

**CONSTRUCTION AND OPERATION OF A CHEMICAL EXTRACTION SOIL
TREATMENT PLANT FOR THE REMEDIATION OF URANIUM CONTAMINATED
SOIL AT A DOE FACILITY**

Jeffrey P. Kulpa
RMI Environmental Services
Ashtabula, Ohio
(440) 993-2804

Ward E. Best
United States Department of Energy
Ashtabula, Ohio

James W. Henderson
RMI Environmental Services
Ashtabula

ABSTRACT

One of the significant contributors to the cost of completing remediation activities at most Department of Energy (DOE) sites is the remediation of contaminated soil. The traditional approach of excavation, packaging, transportation, and burial at an approved disposal site is usually the major contributor to cost. At the RMI Decommissioning Project (RMIDP) in Ashtabula, Ohio, soil remediation in the approved project baseline was estimated to cost over \$45 Million of a total project cost of \$150 Million. In an effort to reduce project costs and shorten project schedules, the RMIDP has undertaken an initiative to design and build a chemical extraction soil washing facility. The facility was constructed between September 1998 and February 1999.

The RMIDP soil washing initiative has included bench scale testing to establish the viability of the process, pilot scale testing to refine engineering approaches and to answer technical questions regarding reliability of plant operations, and finally design and construction of a first of its kind soil washing plant. The RMIDP soil washing plant uses 0.2M carbonate solution which is heated to approximately 115°F and contacts the soil for approximately 90 minutes to leach the uranium from the soil. The process has been proven to result in contaminant removal efficiencies of approximately 85% and volume reductions in excess of 90%. The chemical extraction technology provides a remediation approach for the 40,000 tons of uranium contaminated soil at the RMIDP in Ashtabula, Ohio. The soil washing approach provides projected savings of approximately \$300 per ton when compared to ship and bury costs.

This paper describes the process flow for the carbonate extraction plant and provides detailed description of monitoring conducted to ensure that clean soil meets regulatory requirements to be used as clean back fill in restored areas.

INTRODUCTION

The RMI Decommissioning Project (RMIDP) in Ashtabula, Ohio has developed a remediation approach for removing uranium contamination from soil. The treatment approach has been proven effective in bench scale and pilot plant operations. Soil treatment using carbonate extraction reduces the volume of contaminated material requiring off-site disposal which has the positive effect of lowering total project costs associated with soil remediation from \$45 Million for ship and bury to \$25 Million for treatment. This paper describes the design, construction, shakedown, and operation of this first of a kind, 10 ton per hour, continuous flow, soil treatment production plant.

Background

The RMI Titanium Company operated the RMI Extrusion Site in Ashtabula, Ohio as part of the U.S. Department of Energy (DOE) weapons production program. Depleted, normal, and slightly enriched (up to 2.1% weight percent U-235) was extruded as part of the DOE production reactor fuels manufacturing process. Uranium extrusion operations were performed from 1962 through September 1988. RMI also extruded depleted and natural uranium under a Nuclear Regulatory Commission (NRC) license and extruded non-radioactive metals (primarily copper based) for the commercial sector. However, the majority of material processed at the facility was for DOE. All extrusion operations at RMI ceased on October 31, 1990.

In 1990, the NRC identified the RMI Extrusion Site for accelerated cleanup under the Site Decommissioning Management Plan (SDMP). DOE accepted financial responsibility for the cleanup based on previous site operations, which supported the DOE mission. Since 1990, the site has performed equipment and legacy waste removal in preparation for building demolition, and also performed selected soil remediation, and planning/permitting in support of groundwater remediation. The remediation effort is governed by guidance and regulations promulgated by the NRC for site decommissioning and license termination. In addition, the presence of chemical constituents (TCE) in groundwater has led to involvement by the U.S. and Ohio Environmental Protection Agencies (EPA) in remediation decisions involving a Corrective Action Management Unit (CAMU). RMI Environmental Services is the prime contractor to DOE for completion of site decommissioning. The DOE Ashtabula Environmental Management Project Office (AEMP) provides day to day oversight of the remediation effort. The DOE approved project baseline for the decommissioning project is approximately \$150 Million and is scheduled to complete in Fiscal Year 2005.

The RMI Extrusion Site consists of 25 buildings on 7 acres of the 25 acre site. The site is located in Northeastern Ohio about 50 kilometers north of Cleveland and approximately 1.5 kilometers south of Lake Erie. The area immediately adjacent to the site is sparsely populated. The majority of the site and surrounding area is relatively flat with the maximum elevation variation being 4 feet. The site is on the Lake Plain geographical feature, which formed in the latter part of the Wisconsin Age.

Description of Site Soil Contamination

The primary practice that contributed to soil contamination at the RMI Site was uranium manufacturing. Particulate uranium was generated in the extrusion building during operation of the main 3,850 ton extrusion press and during operation of other machining equipment. Hoods and fans were used to exhaust the fine uranium dusts and fumes outside the buildings. Particulate deposition from the exhaust system contaminated the surrounding soils with uranium.

The soil at the RMI Site is predominantly clay with a small sand fraction and some non-native gravel that was used for plant service roads. The uranium contamination at the RMI Site is generally stratified within shallow topsoils with highest activities found in the top 15 cm. of soil. Site characterization data indicates that in general, uranium activities fall below the treatment standard of 30 pCi/gm at approximately 46 cm. Average uranium contamination levels in the RMIDP soils are approximately 100 pCi/gm. The total amount of soil contaminated with uranium at the RMIDP is approximately 40,000 tons (1 ton = 907 kg). The current approved project baseline for soil remediation using a ship and bury approach estimates the project cost for soil remediation to be approximately \$25 Million. This paper will show that chemical extraction soil washing will provide significant savings over traditional ship and bury approaches.

Project Overview

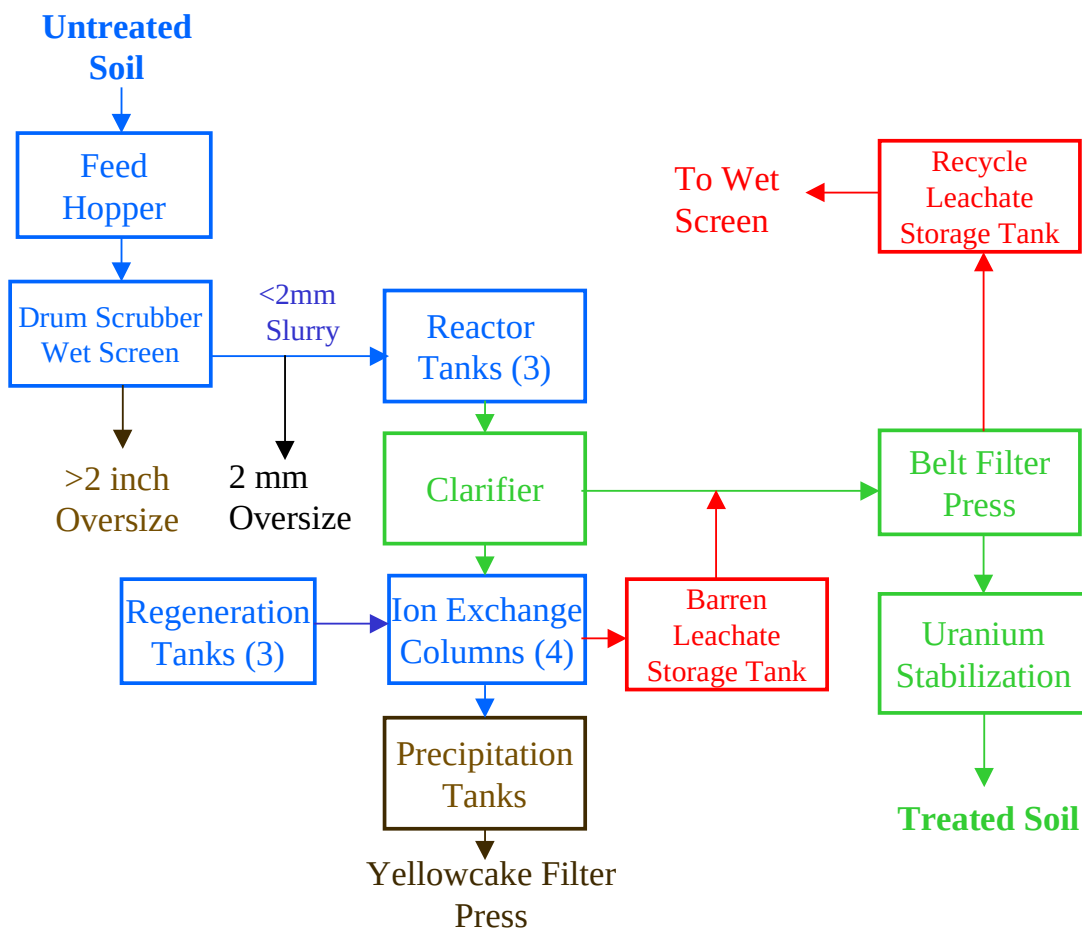
In late 1996, the RMIDP conducted bench scale testing in order to assess the viability of soil washing as a treatment option for the remediation of the high clay content soils present in Ashtabula. This study found that the Ashtabula soils could be treated effectively using a 0.2 M sodium bicarbonate solution at a temperature of approximately 115°F and a retention time of 1.5 hours. Treatability testing showed that chemical treatment using carbonate extraction achieved removal efficiencies of up to 90% and was effective in meeting the treatment standard of 30 pCi/gm for most of the site soils. A cost estimate of soil washing using the chemical extraction approach indicated that significant cost savings could be realized for the RMIDP by implementing soil washing as the soil remediation approach.

Based on the results of the treatability study, a pilot plant was designed to process 2-ton batches of contaminated soil. The purpose of the pilot plant was to validate the results of the treatability study and to optimize process design parameters. The pilot plant was operated on 38 batches in early 1998 to test various feed conditions. The results of pilot plant operations indicated that chemical extraction soil washing at the RMI site would result in contaminant removal efficiencies of approximately 82% and volume reductions of 95% (i.e., <5% residual waste requiring off-site disposal). A cost estimate of full production soil washing operations based on pilot plant results indicated that savings of over \$300 per ton could be realized when compared to ship and bury.

SOIL WASHING TECHNOLOGY DESCRIPTION

This section will provide a brief overview 10 ton per hour carbonate extraction system which has been constructed at the RMIDP. A block diagram of the process is illustrated in Figure 1.

Figure 1: Soil Washing Process Simplified Flow Diagram



The Soil Washing Production Plant is designed to leach uranium from contaminated soil using a nominal 0.2 M sodium carbonate/sodium bicarbonate solution. Following extraction, the soil is dewatered and staged as clean soil. The clean, treated soil is returned to the site as clean backfill. As a result of this process, significant volume reduction is achieved which minimizes radioactive low level waste (LLW) material which has to be transported off-site and buried, and thus minimizes soil remediation costs.

Soil from the Soil Staging Pad is processed through the Soil Washing Production Plant and after treatment it is conveyed outside to a covered Treated Soil Staging Pad. This pad is located on the south end of the Production Plant and functions as a staging area for the soil until it has been sampled, analyzed and field verified to meet the treatment standard. Following field verification

of the treated soil, it is loaded using a front end loader onto a dumptruck and transported back to the excavated areas for staging, free release, and ultimately backfilling.

Leaching, Dewatering, Uranium Recovery Steps

Soil is loaded using a front end loader into the soil Feed Hopper. From the Feed Hopper, the soil is metered by weight at a 10 ton per hour feed rate, and transferred to the Drum Scrubber. In the Drum Scrubber the soil is mixed with Recycle Leachate solution (i.e., recycled process water consisting of a nominal 0.2 M sodium carbonate/sodium bicarbonate solution with a nominal 7 ppm uranium concentration) to create a 30 wt.% solid soil slurry. The slurry is initially wet screened through the Drum Scrubber's trommel screen to remove ≥ 2 " oversize material. Oversize ≥ 2 " material from the Drum Scrubber trommel screen is collected in the Oversize Bin, and sampled and analyzed for disposal. The Drum Scrubber undersize fraction < 2 " falls through the trommel screen and onto the Wet Screen. The Wet Screen is designed to remove ≥ 2 mm oversize material from the Drum Scrubber underflow. Oversize ≥ 2 mm material from the Wet Screen is conveyed outside on the north end of the Soil Washing Production Plant and sampled and analyzed for disposal, or for further treatment. Depending on the oversize fraction and process requirements, the oversize material from the Wet Screen may be crushed to reduce the particle size to < 2 mm within the Rock Crusher, and then the material would be recycled back into the Drum Scrubber feed for further processing. Undersize material < 2 mm which falls through the Wet Screen is pumped into the Reactor Tank System.

The Reactor Tank System consists of 3 gravity feed, steam jacketed, nominal 4000 gallon tanks in series with agitators to maintain the solids in suspension. The Reactor Tanks function as reaction and retention vessels to enable the 0.2 M sodium carbonate/sodium bicarbonate solution (pH=10) to solubilize the uranium at a 115°F process temperature. After approximately 1-1/2 hours of retention time of the slurry in the Reactor Tanks, the leaching of uranium from the soil is completed. The slurry is then transferred to the Lamella Clarifier which functions, with the addition of coagulating and flocculating agents, to perform the initial dewatering of the slurry via gravity settling the solids out of solution, and functions to permit rinsing of the uranium from the solids leaving the underflow of the Lamella Clarifier using Barren Leachate solution (i.e., Ion Exchange System effluent process water with a nominal 2 ppm uranium concentration). The final dewatering of the slurry occurs within the Belt Filter Press. The soil sludge cake created by the Filter Press is stabilized by mixing the soil with chemical amendments (e.g., sulfuric acid to neutralize the soil pH to 7-8, and phosphate treatment to stabilize the residual soluble uranium). Following stabilization, the treated soil is conveyed onto the Treated Soil Staging Pad and staged as clean soil.

The process water which has the highest uranium concentration is defined as Pregnant Leachate solution (i.e., Lamella Clarifier effluent process water with a nominal 30 ppm uranium concentration). The uranium dissolved in the Pregnant Leachate solution is recovered using an upflow Ion Exchange System. The Ion Exchange System consists of 4 pressure vessels. At any one time, three of the vessels are in service, and the fourth is off-line being regenerated or in standby. The vessels contain a nominal 125 ft³ strong base anionic resin, and operated in series with the vessel with the highest uranium loading always operated as the lead vessel. Once the resin in the lead column is exhausted, the fourth regenerated column is brought on-line. The

exhausted column is taken off-line, and it is regenerated to permit reuse. The regeneration process continues iteratively throughout the operation of the plant. Regeneration of the resin occurs using 2.0 M sodium chloride, and 0.1 M sodium carbonate solutions. Uranium eluted from the resin during regeneration is ultimately recovered through a precipitation step using hydrochloric acid which lowers the pH and eliminates excess carbonate, and via the addition of hydrogen peroxide and sodium hydroxide. The process produces insoluble uranium peroxide as "yellow cake". The "yellow cake" is dewatered using a plate and frame filter press, and transferred into drums for offsite burial as radioactive LLW.

EQUIPMENT DESCRIPTIONS

Feed Hopper and Feed Ramp

The Feed Hopper is a apron feeder designed to receive, hold, meter, and convey 10 tons per hour of soil into the Soil Washing Production Plant. The Feed Hopper is fabricated from carbon steel and has overall dimension of approximately 24' long x 10' wide x 12' high. The Feed Hopper has a nominal 60" wide variable speed, chain driven, pan feeder and a minimum 10 yd³ hopper. A 2-3 yd³ capacity front end loader dumps approximately 3 loads of soil per hour to maintain soil in the hopper. A front end loader rated, 18' long x 12' wide Feed Ramp is provided to allow front end loader access to dump soil into the top of the hopper.

Drum Scrubber

A rotating, carbon steel, Drum Scrubber is provided which combines 10 tons per hour of soil from the Feed Hopper, and Recycle Leachate to create a 30 wt. % soil slurry. Undersize <2" material falls through the Drum Scrubber trommel screen, and oversize ≥ 2 " material passes through the Drum Scrubber trommel screen and leaves the unit as oversize. The Drum Scrubber has a working volume of 775 gallons; and nominal dimensions of 6' diameter x 16' long drum, and a 4'3" diameter x 4'3" long trommel screen located on the discharge end of the unit

Wet Screen

A nominal 3' wide x 7' long vibrating Wet Screen is provided to perform additional size fractionation of the <2" material which falls through the Drum Scrubber trommel screen. The wet screen is fitted with a 2 mm screen and spray nozzles to wash the fines from the oversize material. The undersize <2 mm which flows through the Wet Screen is collected in two separate sumps located under the front feed end and rear discharge end sections of the screen, respectively. The under size material that falls through the front section of the Wet Screen consists of the process water and most of the <2mm material from the Drum Scrubber trommel screen. This slurry from the front section of the screen falls into the 300 gallon, carbon steel, Reactor Feed Sump which then is pumped to the Reactor Tank System. The undersize material which falls through the rear section of the Wet Screen consists of Recycle Leachate process water which is used to rinse the undersize material from the ≥ 2 mm oversize fraction. This dilute < 2mm solid slurry from the rear screen section falls through the screen into the 200 gallon, carbon steel, Drum Scrubber Feed Sump which then is pumped into the Drum Scrubber. Oversize ≥ 2 mm material falls off of the end of the Wet Screen and is conveyed out of the Soil

Washing Production Plant. The oversize material is either sampled and analyzed for disposal, or is processed through the Rock Crusher to permit recycling of the material back into the Drum Scrubber for continued processing.

Recycle Leachate Tank

Recycle Leachate solution originates as Belt Filter Press filtrate and is pumped into the 7500 gallon Recycle Leachate Tank. The tank functions as a process water surge and buffer tank. The Recycle Leachate is pumped to the Wet Screen to wash the oversize, and it is pumped to the Slurry Pump Tank to dilute the Lamella Clarifier feed from 30% solids to 10% solids .

Reactor Tank System

The Reactor Tank System consists of 3 gravity feed, steam jacketed (i.e., 2 of the 3 tanks), insulated, nominal 4000 gallon, carbon steel, atmospheric tanks in series with agitators to maintain the solids in suspension. The Reactor Tanks function as reaction and retention vessels to enable the 0.2 M sodium carbonate/sodium bicarbonate solution (pH=10) to solubilize the uranium at a 115°F process temperature. After approximately 1-1/2 hours of retention time of the slurry in the Reactor Tanks, the leaching of uranium from the soil is completed.

The slurry gravity feeds from the third Reactor Tank into the 2000 gallon, carbon steel, Slurry Pump Tank which functions as a slurry dilution and surge tank. The slurry is diluted to 10 wt. % using Recycle Leachate and pumped from the Slurry Pump Tank to the Lamella Clarifier.

The Reactor Tank System is provided with two (2) 3,000 lb bulk bag, dry chemical unloading systems. Each system is equipped with a small hopper and variable speed helical screw conveyor to meter the chemicals. The systems will be used to feed Na_2CO_3 (sodium carbonate or dense soda ash) and NaHCO_3 (sodium bicarbonate), respectively, into the top of the first Reactor Tank. Each system is capable of delivering 50 to 250 lbs/hour of dry chemical.

Lamella Clarifier System

The 10 wt.% slurry from the Reactor Tank System is transferred to the Lamella Clarifier which functions, with the addition of coagulating and flocculating agents, to perform the initial dewatering of the slurry via gravity settling the solids out of solution. The Lamella Clarifier also functions to permit rinsing of the uranium from the solids leaving as a 35 wt.% slurry from the underflow of the Lamella Clarifier using Barren Leachate solution (i.e., Ion Exchange System effluent process water with a nominal 2 ppm uranium concentration). The overflow from the Lamella Clarifier gravity drains to the Pregnant Leachate Tanks.

A 275 gallon Flash Mixer and Flocculator Tank and associated mixers are provided with the Lamella Clarifier System. These components combine the feed with the flocculant going into the clarifier, and assist in the initial floc formation which aids the solid settling.

Pregnant Leachate Tanks

Two 7500 gallon Pregnant Leachate Tanks are provided to collect the overflow from the Lamella Clarifier. Two tanks are provided to act as surge and buffer volume in the event of a Lamella Clarifier upset. The Pregnant Leachate is pumped out of the tanks to provide dilution water to the Lamella Clarifier Flocculant Make-up Unit, and pumped through a filter to remove residual solids ≥ 150 μm particle size and then fed to the Ion Exchange System.

Belt Filter Press and Soil Stabilization System

The final dewatering of the slurry occurs within the Belt Filter Press. The soil sludge cake created by the Filter Press discharges into a screw conveyor and is transported outside and transferred onto the Soil Mixing Conveyor. The treated soil is stabilized by mixing it with chemical amendments (e.g., sulfuric acid to neutralize the soil pH to 7-8, and phosphate treatment to stabilize the residual soluble uranium). Following stabilization, the treated soil is conveyed onto the Treated Soil Staging Pad using the Radial Stacker Conveyor and staged as clean soil.

The Belt Filter Press filtrate and belt wash water is collected in the Filtrate Tank and Belt Spray Water Tank, respectively. The tanks each have a 400 gallon volume. Water from the Filtrate Tank is pumped to the Recycle Leachate Tank, and water from the Belt Spray Water Tank is recycled back to the Lamella Clarifier underflow line to provide dilution water for the slurry.

A second flocculant is added to the slurry upstream of the Belt Filter Press to allow for the reformation of flocs and assist in the soil dewatering.

Ion Exchange System

The uranium from the Pregnant Leachate solution is recovered using an upflow Ion Exchange System. The Ion Exchange System consists of four 3,500 gallon pressure vessels. The vessels are designed and built in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. At any one time, three of the vessels are in service, and the fourth is off-line being regenerated or in standby. The vessels contain a nominal 125 ft³ strong base anionic resin, and are operated in series with the vessel with the highest uranium loading always operated as the lead vessel. Once the resin in the lead column is exhausted, the fourth regenerated column is brought on-line. The exhausted column is taken off-line, and it is regenerated to permit reuse. The regeneration process continues iteratively throughout the operation of the plant. Regeneration of the resin occurs in the Ion Exchange vessels using 2.0 M sodium chloride, and 0.1 M sodium bicarbonate solutions.

Barren Leachate System

One 7500 gallon Barren Leachate Tank is provided to collect the effluent of the Ion Exchange System and serve as a process water surge and buffer tank. Barren Leachate stored within this tank is fed to the Belt Filter Press to supply the belt spray wash water, fed to the Belt Filter Press

Flocculant Make-up Unit to provide flocculant dilution water, and is fed to the Lamella Clarifier underflow in order to dilute the underflow from 35% to 10% solids.

Resin Regeneration and Chemical Make-up System

Regeneration of the exhausted resin occurs in the off-line Ion Exchange vessel using 2.0 M sodium chloride, and 0.1 M sodium bicarbonate solutions. The Resin Regeneration and Chemical Make-up System consists of five (5) 2,000 plastic tanks, and one (1) 3,000 gallon fiberglass reinforced plastic (FRP) Chemical Make-up Tank with an agitator.

Three (3) of the five (5) plastic tanks function as Resin Regeneration Tanks. The Resin Regeneration Tanks function as holding and transfer tanks for the regeneration solution. Each tank contains two bed volumes of the regeneration salt solution. The Resin Regeneration Tanks operate in series. The first Resin Regeneration Tank always contains the regeneration solution which initially contacts the exhausted resin and has the highest initial uranium concentration. The second and third tank follow in sequence; however, the second and third Resin Regeneration Tanks have an intermediate and the lowest initial uranium concentrations, respectively. Once the contents of the first Resin Regeneration Tank pass through the exhausted, off-line ion exchange column, the uranium loaded regeneration solution is transferred to one of the Precipitation Tanks. The second and third Resin Regeneration Tanks then pass in succession through the ion exchange column, and upon completion become the first and second Resin Regeneration Tank for the next regeneration sequence. Following precipitation and chemical make-up, the fresh regeneration solution is transferred from the Chemical Make-up Tank to the third Resin Regeneration Tank.

The remaining two (2) of the five (5) plastic tanks function as a Caustic Wash Tank, and a Spare Regeneration Tank. Due to organic resin fouling concerns, the Caustic Wash Tank is provided to allow for a warm caustic wash of fouled resin. An indirect contact steam heated coil is provided on the Caustic Wash Tank to allow for heating the caustic solution to 140°F.

The Chemical Make-up Tank is provided to allow for the addition of sodium chloride and sodium bicarbonate into the regeneration solution. Manganese dioxide is also loaded into the tank. Manganese dioxide acts as a catalyst to assist in the decomposition of residual excess hydrogen peroxide. The excess hydrogen peroxide is eliminated after completion of the precipitation reactions and prior to resin regeneration to minimize the oxidation and degradation of the ion exchange resin. Chemicals are added into the Chemical Addition Tank via manual dumping from bags.

Precipitation and Yellow Cake Filter System

The Precipitation and Yellow Cake Filter System consists of two 3,000 gallon, conical bottom, FRP Precipitation Tanks with agitators; a 630 mm (24") plate and frame Yellow Cake Filter Press with a capacity of 4 ft³ to dewater the "yellow cake", and associated chemical storage tanks and chemical metering pumps.

Regeneration solution and uranium eluted from the resin during regeneration is transferred to the Precipitation Tank(s). The uranium is ultimately recovered through a precipitation step using hydrochloric acid which adjusts the pH and eliminates excess carbonate, and via the addition of hydrogen peroxide and sodium hydroxide. The process produces insoluble uranium peroxide as "yellow cake". The "yellow cake" is dewatered using the plate and frame Yellow Cake Filter Press, and transferred into drums for offsite burial as radioactive LLW. Two Precipitation Tanks are provided. The first tank is provided to allow a precipitation cycle to occur in parallel with the other system activities (i.e., "yellow cake" settling, supernate decanting, and yellow cake filtration). Following precipitation, the regeneration solution is transferred to the Chemical Make-up Tank to allow chemical make-up and then to the Regeneration Tanks.

Flocculant Make-up Units

Two (2) Flocculant Make-up Units are provided to supply required flocculants to assist in solid/liquid separation. The first Flocculant Make-up Unit provides flocculant to the Lamella Clarifier slurry feed line. Dilution water for the first unit is provided from the Pregnant Leachate Tank. The second Flocculant Make-up Unit provides flocculant to the Belt Filter Press slurry feed line. Dilution water for the second unit is provided from the Barren Leachate Tank.

Each Flocculant Make-up Unit consists of a potable water supply line, dry polymer feeder, mixing chamber, 250 gallon plastic Mix Tank with agitator, 250 gallon plastic Holding Tank with agitator, and associated transfer and metering pumps. To assist in the dry polymer wetting and aging, the potable water feeding the Mix Tank is preheated to a minimum 60°F using an 100 gallon electrically heated hot water tank.

Boiler and Steam Distribution System

A 150 boiler horsepower (BHP) or 5M btu/hr low pressure boiler is provided to supply low pressure <15 psig process steam to the Reactor Tank steam jackets, and intermittently to supply steam to the Caustic Wash Tank steam coil.

Wastewater Evaporator System

Process wastewater is minimized through recycling process water and regeneration solutions as much as possible. Wastewater which can not be recycled (i.e., 175 gallons per day) is sent to the Wastewater Treatment Plant (WWTP) and evaporated using a closed drum evaporator system. The system consists of 6 electrically heated Drum Dryers. The water vapor from the dryers is collected and condensed. Condensate from the condenser is collected within a sump and recycled back into the process. Residual solids from the drums are disposed of as LLW.

Control Room, MCC, Process Power/Control Distribution System

The process is controlled from a programmable logic controller (PLC). Process power is 480 VAC and control distribution power is 24 VDC. A motor control center (MCC) and central Control Room are provided to distribute power and control the operation of the plant.

OPERATIONS

The RMIDP Soil Washing Facility is a 10 ton per hour continuous feed process. The plant is staffed by 8 operator technicians who perform the following operational tasks:

- Plant feed operations using a 2 cubic yard end loader. Feed operations include management of excavated soil staged for future operations.
- Operation of all required plant operating stations which include: plant feed; reactor tank systems, ion exchange and regeneration systems, clarifier and filter press systems, and stabilization systems.
- Chemical make-up operations.
- Minor plant operational maintenance and planned preventive maintenance.
- Clean soil product handling from the treated soil staging area to previously excavated areas for restoration of excavated areas.

Plant operations are controlled by the plant operations supervisor who coordinates all operational activities. Current plans are to operate the soil washing facility in single shift operations for five days a week. Maintenance will be completed on weekends. The planned operating schedule will allow over 1,000 tons of soil to be processed in each month which meets project requirements and DOE funding profiles.

CLEAN SOIL PRODUCT ACCEPTANCE

The RMI Decommissioning Project is governed by the Nuclear Regulatory Commission (NRC) through a approved Decommissioning Plan. Cleanup levels for soil are established at 30 pCi/gm. Monitoring of activity levels in the soil is accomplished by several means. Real time monitoring during plant operations is accomplished through frequent X-Ray Fluorescence (XRF) sampling. XRF can provide total uranium results in less than 1 hour. During pilot plant operations, extensive statistical sampling was compared to ensure accurate agreement between XRF and the regulatorily required Alpha Spectroscopy procedure. In addition to XRF, the processed soil will be sampled and monitored by Alpha Spectroscopy prior to acceptance as clean backfill.

In order to ensure that any residual uranium remaining in the clean soil product does not remain soluble and mobile in the soil, the soil product is treated with sulfuric acid to restore pH to normal and with triple super phosphate to make the uranium insoluble. These chemical additions ensure that the residual uranium will not negatively impact groundwater.

Finally, extensive re-vegetation experiments have been conducted to ensure that areas restored with clean soil product can be returned to vegetated conditions. The uranium stabilization efforts described above also have a positive effect on vegetation efforts resulting in a very acceptable growth medium.

CONCLUSIONS

The RMI Decommissioning Project has constructed a 10 ton per hour chemical extraction soil washing facility at a capital cost of approximately \$2.0 Million. A cost comparison of traditional

soil remediation through transportation and burial and soil washing reveals that at the RMIDP, soil washing will save the DOE approximately \$300 per ton of soil processed.

Reference

1. “Cost and Performance Report – Chemical Extraction for Uranium Contaminated Soil” Innovative Treatment Remediation Demonstration, U.S. DOE, July 1998.