**ELECTRIC POWER RESEARCH INSTITUTE
ENVIRONMENTAL CONTROL TECHNOLOGY CENTER**

REPORT TO THE STEERING COMMITTEE

Monthly Technical Progress Report

**US/DOE Patent Clearance is not Required
Prior to the Publication of this Document**

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EPRI/ECTC
Radian International
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TABLE OF CONTENTS

- I. EXECUTIVE SUMMARY**
- II. FACILITY STATUS**
 - General
 - Clear Liquor Scrubbing with Anhydrite Production
 - Carbon Injection System
 - Financial Report
- III. PILOT AND MINI-PILOT TEST ACTIVITY**
 - Testing Overview
 - Summary of Operations
 - Summary of Results
 - Future Testing
- IV. APPENDIX A Test Schedule(s)**

EXECUTIVE SUMMARY

General Operations

Operations and maintenance continued this month at the Electric Power Research Institute's (EPRI's) Environmental Control Technology Center (ECTC). Testing for the month involved the completion of the Clear Liquor Scrubbing with Anhydrite Production test block extension. Also, the test plan for July (Dry Sorbent Injection with the Carbon Injection System) was developed and reconfiguration activities were initiated.

The 1.0 MW Cold-Side Selective Catalytic Reduction (SCR) unit and the 0.4 MW Mini-Pilot Wet Scrubber remained idle this month in a cold-standby mode and were inspected regularly. These units remain available for testing as future project work is identified.

Pilot Testing Highlights

In June 1997, the extension to the Anhydrite Production test block was completed. The extended Anhydrite test block was funded by the Electric Power Research Institute (EPRI) after reviewing the promising results from the original test program. Both EPRI and the Department of Energy (DOE) funded the original PRDA test program as part of the DOE's Advanced Power Systems Program, whose mission is to accelerate the commercialization of affordable, high-efficiency, low-emission, coal-fueled electric generating technologies. The project is designed to develop an advanced FGD process that produces a useable byproduct, anhydrite (anhydrous calcium sulfate). While the pilot portion of the Anhydrite PRDA project was conducted on the 4-MW wet FGD pilot unit at EPRI's Environmental Control Technology Center (ECTC) in Barker, New York, the extension testing mainly used the 0.4 MW wet FGD pilot unit to reduce operating costs.

As discussed in previous progress reports, the original CLS/Anhydrite process included three steps: chloride removal, clear liquor scrubbing, and anhydrite production. The final step in the process involved sending the calcium sulfite slurry from the sludge bed reactor to the anhydrite reaction tank for conversion to anhydrous calcium sulfate (anhydrite). The original objective in the PRDA project was to demonstrate all three areas of the integrated process. However, the primary focus has been on anhydrite production because:

- The anhydrite process is the least developed and potentially most valuable of the three proposed processes;
- The initial anhydrite tests on the pilot unit were encouraging; and,
- The DOE has placed emphasis on the reuse of byproduct materials.

The anhydrite process offers the following potential advantages:

- The solid byproduct differs from gypsum and is potentially more valuable;
- The solid byproduct is “reactive” without calcination;
- The material be used in other markets such as self-leveling floors, aggregate, or Portland cement; and
- The process is an attractive option for either new or existing inhibited oxidation systems as it produces a useful byproduct.

The objectives of the extension to the anhydrite test block are to:

- Produce anhydrite solids from FGD calcium sulfite slurry under the same chemistry conditions as the previous testing;
- Evaluate the effect of residence time, ionic strength, and temperature on anhydrite production; and
- Evaluate the effect of magnesium on anhydrite production.

FACILITY STATUS

General

The NYSEG Kintigh Station provided flue gas to the Center 100% of the time during this performance period. As the Kintigh Station operated with a variety of coals, fluctuations in the Center's inlet SO₂ concentrations were experienced and SO₂ spiking was initiated across the test unit as required.

Safety training for the month was conducted by the Operations Manager. Safety videos discussing electrical and fire hazards were reviewed by the O&M staff. Inspections of the ECTC Facility and safety equipment (SCR air-packs, fire extinguishers, etc.) were completed and recorded this month. All systems were found to be in good condition. By continuing to emphasize safe work habits at the Center, we have raised the total number of days without a lost time injury to 1852 as of 6/30/97. Also, the monthly safety meeting with the NYSEG Kintigh Station and the EPRI ECTC was held on June 26, 1997 to exchange information and cover joint safety issues.

Pilot and Mini-Pilot Wet FGD System

The equivalent and actual availability for the ECTC 4.0 MW Pilot Wet FGD System was 100% during this period.

The Clear Liquor Scrubbing/Anhydrite PRDA test block continued this month with tests AEX-2 and AEX-3. These tests were designed to characterize the production process for anhydrous calcium sulfate (anhydrite) utilizing the Pilot scrubber unit and the process tanks/equipment from the 0.4 MW Mini Pilot System. The smaller tanks of the Mini-Pilot were used in conjunction with the Pilot system during this testing to reduce slurry residence time and temperature/oxidation demands for the system. The operational parameters for the Pilot Wet Scrubber during this test block included: gas flows of 10,000 and 11,500 scfm; inlet SO₂ concentrations of 2000 ppm; recycle slurry flows of 1350 and 1700 gpm; and an absorber inlet temperature of 320°F. The Beachville limestone prepared for the testing was maintained at a grind of 88% passing 325 mesh screen.

The following maintenance work was completed on the Pilot System this performance period:

- The breaker for recirculation pump 8 was replaced.
- New CEM units for the ECTC inlet and outlet SO₂/O₂ measurements (cabinets 5 & 6) were installed.
- A hose was replaced in pump 9.
- Several sets of coils for the heated tank were repaired and replaced during testing.
- The ESP and the Pilot Booster fans were balanced.

- Several masterflex chemical pumps were rebuilt.
- A pH probe was replaced.
- Various plumbing fittings/couplings were replaced as necessary.
- An 1.5" port was replaced on the M-FLRT tank.

Carbon Injection System

In preparation for the upcoming Dry Sorbent Injection (DSI) test block with the Carbon Injection System, the following activity plan was prepared and initiated:

Post CLS - Extension testing

- Neutralize process slurry from P and MP system, dewater, and dispose of solids
- Drain tanks (P-MRT, M-MRT, M-FLRT), open manways and sample any solids at tank bottom
- Take pictures of tank bottoms to show any solids/condition of sparge rings
- Fill and flush all process tanks, coils, hoses, pumps
- Remove all chemicals from process area and dispose/restock/store
- Remove insulation from P and MP tanks and store for later use
- Disconnect blanket heaters, remove from tank and store

Pre- Dry Sorbent Injection Testing

- Inspect ESP, booster fan, ductwork, dampers, and ports for process testing
- Order parts and repair any ESP components, dampers, etc.
- Inspect ESP inlet (DRG) CEMs (SO_2 , O_2)
- Inspect ESP outlet (CRG) CEMs (SO_2 , O_2)
- Prepare TECO NOx analyzers for later installation at ESP inlet/outlet locations
- Prepare HCl monitor for later use at ESP inlet/outlet locations
- Move flue gas sampling equipment to ESP inlet and outlet locations (method 5, 101, cold cond.)
- Determine appropriate sample port locations
- Determine rate of carbon injection and order required amounts of carbon/sorbent
- Order sampling chemicals, collection bottles, other equipment
- Determine carbon injection method and install/inspect equipment
- Order Norit FGD Carbon, (3) 50 lb. bags currently on-site
- Inspect ESP outlet opacity monitor
- Install ESC P-5A monitor downstream of ESP (CRG)
- Calibrate P-5A and connect to WDPF
- Determine flue gas cooling method and inspect equipment (SDA, atomizer, nozzle)
- Determine ESP gas residence time(s) and system residence times
- Inspect lime slurry system, prepare lime slurry for gas humidification/cooling
- Contact NYSEG to request coal samples daily for the period (M-F testing)
- Check WDPF to insure all data points available and collected

Initial Testing and ESP Configuration

- Configure ESP for 3 field (ABC) operation and 0.1 lb./MMBTU outlet emission
- Collect V/I data and curves for ESP
- Monitor/Collect ESP data log sheets and opacity data
- Monitor/Collect CEM and P-5A data
- Conduct Method 5 sampling at ESP inlet and outlet locations
- Conduct baseline operations and testing without carbon/sorbent injection
- Conduct baseline Method 101 and Method 5 samples (2 @ ESP inlet, 2 @ ESP outlet per day)
- Conduct baseline operations and testing with carbon/sorbent injection at set rates

- Conduct baseline Method 101 and 5 samples (2 @ ESP inlet, 2 @ ESP outlet per day)
- Collect coal samples - NYSEG and ash samples from active ESP hoppers/silo

Carbon Injection Testing - Daily

- Collect V/I data and curves for ESP
- Monitor/Collect ESP data log sheets and opacity data
- Monitor/Collect CEM and P-5A data
- Conduct Method 5 sampling at ESP inlet and outlet locations
- Conduct operations and testing with carbon/sorbent injection at set rate(s)
- Monitor/Adjust carbon feed/injection rate
- Monitor /Adjust lime injection to SDA atomizer/nozzle for gas cooling
- Conduct Method 101 samples (2 @ ESP inlet, 2 @ ESP outlet per day)
- Collect coal samples - NYSEG and ash samples from active ESP hoppers/silo

Financial Report

The Financial Report for the four Operations and Maintenance contract tasks are summarized below for the month of June 1997, the year to date, and the contract total.

Task Definitions:

Task 100: Operations and Maintenance Labor

Task 200: Purchased Materials

Task 300: Engineering Support

Task 400: Training

Table i.
Monthly Operating Costs by Task

	June	Year to Date	Contract Total
Task 100	\$ 54,474	\$ 103,254	\$ 14,582,263
Task 200	\$ 11,977	\$ 29,459	\$ 8,540,654
Task 300	\$ 13,312	\$ 50,923	\$ 1,245,510
Task 400	\$ -	\$ 63	\$ 53,298
DOE Grant	\$ -	\$ 132,616	\$ 248,792
TOTAL	\$ 79,763	\$ 316,315	\$ 24,670,517

The attached graph illustrates the budgeted and actual expenses for ECTC O&M activities through June 1997.

Figure i.
1997 Operation & Maintenance Costs

PILOT AND MINI-PILOT TEST ACTIVITY

Testing Overview

In June 1997, the extension to the Anhydrite Production test block was completed. The extended Anhydrite test block was funded by the Electric Power Research Institute (EPRI) after reviewing the promising results from the original test program. Both EPRI and the Department of Energy (DOE) funded the original PRDA test program as part of the DOE's Advanced Power Systems Program, whose mission is to accelerate the commercialization of affordable, high-efficiency, low-emission, coal-fueled electric generating technologies. The project is designed to develop an advanced FGD process that produces a useable byproduct, anhydrite (anhydrous calcium sulfate). While the pilot portion of the Anhydrite PRDA project was conducted on the 4-MW wet FGD pilot unit at EPRI's Environmental Control Technology Center (ECTC) in Barker, New York, the extension testing mainly used the 0.4 MW wet FGD pilot unit to reduce operating costs.

As discussed in previous progress reports, the original CLS/Anhydrite process included three steps: chloride removal, clear liquor scrubbing, and anhydrite production. The final step in the process involved sending the calcium sulfite slurry from the sludge bed reactor to the anhydrite reaction tank for conversion to anhydrous calcium sulfate (anhydrite). The original objective in the PRDA project was to demonstrate all three areas of the integrated process. However, the primary focus has been on anhydrite production because:

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- The process is an attractive option for either new or existing inhibited oxidation systems as it produces a useful byproduct.

The objectives of the extension to the anhydrite test block are to:

- Produce anhydrite solids from FGD calcium sulfite slurry under the same chemistry conditions as the previous testing;
- Evaluate the effect of residence time, ionic strength, and temperature on anhydrite production; and
- Evaluate the effect of magnesium on anhydrite production.

Operating Summary

The mini-pilot CLS/Anhydrite activities were continued from the operations which began in May. The process configuration for extended anhydrite testing is shown in Figure 1. In May, the process was reconfigured to include the m-ART as the anhydrite reactor (3.5-ft diameter mini-pilot first loop reaction tank) and the m-FGDRT as the sulfite slurry feed tank (6-ft diameter mini-pilot main reaction tank). The pilot wet scrubber with the pilot main reaction tank (MRT or FGDRT) was used to produce sulfite slurry. This slurry was then transferred to the m-FGDRT on a weekly basis, and the chemistry of the slurry in the m-FGDRT was controlled by adding soda ash, sodium sulfite, or magnesium hydroxide, depending on the test requirements. The m-ART was equipped with blanket heater around the tank walls that were capable of maintaining the desired temperature in the tank without sulfite slurry feed. This addition allowed for anhydrite slurry storage over the weekends when the process was not being operated. Since the height of the reaction tank is only 12 ft, a hydrogen peroxide feed was installed to allow for supplemental oxidation if the oxidation air rate was not sufficient.

Figure 1. Process Flow Diagram for Anhydrite Process Test Block Extension.

During June, testing focused on production of anhydrite at the same conditions that successfully produced anhydrite in the previous test block, at reduced residence time conditions, and with magnesium rather than sodium added to achieve the desired solution strength. In June, operation of the ECTC pilot scrubber was limited to only a few days since the size of the anhydrite reaction tank was reduced significantly. In this operating mode, the FGD scrubber was in service only two to three days every three weeks, thus, reducing costs and extending the duration of the test period. During this time, enough sulfite slurry was produced to keep the anhydrite reactor operating continuously.

A summary of operating conditions in June is presented in Table 1.

Table 1. June 1997 Anhydrite Operating Summary

Date	Test Description	Operating Summary
Sun, 6/1	AEX-1C: Mechanism B4, baseline chemistry.	Continuing to run at conditions that produced anhydrite effectively during PRDA project. Both temperature and pH at target conditions. Adding acid to maintain target pH. Peroxide being added to reduce the liquid phase sulfite. Began surface control Mechanism B5.
Mon, 6/2	AEX-1C: Mechanism B5, baseline chemistry.	Temperature slightly low (-2°F below target) so the temperature set point of heated tank was increased and peroxide addition rate was increased. Heated coil failed at 22:00 hours and had to be drained and replaced. Temperature dropped to -5°F below target.
Tue, 6/3	AEX-1C: Mechanism B5, baseline chemistry.	Temperature still -5°F below target at 0600 hours. Heated tank set point was increased. Pump 4 variable speed drive and motor had been repaired and run overnight to test. At 0900 a leak was detected in the heated coils. Slurry flow through the coils was stopped and the heated water tank drained. A sweat fitting had failed and was repaired, and the heated tank placed back in service. The temperature dropped to -8°F below the target without the coils in service. The oxidation air rate was decreased and peroxide increased while the heated tank was out of service to minimize temperature drop. When the temperature increased to -5°F below the target, the air and peroxide rates were returned to normal. System operated well through the night.
Wed, 6/4	AEX-1C: Mechanism B5, baseline chemistry.	At 0600 hours temperature was +1°F above target. Final samples taken (94% anhydrite) and system shut down at 1300 hours. Blanket heaters remained on to maintain temperature. Transferred last of prepared slurry from p-MRT, and spiked chemicals to desired baseline concentrations. Started to lower p-MRT pH to about 6.
Thur, 6/5	Process off-line	Reactor at target temperature.
Fri, 6/6	Process off line	Reactor at target temperature. Ordered Mg(OH) ₂ for magnesium testing.
Sat, 6/7	Process off line	Reactor at +1°F above target temperature.
Sun, 6/8	Process off line	Reactor at +1°F above target temperature.
Mon, 6/9	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	Process back on line at 0230 hours. Could not achieve the reactor feed rate required for desired residence time. The flow problems were ultimately traced to a clogged flow transmitter that restricted the flow through Pump 9. Ordered chemicals required to start the pilot unit to build slurry inventory. Experimented with different air rate and peroxide rates to achieve complete oxidation and desired target temperature. Due to a miscommunication on shift change, the peroxide rate decreased to 0 overnight, which resulted in a loss of oxidation.

Table 1. June 1997 Anhydrite Operating Summary (cont.)

Date	Test Description	Operating Summary
Tue, 6/10	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	Peroxide flow restarted on day shift. Created a chart to guide operators in setting oxidation air and peroxide flows. pH was responding slowly to changes in conditions. Oxidation was measured as 60% in the afternoon. Line was flushed and a clog in the suction line was removed. pH control restored at 2200 hours. At 2230 hours, the peroxide pump burned out and had to be replaced. Peroxide addition restarted at 2300 hours. Parts were ordered to fix masterflex pumps.
Wed, 6/11	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	Scrubber started up at 0200 hours. CEMs were not working as yet so SO ₂ removal was unknown. A problem was noted with SO ₂ check valve and was resolved. Therefore, chemical spiking was done based on previous testing. The ME wash system was taken out of auto control. Blanket heaters around anhydrite reactor tripped off line—not sure when it happened. The temperature had not dropped in reactor, however. Sulfite oxidation was 75% in morning. At 1300 hours, the level in m-MRT (reactor feed tank) dropped below agitator level so feed to anhydrite reactor was stopped. Blanket heaters and acid/base addition were used to hold appropriate conditions in reactor overnight.
Thu, 6/12	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	At 0445 hours, the p-MRT slurry reached 18 wt%, the transfer from the p-MRT to the m-MRT was started, and the m-MRT was chemically spiked to baseline chemistry conditions. At 5:30 the transfer was stopped. At 0715 hours, the pilot was brought back on-line. Pump 8 was not working when pilot was started back up. 5 drums of H ₂ SO ₄ were ordered for pH adjustment. At 1000 surface area control Mechanism B6 was restarted and oxidation air rate wet at the desired value. The morning samples showed a bound moisture of 0.52%, and afternoon was 0.63%, with a 98% oxidation. Parts for the masterflex pumps were ordered—2 pump heads and 2 motors. The scrubber and the anhydrite process ran through the night.
Fri, 6/13	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	At 0330 the heated coils were shut down because a leak was detected. At 0500 the coils were repaired and placed on stand by, because the higher peroxide rates being used allowed the target temperature to be maintained without slurry recirculation through the coils. Morning sampling results showed solids to be 2.62% anhydrite, and the afternoon results showed at 2.99% anhydrite. Oxidation was essentially complete. At 13:00 the pilot system was shut down at. NYSEG went off-line late in the evening.

Table 1. June 1997 Anhydrite Operating Summary (cont.)

Date	Test Description	Operating Summary
Sat, 6/14	AEX-2: Reduced residence time, baseline chemistry, Mechanism B6	At 0230 the m-MRT level dropped below suction, so the m-FLRT was kept heated and agitated until finals could be taken in the morning. The m-MRT was filled and flushed and prepared for AEX-3 with p-MRT slurry and Mg(OH) ₂ . At 0700 final samples were taken—the solids were 2.2% anhydrite and oxidation was complete. The m-FLRT was drained, then filled and flushed. Noticed that the shorter residence time alcohol washed solids are much whiter than those of the longer residence time. The reason for difference in color is unknown. At 1300 began to fill the m-FLRT with m-MRT slurry and Mg(OH) ₂ . Started up the heated tanks, and pH loop, along with oxidation air to add in mixing. Began to lower the pH—pH in both tanks was around 8.8. There is only 3/4 of a drum of acid on site. Ordered acid should arrive Monday. Overnight the m-FLRT slurry temperature was increased and pH decreased. At 2230 the target temperature was reached but the pH remained above target.
Sun, 6/15	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	At 6:00 the temperature was at the target but the pH remained well above target. Tried using peroxide in combination with oxidation air to lower pH but had really no change, just an increase in temperature. By 9:30 the last drum of acid was empty. At 13:00 the feed to the m-FLRT from the m-MRT was started at a rate to achieve the longer residence time. At 14:00 surface area Mechanism B6 was reinstituted. The process ran smoothly through the night, just had the high pH.
Mon, 6/16	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	The m-FLRT pH was still more than 2.5 units above the target. The acid arrived at 1000, and addition to the m-FLRT began. Adding acid only to the m-FLRT. The m-MRT was left at high pH. Morning samples showed 26% oxidation and low Mg concentration, probably because of the high pH. Continued to lower oxidation and raise oxidation through the night.
Tue, 6/17	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	The pH was still more than 2 pH units above target at 0600. The acid addition rate was increased, and a gallon of laboratory grade H ₂ SO ₄ was added to speed the reduction in pH. By 0800 the pH was about 1.5 units above target, at 1100 the pH had been reduced to 0.5 units above target, and the target pH was reached by 1630. Surface area control Mechanism B6 was reinstituted. Samples showed that the Mg and thiosulfate concentrations were in the correct range, but the bound moisture in the product solids was still greater than 10% (less than 50% anhydrite.)
Wed, 6/18	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	The process ran smoothly overnight with the pH maintained at the target value. Lab calibration showed the pH probe required cleaning. Process shut down after afternoon samples in preparation for 4-day weekend. The heated blankets and agitator remain in service to maintain the anhydrite concentration while the process is down. Chemistry was in correct range with 90% oxidation, but only about 10% anhydrite in the solid product.

Table 1. June 1997 Anhydrite Operating Summary (cont.)

Date	Test Description	Operating Summary
Thur, 6/19	process down	At 1315 a leak in the m-FLRT was noticed during inspection rounds. One of the nipples on the tank had developed a penetration. The slurry was transferred to the bulk chemical storage tank where it was agitated but could not be heated.
Fri, 6/20	process down	The nipple was repaired and others inspected. The saved slurry was transferred back to the m-FLRT and the heated blankets were started. No adjustments in chemistry were made nor was additional slurry fed to the tank to bring the level up from the 7 foot level.
Sat, 6/21	process down	Checked process—temperature at target.
Sun, 6/22	process down	Checked process—temperature at target.
Mon, 6/23	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	The process was restarted at 0100. Some initial problems were experienced with the oxidation air, and the temperature dropped with higher than desired air flow. This problems was resolved. Surface area control Mechanism B6 was started at 1130 when the pH and temperature reached the targets. The chemistry conditions were at the desired set points, oxidation was 100% and the solids were about 70% anhydrite. The recovery from Thursday's upset seems to have been made. Working to raise the slurry level in the m-FLRT back to desired level.
Tue, 6/24	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	Lost a heated coil at 0500 and the temperature decreased to 5°F below target. Otherwise, the process ran smoothly. The solids were about 50% anhydrite, but otherwise the chemistry seemed to be close to the set points.
Wed, 6/25	AEX-3: Baseline residence time, Mg chemistry, Mechanism B7	The collected and alcohol washed product solids had different characteristics every day. On some days the sampled solids settle well and on others they do not settle until the alcohol is added. The chemistry is correct, but the product solids are less than 50% anhydrite. The surface control was modified to Mechanism B7 at 1500 hours.
Thur, 6/26	AEX-3: Baseline residence time, Mg chemistry, Mechanism B8	Overnight, several fittings failed and a heated coiled failed at 0100. Morning samples showed chemistry to be correct but less than 50% anhydrite. The liquor had a bluish tint again so the peroxide rate was reduced. The surface area control was changed to Mechanism B8. The liquid still had a bluish tint in the afternoon. Peroxide rate was reduced again to reduce the failure rate of fittings.
Fri, 6/27	AEX-3: Baseline residence time, Mg chemistry, Mechanism B8	Morning samples showed the chemistry within desired range but still less than 50% anhydrite. The liquor did not have a bluish tint, but oxidation was 100%. At 0900 transfer of slurry from p-MRT to m-MRT was started to restock anhydrite feed tank. Feed to the m-FLRT was stopped during this transfer. Mg was spiked to the desired level in the m-MRT. At 1030 feed was re-established to the m-FLRT. Trying to balance complete oxidation without excess peroxide to avoid materials corrosion. A minor problem with pH control was experienced after restocking the m-MRT, but this was resolved.
Sat, 6/28	AEX-3: Baseline residence time, Mg chemistry, Mech. B8	Smooth operation of the process through the day. The anhydrite concentration sill remains below 50%. The temperature in the reaction tank remains on target.

Table 1. June 1997 Anhydrite Operating Summary (cont.)

Date	Test Description	Operating Summary
Sun, 6/29	AEX-3: Baseline residence time, Mg chemistry, Mechanism B8	Smooth operation of the process through the day. The anhydrite concentration increasing slightly to just above 50%. The peroxide addition was increased slightly at 11:20.
Mon, 6/30	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	In the early morning, the surface area control mechanism was switched back to Mechanism B6 since no significant increase in anhydrite production had occurred. Solid samples showed approximately 65% anhydrite.
Tue, 7/1	AEX-3: Baseline residence time, Mg chemistry, Mechanism B6	Morning samples showed 69% anhydrite and appears to be heading in the right direction. After sampling, the process was stopped and the tanks were dewatered to prepare for the next test block.

Results Summary

Several analytical methods have been used to determine the phase of the calcium sulfate being produced in the anhydrite reactor including:

- % Bound Water (measure solid weight loss at about 180°C)—provides an estimate of anhydrite concentration (wt%) assuming solids are a mixture of only anhydrite and gypsum;
- X-ray Diffraction (XRD)—indicates the presence of gypsum, hemihydrate, and/or anhydrite;
- Visual Microscope and Scanning Electron Microscope (SEM)—indicates changes in particle size and shape; and,
- ORTECH Measurements—differential scanning calorimetry, gravimetric hydration phase analysis, and temperature setting characteristics.

Of these analyses, the % bound water and visual microscope measurements were made on site. These measurements, coupled with the subjective observations about the reactivity of the centrifuge or vacuum belt product, were used to make the daily decisions concerning modification of the test conditions.

Test conditions in June included a sodium-based chemistry with solids residence times similar to those in the Anhydrite Process Test Program completed last month, sodium-based chemistry with reduced residence time, and a magnesium-based chemistry with the original residence time. Figure 2 summarizes the solid-phase anhydrite content in the byproduct solids produced during June. The results in Figure 2 are based on the % bound water measurement and the assumption that all of the solids were either anhydrite or gypsum.

Figure 2. June 1997 Anhydrite Concentration Results Summary

In early June, the mini-pilot anhydrite process successfully produced high quality anhydrite—greater than 90% anhydrite in the product solids. This was done with the sodium chemistry and the original residence time used during the CLS/Anhydrite PRDA project. These results confirmed that the mini-pilot process could duplicate the results achieved in the larger system.

After a 4-day outage, the next 10-day run began with a much shorter residence time. Following the restart of the process, the amount of anhydrite initially decreased to less than 50% of the product, but then increased again to greater than 90% after several days of operation. This indicates that anhydrite can be successfully produced with a shorter residence time than that used in the PRDA project which helps the economics of the process.

The drop in anhydrite concentration after the 4-day outage seems to be relatively consistent in this mode of operation. While maintaining the temperature at the target level maintains the anhydrite, but the anhydrite crystals apparently grow in size during the outage period. Since this results in less surface area after the process is restarted, the anhydrite concentration drops until the surface control mechanism can restore the required surface area to produce anhydrite without much gypsum.

Following the lower residence time test, the system was flushed and the final test was conducted with magnesium rather than sodium providing the solution strength required. Otherwise, the chemistry was the same as during the sodium tests.

During the initial phase of this test, there were some problems maintaining the correct pH and high oxidation. As a result of the inconsistent operation, the product solids were 90% gypsum as the process was shut down for the 4-day weekend outage. With the temperature maintained in the target range for the final couple of days of

the outage, the solids were converted to about 70% anhydrite before the process was restarted on June 23. This dropped to less than 50% during the next several days of operation before increasing to above 70% just before the end of the test block. As discussed previously, the anhydrite solids were apparently too large to sustain high levels of anhydrite production, and several days were required before the surface control mechanism could take control. The trend of increasing anhydrite at the end of the test block is a good indication that high quality anhydrite can be produced with magnesium as well as sodium.

Future Testing

Testing in July will commence with a Dry Sorbent Injection (DSI) investigation across the ECTC ESP. The objectives of this testing are to determine the effectiveness of various sorbents (activated carbon) for total mercury removal when injected upstream of the ESP, and to determine the impacts that such sorbents have on ESP performance.

APPENDIX A

TEST SCHEDULE(S)

4.0 MW Pilot FGD Unit	1 9 9 6												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	EPRI Wet FGD Toxics Testing		DOE/PRDA Phase I - Mercury and HAPs Control with Wet FGD			EPRI Wet FGD Toxics Testing		Thrd party Testing - Rotorfilter Technology	EPRI Toxics Removal Testing	EPRI SOx/NOx Process Testing	ECTC Fall Outage		
	UNIT DOWN		DOE/PRDA Phase I - Multiple Pollutant Removal Using the Condensing Heat Exchanger (CHX)										
0.4 MW Mini-Pilot FGD Unit													

1 9 9 7											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
4.0 MW Pilot FGD Unit	DOE/PRDA Phase I - Clear Liquor Scrubbing (CLS) with Anhydrite Production			NYSEG Spring Outage	CLS Anhydrite extension testing	Dry Sorbent Injection for Hg Removal and ESP performance studies			EPRI ECTC Testing	ECTC Fall Outage	
										DuPont FGD Additives Study	API Process Additives Study
	DOE/PRDA Phase I - Condensing Heat Exchanger (CHX) Testing		Reconfigure Mini-Pilot Scrubber		Unit Available for EPRI / Third-Party Testing						
ECTC Bench-scale FGD Unit (proposed)											
0.4 MW Mini-Pilot FGD Unit											

4.0 MW Pilot Wet FGD Unit	1 9 9 8 (proposed)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	DOE/PRDA Phase II Clear Liquor Scrubbing with Anhydrite						DOE/PRDA Phase II Condensing Heat Exchanger (CHX) Testing			EPRI / Third-Party Testing		
	EPRI / Third-Party Testing											
0.4 MW Mini-Pilot FGD Unit												

ECTC Test Schedule ('96 - '98)

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