ABSTRACT

Hemi-Di-Hydrate Rationale for Technology Selection

Author / Presenter:

Dharmeshkumar Desai

JESA TECHNOLOGIES

3149 Winter Lake Road, Lakeland, FL 33803
P.O. Box 2008, Lakeland, FL 33806-2008

Prepare for

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ABSTRACT

In recent years, producers of wet-process phosphoric acid have faced growing pressure to balance economic performance with tighter environmental expectations. Traditional dihydrate and hemihydrate routes, though proven for decades, are increasingly challenged by higher energy costs, evolving regulatory requirements, and the need to extract more value from lower-grade phosphate rock.

To address these constraints, JESA Technologies has advanced a next-generation Hemi-Dihydrate (HDH) process that builds on the strengths of both conventional methods while mitigating their major limitations. The HDH configuration improves P_2O_5 recovery, reduces overall energy demand, and incorporates fluorine-recovery capabilities that allow production of saleable FSA and high-quality gypsum rather than waste by-products.

The process consistently yields wet-process acid in the 40–54% P_2O_5 range with low sulfate and suspended solids, reducing downstream treatment needs. These design parameters are supported by extensive pilot testing focused on reaction behavior, crystallization dynamics, and filtration performance. The resulting data have been used to define the operating envelope for commercial-scale units.

A full-scale 600 t/day P_2O_5 HDH plant is now under construction and scheduled to start up in mid-2026. Its operation will provide the first industrial demonstration of the optimized two-stage HDH flowsheet.

The primary factors driving interest in HDH technology include:

- Improved P_2O_5 recovery, lowering phosphate rock consumption.
- Reduced energy use, particularly relative to single-stage processes.
- Environmental alignment, with integrated fluorine recovery and marketable gypsum/FSA co-products.
- Enhanced overall economics, helped by better resource efficiency and by-product value.

With its emphasis on efficiency, regulatory compliance, and reliable performance, the HDH process offers a compelling modernization pathway for producers seeking long-term competitiveness in phosphoric acid manufacturing.

AIChE Central Florida Phosphate Fertilizer & Sulfuric Acid Conference 2026

Paper Title: Production Uplift for Phosphoric Acid Plants using Advanced Process Control

Abstract:

The phosphoric acid plant (PAP) presents significant control challenges due to the long response time of the reactor and its strong interaction with the tilting pan filter. Optimizing reactor yield requires maintaining residual sulfate at an optimal concentration through precise sulfuric acid addition, which stabilizes crystallization within the reactor. Maximizing production depends on stable control of reactor residual sulfate, solids concentration, and P_2O_5 levels, as well as the final filtrate density of the tilting pan filter, which often determines filter capacity and overall plant throughput. However, these critical variables—particularly reactor residual sulfate, solids, and P_2O_5 concentration—are typically measured only through periodic laboratory analyses, limiting the ability to optimize the process in real time.

This work presents the development and implementation of ACE (Advanced Control Expert by ANDRITZ) for Tilting Pan Filters, ANDRITZ's advanced process control (APC) solution that integrates model predictive control (MPC) with a hybrid digital twin to optimize phosphoric acid production. The MPC coordinates control of the reactor and filter units, regulating key process variables to minimize variability and improve stability. The hybrid digital twin combines first-principles modeling with adaptive estimation techniques to continuously predict unmeasured parameters such as reactor residual sulfate and solids, using online data from key process streams. Periodic alignment with laboratory measurements allows the model to adapt automatically to variations in rock quality and reactivity.

Field results from the application of this APC solution to a confidential industrial PAP plant demonstrate improved operational stability, reduced process variability, and increased production rates, while maintaining consistent product quality.

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ABSTRACT FOR AICHE - St. Pete's CONFERENCE 2026

TITLE: Effects of Steam Conditions and Operating Variables on Graphite Evaporator Performance in Phosphoric Acid Service

PRESENTER: Greg Becherer, Sr. Vice President – CG Thermal, LLC

ABSTRACT

Operational challenges associated with graphite shell and tube evaporators in phosphoric acid service are well known in the industry. While material selection and exchanger design are critical, steam quality and operating conditions can significantly impact performance and tube life.

Erratic desuperheater performance, superheated steam exposure, fouling, stalled steam flow, and condensate accumulation all influence thermal stress, vibration, and overall exchanger capacity. These conditions contribute to premature tube failure, increased downtime and maintenance requirements.

This presentation will provide an overview of the effects of steam temperature variability and operating conditions on phenolic-impregnated graphite tubing. We will discuss the relationship between steam properties, radial temperature gradients, vibration forces, and the potential consequences of condensation-induced water hammer in phosphoric acid evaporator service.

Title: Erosion–Corrosion Challenges in Phosphate Fertilizer Slurry Systems: Material Strategies to Extend Equipment Service Life

Abstract:

Wet-process phosphoric acid and downstream phosphate fertilizer production present some of the most aggressive slurry handling environments in industry. High acid concentrations, elevated temperatures, and large volumes of abrasive gypsum and phosphate rock solids create severe erosion–corrosion conditions for slurry pumps and associated process equipment. Conventional metallic materials of construction—including duplex stainless steels, high chrome iron, titanium, and nickel-based alloys—are commonly deployed in these services but often experience accelerated degradation when exposed to simultaneous chemical attack and abrasive wear.

This presentation evaluates the application of silicon-carbide-based mineral cast materials and engineered composite repair technologies as alternatives to traditional metallurgies in phosphate fertilizer processing equipment. The discussion will focus on the interaction between particle-induced abrasion and acid corrosion in wet-process phosphoric acid systems, and how material properties such as extreme hardness, chemical inertness, and composite structure influence wear resistance and hydraulic component longevity.

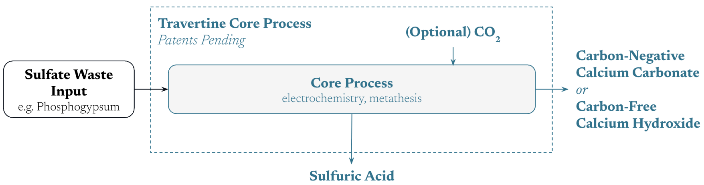
Field case studies from operating phosphate fertilizer facilities will be presented, including applications involving phosphoric acid–gypsum slurries and clarifier underflow streams. In these installations, conventional metallic pump wet-end components required rebuild intervals as short as 3–6 months due to erosion–corrosion damage. Implementation of silicon-carbide mineral cast pump components increased mean time between rebuilds to more than 24,000 operating hours while significantly reducing maintenance interventions and improving equipment availability.

In addition to new equipment applications, the presentation will examine refurbishment and retrofit strategies using silicon carbide composite coatings to restore worn pump hydraulics, piping, and agitator components commonly found in phosphate processing plants. Practical limitations related to temperature, particle size distribution, and chemical concentration will also be discussed to provide engineers with realistic guidelines for evaluating these materials in phosphate fertilizer service.

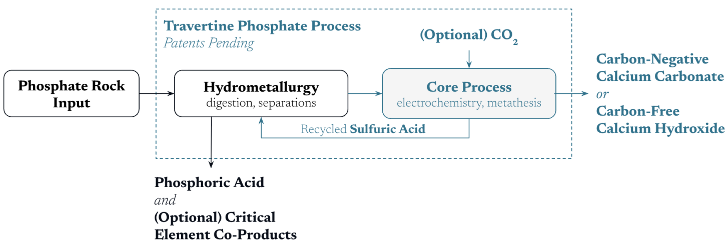
The session will provide process and reliability engineers with a framework for assessing material selection and equipment life-cycle optimization in highly abrasive, acidic slurry systems typical of phosphate fertilizer production.

Title: The Travertine Process: Purified Phosphoric Acid Without Phosphogypsum
Authors: Corey Atwell, Laura Lammers, Tom Miller
Email: Corey@travertinetech.com
Institution: Travertine Tech

Phosphate fertilizer production has generated an inventory of over 1 billion tons of phosphogypsum in the United States and produces approximately 30 million additional tons annually. In the U.S., regulations require phosphogypsum to be sequestered in engineered stacks, and declining ore quality has further constrained domestic phosphoric acid capacity. These combined pressures have limited the U.S. industry's ability to expand production and remain competitive. Travertine has developed a technology to address these challenges by eliminating phosphogypsum formation, recycling sulfur electrochemically, and producing purified phosphoric acid (PPA) alongside carbon-negative cementitious co-products.



The Travertine Phosphate Process consists of four unit operations: Metathesis, Electrolysis, CO_2 Capture (e.g., the "Core Process"), and Phosphate Digestion. In metathesis, phosphogypsum from the Wet Phosphoric Acid (WPA) process is neutralized before being reacted with Na_2CO_3 (aq) to generate Na_2SO_4 (aq) and $CaCO_3$(s), with a conversion rate of greater than 96%. The Na_2SO_4(aq) is sent to electrolysis, where salt-splitting forms separate streams of NaOH (aq; >2M) and H_2SO_4 (aq; >12 wt%). Produced sulfuric acid is used for phosphogypsum filtration, used for repulping phosphogypsum for increased P_2O_5 recovery, concentrated to 50 wt%, and finally used to digest incoming rock in a typical hydrometallurgical process step. The sodium hydroxide is used as a scrubbing solution for either Direct Air or Point Source CO_2 capture, producing Na_2CO_3 for use in the metathesis reaction. In 2025, Travertine proved the technical feasibility of the process using commercial equipment in a first-of-a-kind field pilot plant producing 180 T/yr H_2SO_4(s) and $CaCO_3$(s) from 310 T/yr of gypsum.



In parallel, Travertine has piloted the use of recycled sulfuric acid for production and purification of phosphoric acid. Digestion of rock in lower strength phosphoric acid (18-22 wt% P_2O_5) generates process streams that are directly compatible with membrane filtration for purification and are also more suitable for processing high MgO ores. Purification of the digestion acid is achieved through nanofiltration, ion exchange, evaporation, and clarification. Nanofiltration removes major impurities such as Ca^{2+}, Mg^{2+}, $Fe^{2+/3+}$, Al^{3+}, SiO_2(aq), SO_4^{2-}, etc., while ion exchange using a combination of resins reduces the concentration of residual trace cationic impurities including Na^+, Cu^{2+}, etc. The final clarified product is competitive for PPA at 53 wt% P_2O_5.

This work demonstrates a commercially-viable pathway to produce purified phosphoric acid without generating phosphogypsum and with significantly reduced sulfur demand. Adoption of this process could alleviate environmental burdens on U.S. phosphate producers while providing new revenue streams and enhancing long-term supply resilience.

Unlocking the Potential of Phosphate Beneficiation: A Mine to Mill Transformation

By: Keenan Collins (Hatch), Jayden Ladebruk (Hatch), Edward DeRose (Hatch)

A North American phosphate beneficiation and phosphoric acid production facility faced a significant operational setback in 2022 following a critical structural failure and subsequent repairs that disrupted the site's ability to meet historic concentrate production targets. Despite internal efforts to stabilize operations, persistent challenges in throughput, equipment reliability, and inventory balance remained.

To address these issues, the Client partnered with Hatch to support management in identifying value-creating initiatives to improve the site's concentrate production in the beneficiation circuit in 2025, and later in 2026 to make improvements within their phosphoric acid production plant. The project focused on improvement in the beneficiation plant was organized into three targeted workstreams: Mine, Mill, and Maintenance, enabling a focused approach to diagnosing constraints and implementing improvements. Through a collaborative one-team approach, Hatch and site personnel identified and executed a series of quick wins while developing a roadmap for sustainable long-term gains.

Key initiatives included optimizing mobile equipment utilization and feed consistency in mining operations, enhancing preventative maintenance planning and execution, and improving mill performance through water pressure stabilization, cyclone efficiency, and flotation circuit reliability. These integrated efforts led to a sustained concentrate production increase of approximately 20%, significantly advancing the site toward its annual production target.

Following the successful improvement achieved in the beneficiation plant, the client retained Hatch to continue the operational improvement program in their downstream phosphoric acid production plant, which is currently underway.

phosphate;beneficiation;flotation;cyclones;washing;clay removal;operational improvement;mining;utilization;production;reliability;phosphoric acid

ANDRITZ and Technip Energies (T.EN) introduce the new generation UCEGO® table filter with model UCEGO® 12 installed on T.EN's High Recovery dihydrate process at Eti Bakir, Samsun, Turkey

Fabian Germain BODINAUD - Product Specialist – Project Manager
ANDRITZ ENVIRONMENT & ENERGY S.A.S.
T: +33 (0) 6 12 70 11 00; @: fabian.bodinaud@andritz.com

Keywords: UCEGO® Table Filter, Vacuum filtration, New Greenfield Phosphoric acid plant, High Recovery Dihydrate process, Brownfield expansion, Surplus sulfuric capacity

In partnership with T.EN, ANDRITZ has developed the new generation of ANDRITZ UCEGO® table filter. This innovative filter provides enhanced productivity with highest P2O5 recovery and lowest operation and maintenance costs. The filter can adapt to changing rock and process conditions, including new phosphate rock from various mines or blends of different rocks. The model 12 UCEGO® filter has been successfully installed and commissioned at ETI BAKIR's new greenfield phosphoric acid plant in Samsun, Turkey, utilizing the high recovery diplo dihydrate process licensed by T.EN. The compactness of the design and its outstanding performances make UCEGO® filter the best choice when additional filtration capacity is required for debottlenecking brownfield projects. This process design is a result of T.EN's extensive experience over the past decades in improving the performance of its proprietary UCEGO® filters.

The UCEGO® filter is engineered to handle a variety of rock qualities including low grade from Morrocco and achieve an impressive 99% recovery of water-soluble P2O5, with dilution reduced to 0%. The partnership between ANDRITZ and T.EN demonstrates their commitment to advancing industrial filtration technology and optimizing production processes in the phosphoric acid industry. The successful implementation of the UCEGO® filter at the Eti Bakir's Samsun plant marks a significant milestone in the pursuit of efficiency and reliability in phosphoric acid production.

Abstract – Crystallization of High-Purity Phosphoric Acid

Electronics-grade phosphoric acid has become increasingly strategic for semiconductor manufacturing, where it enables precise etching and cleaning of ever-more complex device architectures. As the industry shifts toward high-density designs for microchip and integrated circuits that become more complex, the requirements for chemical purity have become much stricter. Even tiny amounts of impurities such as metals, organic residues, or particles (in the ppm, ppb, or even ppt range) can disturb the etching process, create small defects, and reduce production yield. Because of this, the industry is moving toward purification methods that offer much better control and much lower contamination limits., the tolerance for impurities has tightened significantly. Trace metals, organics, and particulates at ppm, ppb, or even ppt levels can affect etch uniformity, lead to micro-defects, and compromise yield. This trend is driving a global shift toward more robust and controllable purification technologies.

Fractional melt crystallization has emerged as a reliable route for producing ultra-pure phosphoric acid that meets these new specifications. To push purity beyond thermodynamic limits, the acid is redissolved in ultrapure water and re-crystallized in multiple stages. Each cycle selectively rejects metal ions and other contaminants, progressively achieving ppb–ppt impurity levels required for semiconductor etching applications.

Recent industrial and pilot-scale studies show that multi-stage melt crystallization is well aligned with the semiconductor sector's transition toward higher purity standards. The equipment, built from fully inert materials, eliminates ion leaching and provides a particle-free environment with no moving parts. As semiconductor technology continues to evolve, crystallization offers a flexible approach to meeting the demands of the market.