Water and Energy Balances in Mineral Processing Plants

Osvaldo Bascur and Ales Soudek
Introduction

- Water - Scarcity (Chile, Australia)
- Energy - Expensive
  - Energy Price Volatility
- Enterprise Energy and Water Management
  - Management of corporate energy consumption is essential for carbon management program and initiatives
  - Metal Loss Management
- Role of Mass and Energy Balances
PI Value Drivers in Mining and Metals

How to identify risks and plant availability constraints?
How to validate the data for business decisions?
How to track variable costs by product, by area, by recipe?

Mining | Mineral Processing | Metallurgical | Products

Energy | Assets | Reagents | Environmental

Process Management Workflow
Corporate Architecture with Enterprise Center(s) of Competency

Site Data Replication, Aggregation and/or Consolidation and Access anywhere and anytime

Codelco Norte
- PI Server
- Firewall
- Client Apps

Teniente
- PI Server
- Firewall
- Client Apps

Engineering/R&D
- PI Server
- Firewall
- Client Apps

Other Sites, etc...
- PI Server
- Firewall
- Client Apps

PI Central Server(s) with HA
- SAP Business Systems
- Microsoft Portal Servers
- More Client Apps
- Mobile Clients
- Wireless

Site Data Replication, Aggregation and/or Consolidation and Access anywhere and anytime
PI Fundamentals: The Shifting Platform Usage

Time Series Centric

Operations Centric

Connectivity

Time Series

Context (Data Directory)

Data Access

Analytics
Enterprise Agreement: Software

The PI System

The Applications
XCu Builds:

Performance
KPI’s

Inventory
Visibility

Asset
Management

Environmental
Reporting

Production
Planning

Production
Reporting

The Visuals

ReWebParts, Processbook, Datalink, SQC,
Batch add-ins, Manual Logger, etc..

The Analytics

Advanced Computing Engine, PI
Notifications, etc…

The Data

Historian, Analysis Framework, Module
Database, Batch management, Support of
“High Availability”

The Interfaces:

Over 400 Standard PI interfaces including
OLEDB and MCN Health Monitor

IT Data
Asset Grouping - Operation-Centric

- Start with a collection of assets
- Associate data (tags) with the assets
- New assets are based on templates
- Assets can be connected
- Assets can be grouped
  - By function
  - By location
- Calculations are sourced from assets
- Build once, apply to many
- Visualize results from multiple assets with one graphic

Asset Attributes:
- Name plate information
- Trays
- Related data references
- Limits

Asset Attributes:
- Name plate information
- Related data references
- Operating limits

Hierarchical Connectivity Equipment
Copper Production Process

Major Energy Users

- Mine Extraction
- Crushing
- Agglomeration
- Leaching
- SX Extraction
- SX Re-Extraction
- Electro Winning

Flow:
- Sulfuric Acid
- Process Water
- Rich Solution
- Refine Solution
- Organic Loaded
- Poor Electrolyte
- 99.999% Cu
Effect of Grade and Recovery on Energy

- Mining
  - Open Pit, hard rock 3-5 kWh/t ore
  - Underground, hard rock 12-40 kWh/t ore

- Milling
  - < 100 mesh grind, flotation 15-24 kWh/t
  - < 200 mesh grind, flotation 24-34 kWh/t

D.W. Fuerstenau, IMP Latam Rio J, 2001

- Comminution Energy 72% of Milling Energy
- Total Energy Including Milling
- Smelting
- Refining
- Recovery

90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Measurement Error

\[ \varepsilon_{Total} = \varepsilon_{Gross} + \varepsilon_{Bias} + \varepsilon_{Random} \]

- All measurement has error
- Meter Composite Accuracy
  - Repeatability
  - Accuracy
  - Linearity
Balancing Process

- PI
- Manual Data
- Process Data
- LIMS
- Inventories
- Analysis Framework
- Model
- Gross Error Check
- Sigmafine
- Reconciliation
- Reconciled Data

Sigmafine Analysis Framework

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Verify meter performance

Meter 18

\[ y = 0.7732x - 13.639 \]

Typical Meter

Meter 8

\[ y = 0.6773x + 121.01 \]

Biased Meter

Meter 11

\[ y = 1.3984x - 196.99 \]
\[ y = 0.9556x - 15.071 \]

“Sticky” Meter
Mass and Energy Balance
Water Balance
Asset Management

- Common asset model
- Unrestricted access and storage of high fidelity data, including:
  - Historical
  - Real-time
  - Future
Example for Basic Industries

Business Perspective
1. What we do KPI’s (Management)
   1. Variances (Plan – Current)

What we manage Metrics
1. Production
2. Costs, KWh/ton, $/ton
3. Availability
4. Yields
5. Quality
6. Environmental
7. Safety

Plant Data
1. Inventories
2. Lab
3. Process
4. Equipment
5. Receiving/Shipping
Modernización y Aumento de valor en las aplicaciones existentes

CONTEXT

General Structure for each asset is configured in Contex Data Base

Module Relative Display Example
## Transformer Performance Report

<table>
<thead>
<tr>
<th>Date</th>
<th>March 28, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset</td>
<td>TR1123</td>
</tr>
<tr>
<td>Station</td>
<td>Wolverine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value 1 Hour</th>
<th>Value 1 Day</th>
<th>Value Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Oil Temperature</td>
<td>77.6 Deg F</td>
<td>78.2</td>
<td>77.9</td>
</tr>
<tr>
<td>Bottom Oil Temperature</td>
<td>45.5 Deg F</td>
<td>45.2</td>
<td>44.9</td>
</tr>
<tr>
<td>LTC Motor Current</td>
<td>20.3 Amps</td>
<td>19.7</td>
<td>19.8</td>
</tr>
<tr>
<td>LTC Motor Status</td>
<td>RUN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Fan Current</td>
<td>20.5 Amps</td>
<td>20.1</td>
<td>20.0</td>
</tr>
<tr>
<td>Cooling Fan Status</td>
<td>STAGE 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LTC Motor Use
- 0% STOP
- 100% RUN

### Cooling Fan Use
- 25% OFF
- 24% STAGE 1
- 51% STAGE 2
Enterprise Visibility

- Rich and easy-to-use set of analytical tools and capabilities, including:
  - Event detection and notification built-in
  - Configurable—no programming required
  - Scalability

Enterprise energy management infrastructure for managing energy price volatility
KPIs

- Actual yields calculated via PI-ACE based on reconciled values:
  - Per hour
  - Per shift
  - Per running plan

- Overall KPIs calculated via PI-ACE
  - Performance (positive when producing more valuable products than expected)
  - Deviation (gives indication of the distance between target and actual yields)

- Show KPIs - change to notifications/AF
Enterprise Water & Energy Management

Optimal

Design

Actual

Performance

Design

System commissioning

Continuous Monitoring, Analysis, and Action

Time

Continuous Improvement

What Could be

What Should be

What Is

Gap
Improving Mine and Metallurgical Performance

DATA UNIFICATION

Fernando Romero and Manuel Suarez
Compañía Minera Doña Inés de Collahuasi
SCM, Chile
Osvaldo A. Bascur
OSIsoft, USA

2004 SME Annual Meeting & Exhibit

Denver, Colorado
February 24, 2004
Minera Los Pelambres

Plataforma RtPM

Santiago, Agosto 2005
Virtual Site for access any where and anytime

BU 1
- PI Server
- Firewall
- Client Apps

BU 2
- PI Server
- Firewall
- Client Apps

BU 3
- PI Server
- Firewall
- Client Apps

BU N
- PI Server
- Firewall

Mines, Concentrators, Smelters, Refineries, Power Plants, PI Servers (n)
Central San Isidro

Características Generales

Ubicación: 8 km. de Quillota, V Región.

Tipo: Térmica de ciclo combinado.

Características Generales

Potencia: 379 MW
Generación media anual: 1,787,979 GWh
Frecuencia: 50 Hz
Factor de carga medio: 53,79 Combustible: Gas natural

Datos de Generación

<table>
<thead>
<tr>
<th>Unidad</th>
<th>Tipo</th>
<th>Potencia Activa [MW]</th>
<th>Potencia Nominal [MW]</th>
<th>Disponibilidad Dia Anterior [%]</th>
<th>Estado Interrupción</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unidad 1</td>
<td>Gas</td>
<td>134</td>
<td>240</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Unidad 2</td>
<td>Vapor</td>
<td>85</td>
<td>139</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>219</td>
<td>379</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

INFORMACIÓN TÉCNICA

Nota:
Información provisoriamente no disponible de las Centrales:
- Betania, en Colombia
- Cartagena, en Colombia
- Diego de Almagro, Chile
- Ventarrilla unidad 5 (TV), Perú
- Detalle por unidad en Chocón, Argentina
- Detalle por unidad en Aconcagua, Argentina

En la información no disponible de estas Centrales, se reflejan con el valor -1.

Gráfico de potencia diaria (24 horas)
After 25 years of designing, implementing and supporting customers, OSIsoft realized customers needed a new purchasing framework to encompass 3 components of software competency in a single purchase plan.
Enteprise Sales Program

Software
- PI deployment across the defined enterprise
- Asset based licensing
- Simplified contract & procurement processes
- Allowance for material change in business

Support
- Automatic Download of New Versions
- Automated Upgrades Available
- Remote monitoring and alerting
- Help Desk, Developers Network and Training

Services
- Managed rollout
- Remotely PI management
- Center of Excellence (CoE) access
- Architectural design & application

OSIsoft’s Enterprise Agreement Program is designed to “Get PI done right” and ensure customers “Get value out of PI”
The Enterprise Process

- Enterprise Agreement in Place
- Corporate Questionnaire
- Create Extranet and Workspace
- Roll Out Meeting
- Prepare Draft Roll Out Document
- Rollout Architecture
- Install Sites
- Center of Excellence Support
- Celebrate Success
Water and Energy Balances in Mineral Processing Plants

Osvaldo Bascur and Ales Soudek
Kodak Park
Kodak Park Utilities

- Kodak Park Utilities Power Plants
  - 2,000,000 Pound/ Hour Steam Load
  - 125 MW Electric Load
  - 80,000 Ton Refrigeration Capacity
  - 30,000,000 Gallons/Day Process Water Load
  - 35,000 SCFM Compressed Air Load
KODAK Workforce Portal
Welcome JAMES BREEZE

Welcome | myHR | KP Energy
Utilities Home | Utilities Generation | Building Usage | Ad-Hoc Trend

Steam Scorecard
Electric Scorecard
Chilled Water Scorecard
Kodak Water Scorecard
Compressed Air Scorecard

Total KP Plant Steam Flow
KPE Steam Flow to MFG & Refrigeration
KPW/X&M Steam Flow to MFG & Refrigeration
KPS Steam Flow
Exhaust Steam to Atmosphere
Total Boiler Build-Up
250# Steam - Tie Line Flow from B-321 to B-31
Total Megawatts
Purchased Power

KPE Steam Flow to MFG and Refrigeration

Goal = 400 KPPH

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Expanded use of our Energy Information System has been an effective tool to help enable us to consolidate two High Purity Water Systems and a de-mineralized water system down to just one High Purity Water System.
Harvest Time

- The Energy Information System (EIS) has been an essential tool to help us reach our goal of:
  “One Powerhouse for Kodak Park”

Collectively these efforts have yielded savings into the millions of dollars.
Lessons Learned

- No BIG BANG – 1000 little bangs
- Continuous Improvement Process
- Combined Capital and Intelligence Operation
- Infrastructure Approach – Remove Infrastructure from Projects
- Lowers the Cost of Curiosity
Metals Enterprise Business

- Objectives
  - Site Integration for Enterprise Optimization
  - Enterprise Competence Center
    - Leverages expertise across entire enterprise
    - Identify and promote best practices
    - Tracks effectiveness of business processes
    - Collaboration

- Required Tools and Supported Methodology
  - Flexible Collection of Real-Time Data
  - Asset-based Organization for Analysis
  - Web-based, Easy Access to Information
  - Scalable Analysis and Visualization
  - Managed PI and COE Services