by conventional physical soil separation.

Table I demonstrates the volume reduction of soils washing with ACT*DE*CON^{SM} as opposed to conventional soils washing only.

TABLE I
Volume Reduction with ACT*DE*CON^{SM}

Soil Fraction -125 micron (%)	Waste Volume (1% of total) Conventional	Waste Volume (% of total) w/ACT*DE*CON^{TM}
50	50	<3
60	40	<4
70	30	<3
80	20	<2
90	10	<1

TEST EQUIPMENT

The RUST pilot-scale physical soil separation system consists of all the necessary test components required to provide a complete pilot-scale physical separation testing program and provides required data for full-scale design. The individual components included in the pilot-scale physical soil separation plant are:

- Scalping Screen

  The scalping screen is used to remove oversized material (nominally 3/4") from the test soil.
- Trommel Screen

  The trommel screen is used to both wash and size the fine material generated from the scalping operation. Products from the trommel are a washed coarse material (nominally 3/4" x 1/4" [20mm x 6mm]) and a slurry consisting of nominal -1/4" (-6mm) particles.
- Derrick Fine Sizing Screen

  The Derrick screen is used to remove fine material which may not be recoverable as a clean product. The Derrick is supplied with a screen cloth to effect a nominal 170 Mesh (0.090mm) cut.
- Attrition Scrubber

  The Attrition Scrubber serves to liberate surficial contaminants from coarser sand grains by subjecting the soil to a high shear environment in which the grains of sand are scoured against one another.
- Hydrosizer (DMS)

  The DMS is capable of making solid-solid separations on the basis of size (for feed consisting of materials of similar relative densities) or relative density (for feed material which is comprised of distinctly different relative densities). In soils washing it is typically employed in a circuit to remove light gravity organic materials such as twigs, leaves, coal, and lignite.
- Pressure Filters

  Two flow mounted pressure filters are supplied to dewater slurries generated within the soils washing plant.
- Dissolved Air Flotation (DAF)

  Typically, the wash water used in soils washing plants will contain dissolved metals. To simulate the removal of these metals, a special locked cycle DAF unit is supplied.
- Spiral Test Stand

  A spiral test stand supplied on the trailer to be used to check the applicability of simple gravity separation on soils contaminated with free (liberated) high specific gravity materials.

TEST PROCESS

The pilot-scale treatability test process consists of separation of the test soil by size and density followed by additional treatment of the contaminated fractions using the ACT*DE*CON^{SM} process. The process flow diagram provided as Fig. 1. The process flow diagram depicts the flow path of the soil and shows the various waste streams generated during processing.

The following steps to be followed during the pilot-scale treatability test process are discussed below for the physical separation and ACT*DE*CON^{SM} process.

Physical Separation Test Process

The test soils are taken and processed through the Scalping Screen to remove material greater than 3/4" in size. The -3/4" material is transferred into the stainless steel material transfer buckets and the +3/4" material is collected in storage drums.

The -3/4" material in the stainless steel material transfer buckets is loaded into the Trommel inlet port and processed through the Trommel and Derrick Screens. The trommel washes and removes material +1/4" and directs this material into a separate storage drum. The -1/4" material is processed through the Derrick Screen to wash and remove +170 mesh material. The +170 mesh material is transferred into one of the stainless steel material transfer buckets and the -170 mesh material is collected in the Slimes sump.The +170 mesh

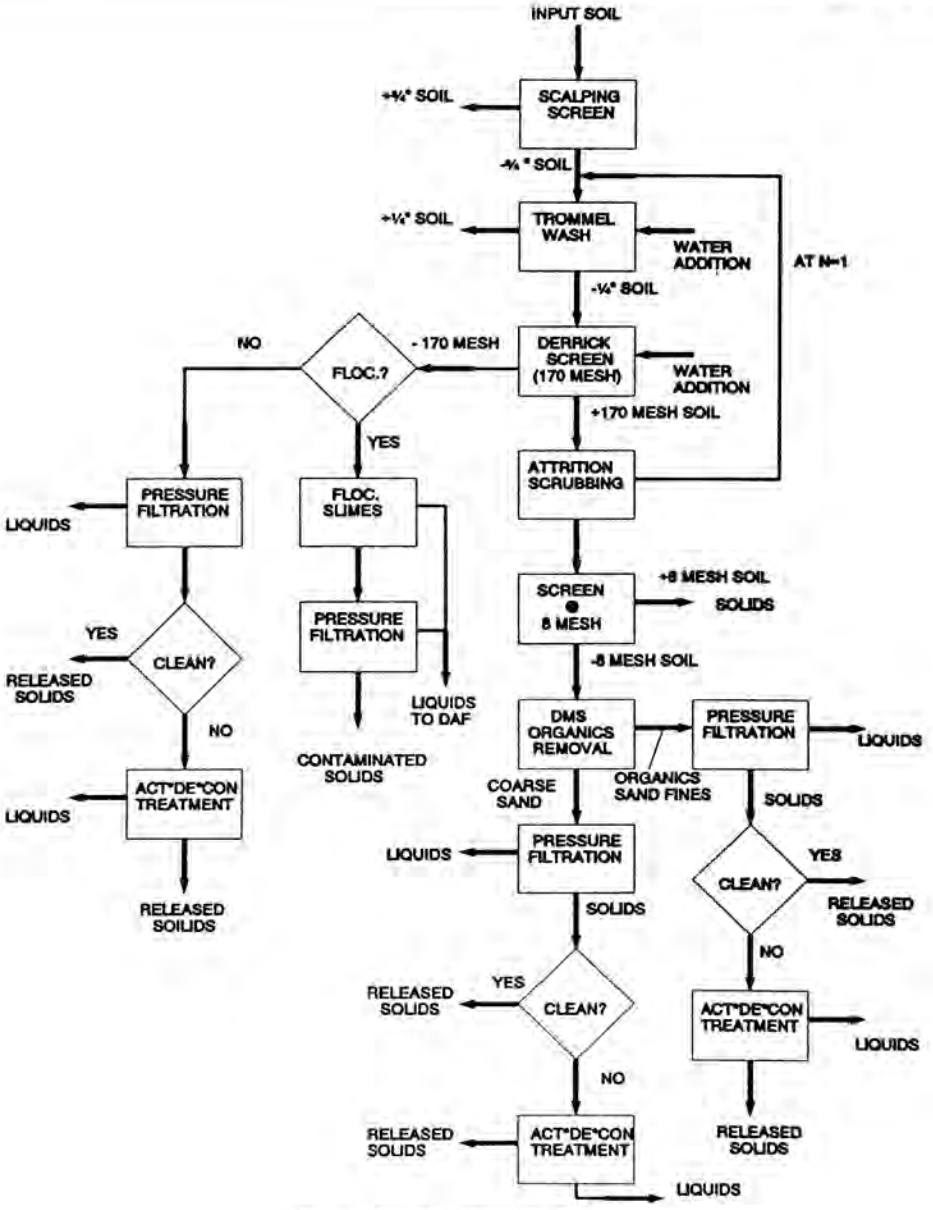

Fig. 1. Treatability test flow diagram.

material collected in the material transfer bucket(s) is transferred to the Attrition Scrubber unit. The blades are lowered into each bucket and the material is processed for approximately 15 minutes.

The material processed through the Attrition Scrubber is then transferred via the overhead lift and again processed through the Trommel and Derrick Screens. The +170 mesh material is directed into stainless steel material transfer bucket(s) and the -170 mesh material is directed into the Slimes sump.

The liquids collected with the -170 mesh material can be processed by addition of flocculent to precipitate dissolved contaminants. Following flocculation and settling, the liquids are processed through the Dissolved Air Flotation unit or as determined from characterization and analysis of the liquids.

The -170 mesh material collected in the Slimes sump are transferred into the Pressure Filtration unit(s) for dewatering. Approximately 50 PSI air is supplied to the units for dewatering of the waste. The waste is dewatered to approximately 60-70% solids by weight.

The scrubbed material collected in the stainless steel material transfer buckets, (nominally 170 mesh x +¼"), is screened through the 8 mesh screen to remove solid organics such as lignite, twigs, leaves or other vegetative material. The oversized material is collected in a storage container. The -8 mesh material is collected in the material transfer bucket(s) for processing through the Dense Media Separator (DMS).

The DMS injection water is adjusted to approximately 4 gpm to provide a counter current flow. The controller set point is set at 1.4. The -8 mesh material is slowly poured into the top of the DMS. As material is added a bed will form in the DMS. The fine sand and solid organics are collected from the top discharge port and the heavy coarse material is collected from the bottom discharge port. The generated waste streams are dewatered following physical separation.

The Spiral Concentrator can be used to further separate collected materials with varying specific gravities. These materials are slurried and transferred into the Spiral's sump. The material is then transferred to the top of the Spiral. As the material is transferred through the spiral, the high specific

gravity materials are separated from the lighter specific gravity materials. Once separated, the high specific gravity materials are transferred into a separate storage container.

Separated solid materials are analyzed for radioactivity and materials above the applicable release limits are treated using the ACT*DE*CON^{SM} process as presented on Fig. 1. Following treatment the material is dewatered.

The specific operational steps are altered during treatability testing as required to obtain the most efficient separation practical.

ACT*DE*CON^{SM} Test Process

Following soil classification as described above, samples of the contaminated materials will be taken for dissolution treatability testing. The purpose of the extraction step is to provide an environment for dissolution of the contaminants from the solid phase to the liquid phase. Key portions of the chemical and hardware components will be tested. The ACT*DE*CON^{SM} surfactant chemistry will be employed for the extraction experiments with soil samples using a laboratory scale pulper/mixer. These experiments will determine the overall dissolution efficiencies of uranium, heavy metals, and other applicable contaminants as a function of several operating conditions. The treatability study objectives will include consideration of the following important parameters:

- Contact time
- Intensity of mixing
- Additive concentrations
- pH
- Number of extraction stages

The extraction treatability testing will produce two streams: a supernatant containing the extracted contaminants, and a slurry containing the majority of the solids. The liquid containing the dissolved contaminants is typically solidified and returned to the waste generator. The slurry containing the solids (soil) is used for batch filtration experiments prior to being returned to the waste generator.

CONCLUSIONS

RUST's pilot-scale soils washing mobile plant contains all of the necessary test components required to provide a complete pilot-scale physical separation test program. The mobile plant can be set-up and evaluated at various locations at the contaminated site. The integrated treatability test program incorporates both physical separation and the demonstrated ACT*DE*CON^{SM} actinide dissolution and surfactant chemistry for separation and decontamination of radioactive, hazardous, and mixed waste soils. The results obtained from both the physical and chemical processes will determine the effectiveness of a comprehensive soils washing process.