PI System Based Industrial Big Data Applications

Presented by Jeremy Kuo & Nancy Jiang

Dragon Steel Co.
Introduction of CSC (China Steel Corporation)

- Founded in December 1971
- Located at Kaohsiung, Taiwan
- Annual production (crude steel) around 10 million tones
- Products include plates, bars, wire rods, hot and cold rolled coils, electrogalvanized coils, electrical steel coils, hot-dip galvanized coils and Ti/Ni-base alloy
- CSC is the largest steel company in Taiwan including investment in transport, resource and environment protection, etc.
Introduction of DSC (Dragon Steel Co.)

- July 2004: Kuei-Yi Industrial Co. renamed as DSC
- Feb 2010: 1st BF blow in
- Mar 2013: 2nd BF blow in
- Yield
  - BF: 5 million tones/year
  - EAF: 1 million tones/year
- Employees: 3,200
- Product: Hot-rolled coils, Flat, H beams and Billets
PI System @ CSC

10+ Years Data in PI

1K Tags PI ProcessBook PI DataLink

2007.1

20K Tags AF PI WebParts

2008.5

100K Tags Event Frames Future Data PI Coresight

2012.5

150K Tags

DSC Joined

2015.12
PI System Architecture @ DSC

A bridge connecting office and plant

Client

Server

CNI (China Network Isolator - Fire Wall)

Primary

Secondary

HA

Source

vm vm

OPC PI

vm vm

ACE RDBMS

Cisco UCS Server

Shared disks

PI Server

PI Server

2015

2015
Outline

A. Introduction
B. Requirements
C. Application in DSC/CSC
D. PI System + iEM
E. Conclusion
PI (Plant Information) System

- Collecting plant information efficiently
- Integrating data from different sources and platforms and providing a uniformed user-interface to all users
- Building Big Data applications on top for intelligent manufacturing and better effectiveness
Requirements

Industry 4.0 Plant...

- **Process**
  - Control System
  - Instrument Sensor

- **Control Strategy**

- **Planning / Optimization**

- **Process Data**
  - Operation Data

- **Process Modelling**
  - Simulation

- **Process / Asset Monitoring**

- **Control Efficiency Monitoring**
  - Good
  - Exception

- **Diagnosis**

- **Virtual Measure**
  - Status Estimate

- **Control Parameters Tuning**

- **Requirements**
  - Industry 4.0 Plant…
Requirements

To be honest……
Why Do We Need the OSIsoft PI System?

A tool for

● Data Collecting

● Problem Solving and Analysis

● Management (Processes, Power and Resources, etc.)
Outline

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動力工場運轉數據總覽畫面（18:9比例）
ASU: Oxygen Load Forecasting System

Function of Oxygen

1. For oxygen enriched combustion in BF
2. Convert iron to steel in Basic Oxygen Converter  EAF
Oxygen Supply in DSC

- 3,400MT LP LOX
- 114MT HP LOX
- Evaporator
- 32kg/cm²(g)
- 2nd source 24 reduce to 13kg/cm²(g)
- EAF Bloom CC
- 13kg
- Pressure station 18kg
- BOF CC
- Pressure station
- 11kg
- BF Hot rolling

P1
P2
P3

O2 Buffer Vessel 16x150=2400 Nm³

32kg/cm²(g)
11kg/cm²(g)

vent
Problem 1: LOX Consumption

Even though oxygen’s supply met demand, LOX consumption still could not be avoided when BOC operated unstably.

Pressure of BV reduce to set P (about 19~20kg/cm²), LOX consume

Set P

Pressure of buffer vessel

Flow of blowing (NM³/H)

Kg/cm²

0
5
10
15
20
25
30
35

0 1 2 3 4 5 6

Double BOF 90000

Single BOF 45000

Time: H
Problem 2: Blow Off

Due to the nature of BOC’s batch processing, when BOC stopped or uneven blowing also makes oxygen blow off.

Due to the nature of BOC’s batch processing, when BOC stopped or uneven blowing also makes oxygen blow off.

Pressure trend of buffer vessel

- Blow off pressure 32 kg/cm²
- Blow off
- Stop blowing
- Uneven blowing
- Blow off

Flow rate of BOF blowing NM³/H

- 90000
- 45000

Kg/cm²

Pressure of BV.

T

0 1 2 3 4 5 6

Pressure trend of buffer vessel

hour
Oxygen Load Forecasting System

Product status

Trend of buffer vessel

Total GOX

Prediction of next 2 hours

Inf. of BF & BOC & EAF

Prediction

Pressure of BV.
Applying Forecasting System (Before)

B.V. reach 28 then load down

Blow off

B.V. 20 then load up

LOX consumption

B.V. pressure
total GOX

Blow off
LOX consumption
Applying Forecasting System (After)

- **B.V. 28.4**
  - HIGH still load up
  - Avoid LOX consumption

- **B.V. 24.9**
  - LOW still load down
  - Avoid blowing off

**B.V. pressure**
- Blow off
- LOX consumption

**total GOX**
Reduce LOX Consumption and Blow Off

Monthly Average LOX Consumption

Before Forecast Sys.
816.8T
Blow off 3-7%

After Forecast Sys.
443.4T
Blow off <3%

Reduce 45.7%
LOX Consumption

9/M Forecast Sys. Test Run
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Evolution of PI System Analysis Methods

- Small sample
- Mechanism analysis
- Causal relationship
- Empirical rules

Manual analysis

- Multi parameter
- Association analysis
- Data model
- Knowledge discovery

Machine learning
Why Do We Need Big Data Analysis?

Most PI Server Data is Sleeping…

- 3+ Year Data
  - 0 Apps
- 1+ Year Data
  - Less 1% Apps
- 1 Year Data
  - 5% Apps
- 3 Months Data
  - 30% Apps
- 3 Weeks Data
  - 95% Apps

PI-DA & AF
What is iEM?

Raw PI Server Data + iEM = iEM

Data Cleaner

IBD Model

PI Server

Refined Data

IBD Modeling

Hypersphere Model

Intelligent Engine for Machine-learning
PI System Based Industrial Big Data Apps

IBD - Hypersphere Modeling

Tags View

Process/Equipment

Years+ Data in PI

Hyp-Modeling

Hyp-Evaluating

HPI Trend

Tag Trend

$H_v = 80\%$

$H_{th} = 97\%$

IBD View

$\begin{bmatrix}
    c_1 \\
    c_2 \\
    c_3 \\
    c_4 \\
    c_5 
\end{bmatrix}$

$\begin{bmatrix}
    \nu_1 \\
    \nu_2 \\
    \nu_3 \\
    \nu_4 \\
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Years+ Data in PI

$\begin{bmatrix}
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    \nu_{41} \\
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    \nu_{12} \\
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HPI Trend

Tags View

Process/Equipment

Years+ Data in PI

Hyp-Modeling

Hyp-Evaluating

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PI System Based Industrial Big Data Apps

IBD - Hypersphere Model
PI System Based Industrial Big Data Apps

- PI AF
- PI EF
- PI ProcessBook
- PI Coresight

- iEM Manager
- iEM Explorer
- iEM Monitor

Data Source | Interface | Buffer | PI Server | PI User
---|---|---|---|---
PI Point DR | RawData | Asset Frame | HPI | PI AF
Table Lookup DR | PI AF | PI Server | iEM Server | iEM User
Relational Database | PI ProcessBook | PI Coresight

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PI System Based Industrial Big Data Apps

**PI Server + iEM**

**Solutions**

**IBD Applications**

**Multi-Year Data**

- Asset Health Management on Sintering & Iron-Making
- Equipment Early Warning & Prognosis on Pumps & Fans
- Electric Power Generator Remote Diagnosis
- Process Health & Performance Optimization on Air Separation
- Energy Efficiency Online Monitoring & Analysis

**PI Server/IBD Model + Asset Framework + PI Coresight**
With Big Data Apps

Most PI Server Data is Awakening...

- 3+ Year Data Apps
- 1+ Year Data Apps
- 1 Year Data Apps
- 3 Months Data
- 30% Apps

PI Tags
Intelligent Monitoring

Before

After

At least 5 ~ 10 times of efficiency improvement
Benefits

• 360° 24 / 7 Monitoring
  – Promote equipment efficiency > 50%
• Early-Warning
  – Save maintenance cost > 10%
  – Improve equipment reliability > 20%
  – Reduce the number of accidents/losses
• Operations Optimization
  – Identify equipment and process optimization operation key points
  – Real-Time optimization prediction
  – Guide optimal operations
  – Improve production rate and equipment energy efficiency > 5%
Case 1: Air Compressor Online Diagnosis

IBD HPI Monitoring

Key Relevant Tags:

Root Cause:
Cooling water temperature too low
Case 2: Boiler System Online Diagnosis

Root Cause: Feed water flow error / Pump stopped
Case 3: Air Separating Process Online Diagnosis

IBD HPI Monitoring

Root Cause:
Tower temperature too low
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Summary

COMPANY and GOAL
China Steel Group aims to increase cashflow with a better data integration platform for problems solving and analysis, and better management of processes, power and resources, etc.

CHALLENGE
Various data sources, a lot of manual work, difficult to achieve Industry 4.0 objectives
- Need a unified data integration platform
- Need a uniformed user-interface
- Need to utilize data to achieve intelligent manufacturing for better effectiveness

SOLUTION
Implemented PI System for data integration; with iEM for Big Data analytics
- Use PI System as the bridge between office and plant
- Use Future Data for Forecasting
- Use iEM for Big Data analytics and prediction

RESULTS
Intelligent manufacturing and better effectiveness
- 5-10 times efficiency improvement
- Increase equipment efficiency > 50%
- Early warning to save maintenance cost > 10%
- Reduce accidents and losses, improve equipment reliability > 20%
- Improve production rate and equipment energy efficiency > 5%
Conclusion
Best Decision – PI System!!

Industry 4.0

Analysis
Sensors
Data Platform (Management)

Application (Management)

Resources, Energy, Customers and Marketing, ...etc.
Contact Information

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General Foreman
Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

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Thank You

감사합니다

谢谢

Danke

Merci

Gracias

Спасибо

Obrigado

ありがとう