

Enrichment of By-Product Materials from Steel Pickling Acid Regeneration Plants

9th TRP-AISI/DOE Industry Briefing Session

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Bailey-PVS Oxides, L.L.C.

Canonsburg, PA 15317

Participating Companies & Organizations

- AISI/U.S. Dept. of Energy Cooperative Agreement DE-FC36-97ID13554
- Chemical Products Corporation (Technical Support Partner)
- Dofasco, Inc.
- Stelco, Inc.
- U.S. Steel Corp.
- U.S.S.- POSCO Ind.
- Bailey-PVS Oxides, L.L.C.



Background Highlights

➤ General

- Steel Pickling Process – Steel finishing process where surface oxides (Fe_3O_4 , Fe_2O_3 & FeO) are removed by immersing products into an acid bath, predominantly employing hydrochloric acid.
- Iron Unit Loss - Pickling process results in a material weight loss between 0.3% and 1.0%, which is contained in the pickle line effluent as aqueous ferrous chloride, commonly named “Spent Pickle Liquor” or SPL.

Background Highlights (continued)

- Typical Pickling Line Iron Loss Example:
 - ✓ Steel Pickled: 900,000 tonnes/yr.
 - ✓ Iron Loss @ 0.5% (as oxides): 4,500 tonnes/yr.
 - ✓ Net Iron Yield Loss (as Fe): 3,200 tonnes/yr.

Background Highlights (continued)

➤ General (continued)

- Acid Regeneration Plants – Facilities that process and regenerate SPL into fresh acid, producing as byproducts, iron oxide powders.
- By-product recycling – Material's physical characteristics limit its demand as a commercially viable product for recycling. Portion of byproduct production now sold to the magnetic industry for use as an iron-containing feed stock, or to colorant pigment users. Surplus material is discarded.

Background Highlights (continued)

Host Acid Regeneration Facility
Bailey-PVS Oxides, L.L.C. , Delta, Ohio



Background Highlights (continued)

➤ New Technology

- Pilot-plant trials conducted during 2003 at an acid regeneration plant, confirmed the viability of the new co-roasting process to produce magnetic ferrite powders.
- Trials performed on the basis of new process U.S. Patent no. 6,660,242 B2, awarded to Chemical Products Corporation.
- Pilot-plant trials confirmed that the new co-roasting process does not adversely affect the operation or efficiency of the plant's acid regeneration process.

Project Goals

- Develop and demonstrate a new process for improved recycling of iron-bearing byproducts from steel pickling operations and acid regeneration plants.
- Demonstrate a new process to produce value-added materials from the recycling of byproduct iron oxides in an energy efficient manner.
- Develop and demonstrate the production viability of magnetic-type ferrite powders.
- Establish an effective means of converting these waste materials to commercially viable products for the magnetics industries.

Project Deliverables

- Process development for feed stock preparation, blending, and co-roasting to produce magnetic-type ferrite materials.
- Process development and operational trials to attain the proper composition, admixture and grain structure for materials produced.
- Process development and operational trials to post-treat materials to meet quality specifications.
- Develop process control methods, testing and operational protocols to maintain product uniformity, repeatability, and compliance to specifications.

Industry Impact

- New process will greatly improve the recycling of iron-bearing units now being discarded as process yield losses. Recycling of up to 42,000 tons/year (as Fe) may be achieved.
- First plant annual production of 16,400 tons of magnetic ferrite product via new process is expected to yield fuel savings of 1.8×10^6 kcal/ton in direct fuel savings.
- Additional savings of 55 kWh/ton in electrical savings are expected through new product post-treatment, eliminating product grinding operations now used to refine such ferrite powders.

Project Approach

➤ PHASE NO. 1:

- Design and construct new process feed stock preparation system (SPA).
- Design SPA system for integration into an existing acid regeneration facility.
- Design SPA control system and instrumentation to allow complete process data acquisition and monitoring of all critical process parameters.
- Develop operating protocols.

Strontium Prep Area SPA Building – Phase 1



Strontium Prep Area eqpt.

- Internal feeding & blending system



Project Approach (continued)

➤ PHASE NO. 2:

- Design and construct new co-roasted product handling and post-treatment system for both CRPA-1 & CRPA-2.
- Design CRPA-1 integration into existing plant.
- Design CRPA-1 & CRPA-2 system control and new data acquisitions.
- Develop operating protocols.

Calciner – Ball Mill Bldg Phase 2



Calciner – Ball Mill eqpt.



- Calciner & cooling tube set
- Product bin & bucket elevator set

Calciner – Ball Mill eqpt.



- Ball Mill set in place

Calciner – Ball Mill eqpt.



- Mixing chutes set on platform, feeding the mixing tanks

Calciner – Ball Mill eqpt.

- Bricking the inside of the Calciner



Calciner – Ball Mill eqpt.



- Baghouse at rear of the Calciner – Ball Mill bldg.

Schedule and Milestones

- Project start: May 28, 2004.
- Process development and R&D activities for feed stock preparation and co-roasted product post-treatment: **complete.**
- Process development for new feed stock introduction into existing plant: **complete.**
- Mass balances & flow diagrams for SPA, CRPA-1 & CRPA-2: **complete.**

Schedule and Milestones (continued)

- Design, Procurement & Installation of SPA, CRPA-1 & CRPA-2: **complete**
- Commission SPA & CRPA-1 systems: **complete**
- Co-roasting process trials, phase no. 1:
Trial conducted in April 2007
- Commission CRPA-2 system: **complete**
- Co-roasting process trials for Phase 2 start :
ongoing

Work to Date

- Processed 6300 gal of spray roaster feed solution through system.
- Adjustments were made based on ICP analysis to adjust each batch to the proper mole ratio.
- Fed solution through roaster for 4.5 hours at which point some conveying equipment broke down.

Current Plans

- Continue technical analysis of co-roasted product produced in April '07.
- Repeat Phase No. 1 production trials: There are several potential iterations.
- Compile results of Phase No. 1 trials: **When production trials are completed, results will be given to AISI / DOE.**
- Begin Phase No. 2 production trials: **October 2007.**
- Finalize Phase No. 2 production trials: **March 2008.**

Summary

- This new by-product enrichment process will greatly improve the recycling of iron-bearing units from steel making operations.
- The value-added magnetic ferrite powders will be produced through energy-saving methods.
- Prior process trial tests and current progress made on this project indicate viability to add this process to existing acid regeneration plants.

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Question & Answer Session