International Fertilizer Industry Association

IFA Technical Conference

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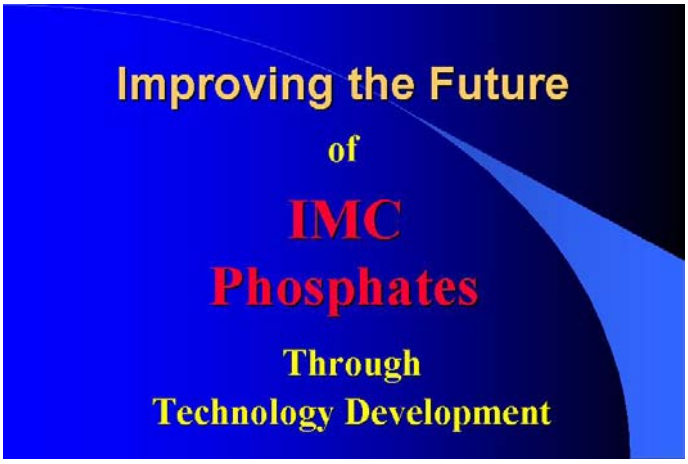
Presentation: Putting really cool ideas to work in phosphates

Vaughn Astley, IMC Global, USA



So What Was The Problem, Really

- Company Had a Lot of Ideas but Could not Manage to Study Them All
- No Project Evaluation Process
- Many Areas Were Backlogged With Existing Work Load and Short Term Projects

How do we Begin to Evaluate All the Potential Projects and Ideas

- Need Increased Resources
  - Separate from Day to Day Operations
- Must Also Look to Outside for Help
  - Infusion of Technology
  - Don't Reinvent or Develop Stuff

Who or What is Out There

- In-House
- Industrial Contract Organizations
- Universities

In House

- Cons
  - Stalled projects
  - Short term demands
  - Short of staff
- Pros
  - Dedicated inquisitive people
  - Knowledge base
  - Promotable group in training
  - Proprietary information controllable
  - Pride in accomplishments
  - Long hours are not charged for
  - Can appreciate impact of work on other operational areas
  - If fully occupied, cheaper than contract

Industrial Contract Organizations

- Cons
  - Lack of secrecy
  - Lack of proprietary protection
  - Lack of detailed specific plant knowledge
  - Usually costs more than In-House
  - Need oversight to keep direction and costs in check
  - Scope of work and goal must be well defined
  - Frequent project overview is required
- Pros
  - Responsive
  - Wide general knowledge base
  - Specialized knowledge and experience in area of study
  - Flexible, varied manning availability
  - Can expeditiously stop funding

Universities

- Cons
  - Slow
  - Lack of secrecy
  - Lack of proprietary protection
  - Lack of detailed specific plant knowledge
  - Need oversight to keep direction and costs in check
  - Preference for work that can be published
- Pros
  - Inexpensive
  - No pre-conceived ideas

So What Did We Do?

- Board Presentation - Form an In-house Group, but With the Majority of Work Carried Out With Outside Assistance
- Called It "Technology Development" Rather Than "R & D"
- Essential to Fund It From Corporate
  - No Charges to Local Operations
- Report to Chief Operating Officer
- No Rules

Technology Development

No Rules, except

Never Exceed Annual Budget

Or At Least Not By Much

Goal and Objective of Technology Development

- Responsible for Developing New Technology to Lower Costs by $10/ton DAP
- Explore Other Sources of Income
- Evaluate Projects or Proposals From Conceptual to Commercialized
- Find and Challenge the Paradigms
- To Funnel Projects Into Present Process & Project Engineering Structure
- To Take on Longer Term Projects Requiring Development

The Technology Development Group

- Formed Sept. 27, 1995 by JV Policy Board (Yes, We're Almost 7 Years Old)
- Mission is to Implement New Technology to Increase the Profitability of the Corporation
- We Were Told by Many, the Areas Where We Did Not Need to Look, or Should Not Work

The Technology Development Group

Senior Management Told Us Where We Were Not To Look For These Improvements

Here's the List

Areas Excluded From Technology Development

How Do We Work

- Work Performed Internally
  (Mostly Computer, Pilot Plant and Field)
- Contract with Experts (Over 100)
- Provide Tools for Others in Organization That Have Valuable Ideas But Cannot get The Tools
- Random Acts of Kindness
- We Welcome All Ideas/Problems/If Onlys

Our Focus

- 1996 Worked on 5 years Out
- 1997 Worked on 4 years Out
- 1998 Worked on 3 years Out
- 1999 Worked on 2 years Out
- 2000 Worked on 2001
- 2001 Short Term Implementations
- 2002 Working on now, and 5 years Out

•Luckily, We were going Short Term when DAP price Fell

Talking Points

- ~~Permitting~~
- ~~Le[illegible]draglines~~
- ~~Ke[illegible]or~~
- ~~Dilbert~~
- ~~Rock Piling Programs~~
- ~~DAP Process Controls~~
- ~~Plant~~
- ~~P2O5 Recovery~~
- ~~Magnesium Avoidance~~
- ~~Smart Fertilizers~~
- ~~DRM Database~~
- ~~Thickened Clay~~
- ~~Wells~~
- ~~Conveyors~~
- Attack Controls
- ~~Trends in Mining~~
- Pond Water Remediation
- ~~Donuts~~

Pond Water – Reverse Osmosis

- Previous Efforts (~1980's)
  - Failed Because of Irreversible Membrane Fouling
- Pretreatment is Essential
  - Pond water is SuperSaturated Solution
  - Saturation Must be Relieved to Allow Removal of Water Without Precipitation

Pond Water – Reverse Osmosis

- Pre-Treatment developed that allows Pond Water to be processed through R. O. System
  - ~75% of Feed volume meets (exceeds) discharge requirements
  - Sludge volume reduced ~75%
  - ~70% of P_2O_5 Recovered in Concentrate
- Process Chemistry confirmed at bench & Pilot scale (Including R.O. System)
- Patent Applications Filed (Have Provisional)

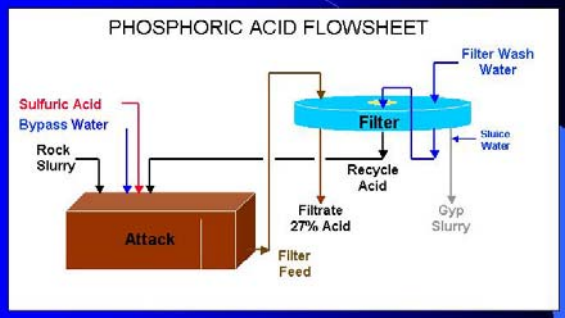
Pond Water – Reverse Osmosis

- Pre-Treatment to De-Saturate System
- But Majority of P_2O_5 Retained in Solution
- P_2O_5 Recovered as Concentrate - Economic Value ~7 to 8% P2O5
- Permeate is Essentially Pure Water

PROCESS CONTROLS

- Development started in 1988
- Process Control Computers
- Basic program language
- Rules and Fuzzy Logic
- Adaptive Controls
- On-Line Controls in 1990

PROCESS CONTROLS



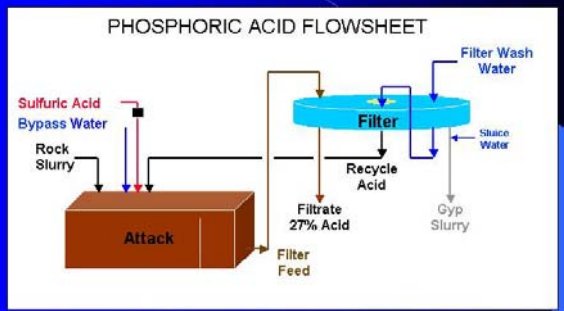
PHOSPHORIC ACID PLANT ON-LINE CONTROLS

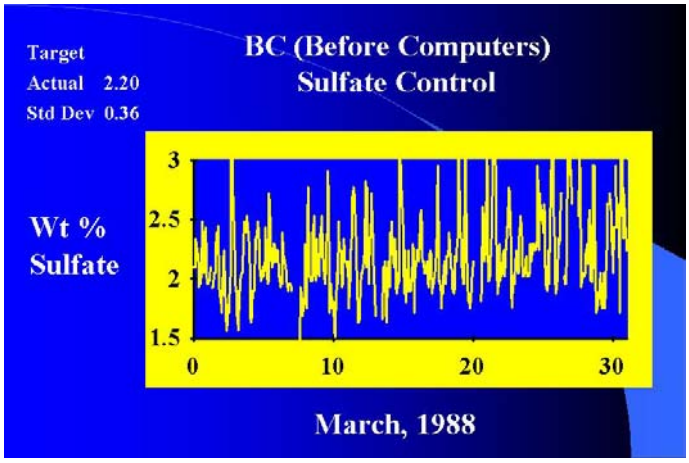
- Sulfate Control
- Phosphoric Acid Strength Control
- Filter Feed Control
- Rock Rate

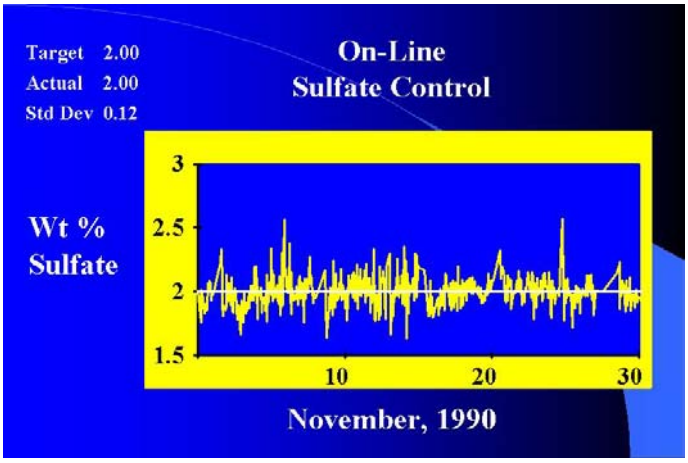
PHOSPHORIC ACID PLANT ON-LINE CONTROLS

- Sulfate control
  - Sulfate target
  - Acid to rock ratio
  - Total flow deviation control
  - Adjust ratio after every sample

PROCESS CONTROLS



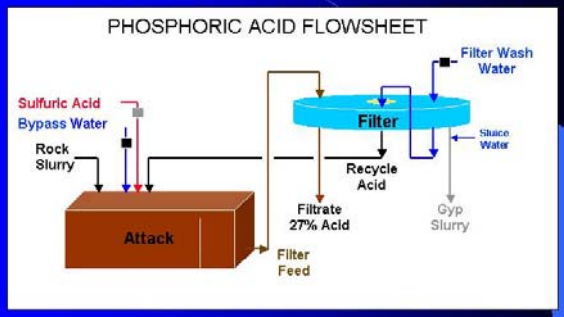


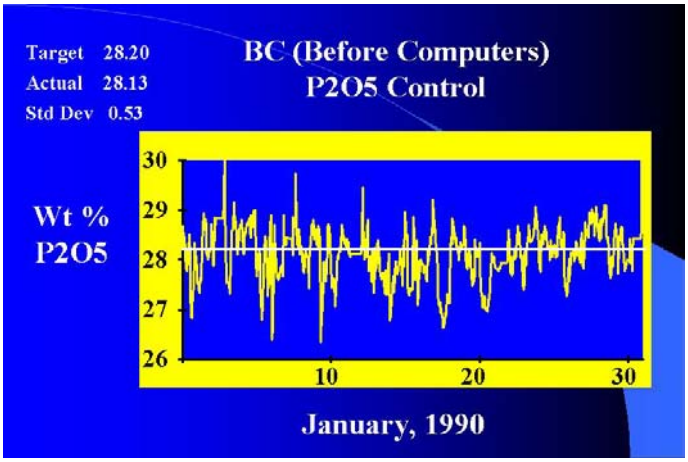


PHOSPHORIC ACID PLANT ON-LINE CONTROLS

- Sulfate Control
- Phosphoric Acid Strength Control
  - –P2O5 target
  - –Water to rock ratio
  - –Adjust filter wash water
  - –Bypass water
  - –Adjust ratio after every sample

PROCESS CONTROLS

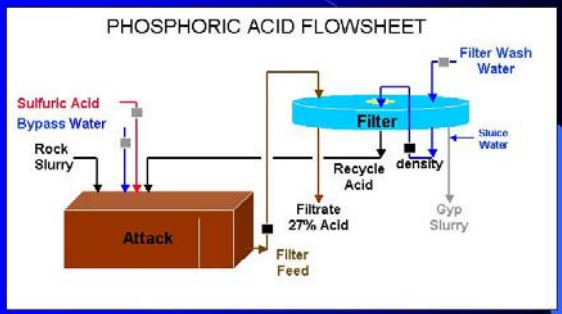


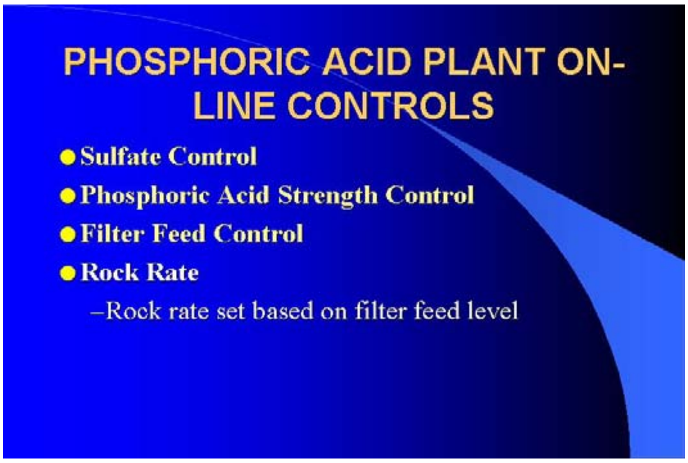


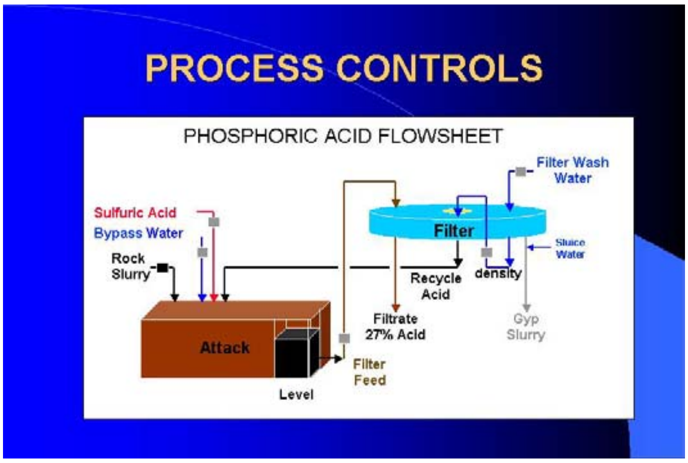
PHOSPHORIC ACID PLANT ON-LINE CONTROLS

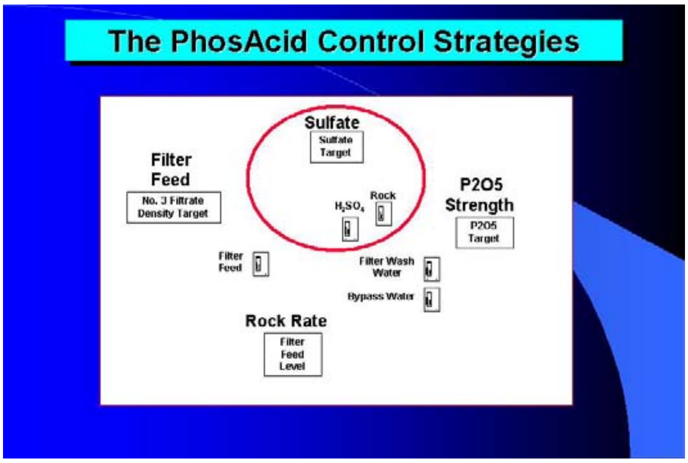
- Sulfate Control
- Phosphoric Acid Strength Control
- Filter Feed Control
  - – No. 3 Filtrate density target
  - – Density target sets filtration recovery
  - – Filter feed rate set based on No.3 filtrate density

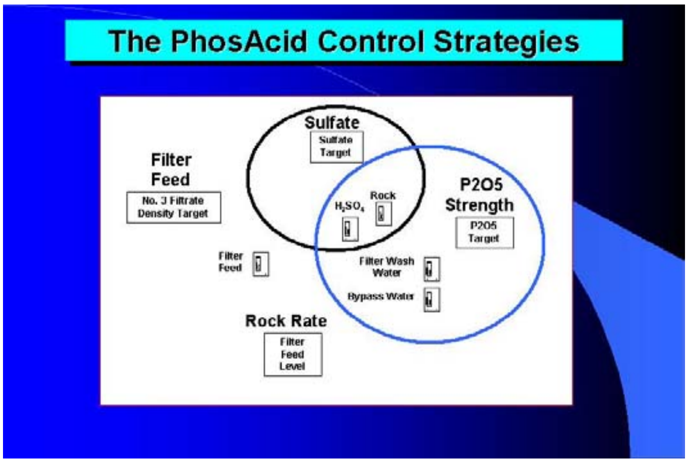
PROCESS CONTROLS




PHOSPHORIC ACID PLANT ON-LINE CONTROLS
Sulfate Control
Phosphoric Acid Strength Control
Filter Feed Control
Rock Rate
–Rock rate set based on filter feed level


PROCESS CONTROLS
PHOSPHORIC ACID FLOWSHEET
Filter Wash Water
Sulfuric Acid
Bypass Water
Rock Slurry
Filter
Sluice Water
Recycle Acid
density
Filtrate 27% Acid
Gyp Slurry
Attack
Filter Feed
Level


The PhosAcid Control Strategies
Sulfate
Sulfate Target
Filter Feed
No. 3 Filtrate Density Target
Rock
P2O5 Strength
P2O5 Target
Filter Feed
Filter Wash Water
Bypass Water
Rock Rate
Filter Feed Level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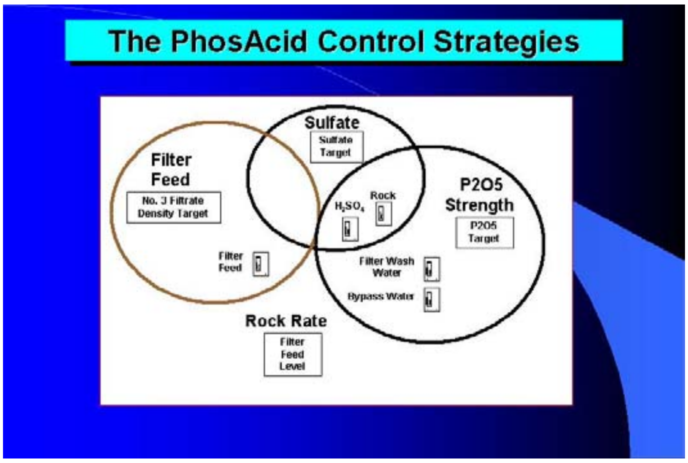
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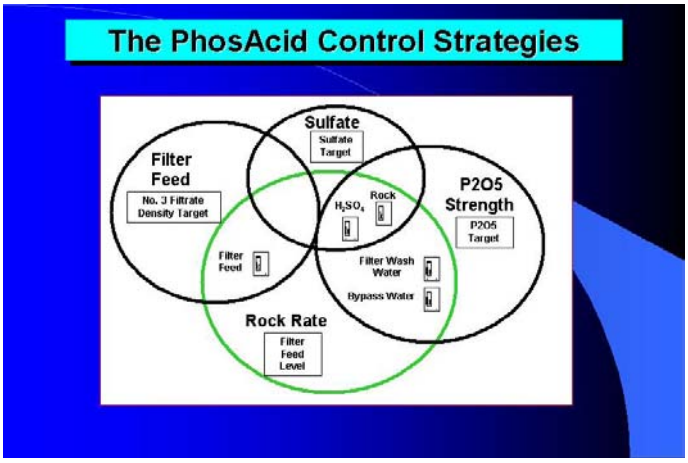
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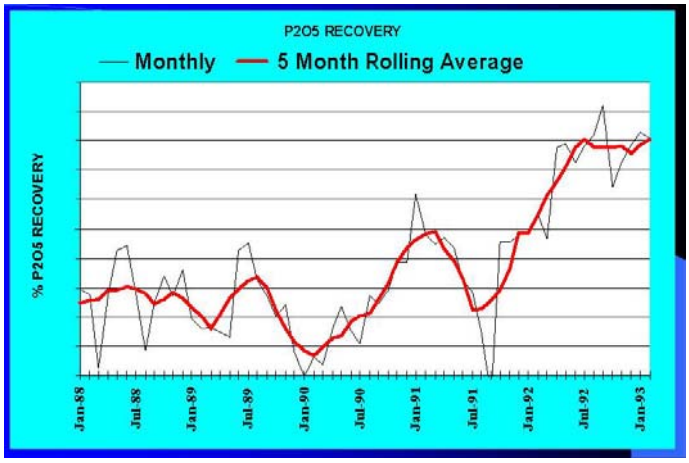
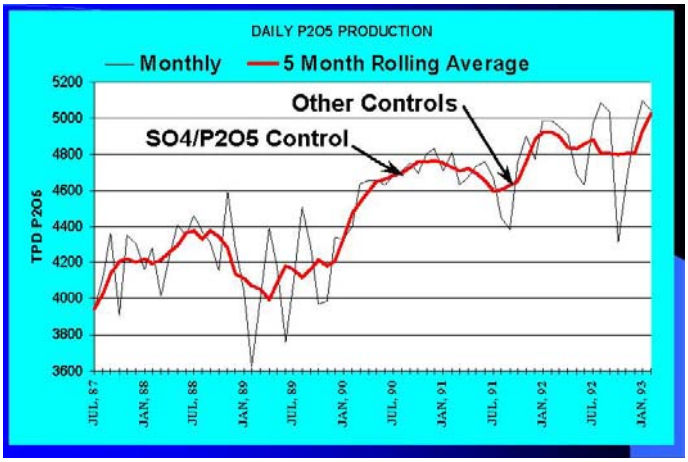
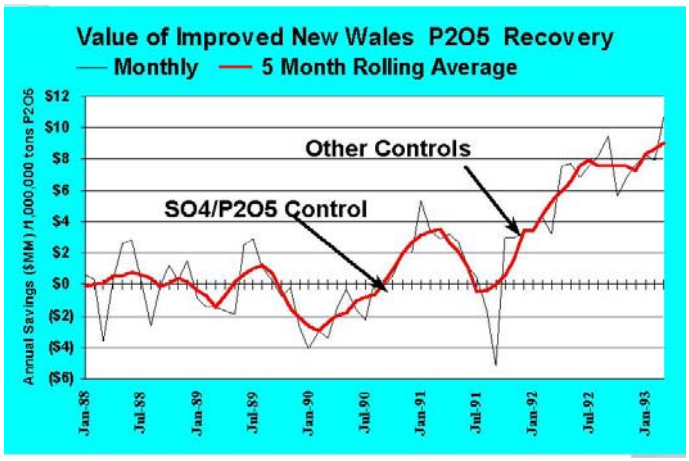
PHOSPHORIC ACID PLANT ON-LINE CONTROLS

- **Control Limits and Logic for**
  - –Upset Conditions
  - –Data entry errors
  - –Rate and flow limits
  - –Sensor drift and scaling





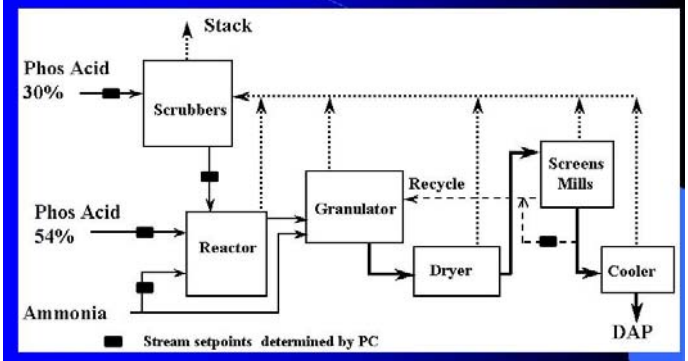


Advanced Process Control For DAP

DAP APC Objectives

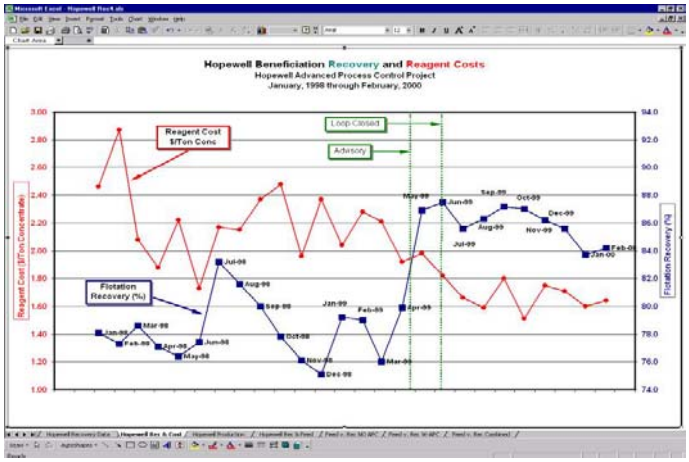
- Improve DAP Plant Controls
  - Stabilize the process
  - PC based controls
  - Additional instrumentation
- Determine optimum operating parameters
  - Reactor mole ratio and gravity
- Improve Granulation

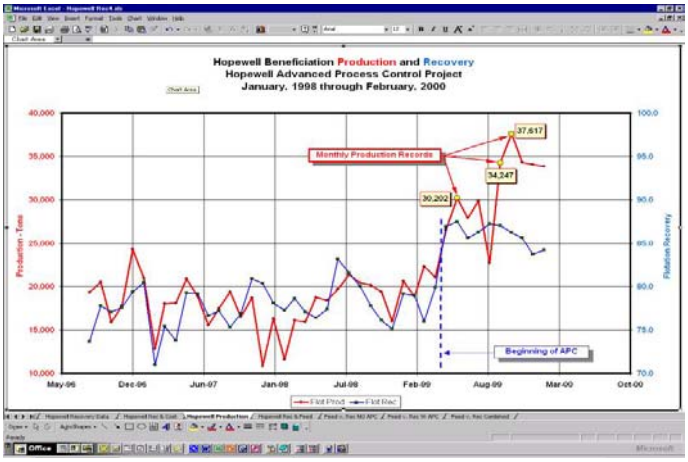
DAP2 Plant Overview



DAP2 APC Benefits

- Improved plant process control
  - Reduced P2O5 losses
  - Reduced ammonia losses
  - Improved DAP quality




Hopewell Beneficiation Production and Recovery
Hopewell Advanced Process Control Project
January, 1998 through February, 2000
Monthly Production Records
37,617
34,247
30,202
Beginning of APC
May-06
Dec-06
Jun-07
Jan-08
Jul-08
Feb-09
Aug-09
Mar-00
Oct-00


So Many Rocks . . .
So Many Opportunities . . .


Which Rock Would You Pick Up First?