Development of process digital twin and how AVEVA™ PI System™ helped

AGC Inc.

Kosuke Nakai, Ryosuke Kobayashi
1. Company Profile
2. Overview of the Presentation
3. AGC Chemicals DX Strategy and AVEVA PI System
4. Concept of Process Digital Twin
5. Process Digital Twin Development
6. How PI System helped Process Digital Twin Development
   ✓ PI System as Infrastructure
   ✓ PI System as User Interface
   ✓ PI System covers the Last Mile
7. Benefits and Further Use
8. Summary
### AGC Inc.

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Office</td>
<td>Tokyo, Japan</td>
</tr>
<tr>
<td>Founded</td>
<td>Sep 8, 1907</td>
</tr>
<tr>
<td>President &amp; CEO</td>
<td>Yoshinori Hirai</td>
</tr>
<tr>
<td>Capital*</td>
<td>91 billion JPY (~690 million USD)</td>
</tr>
<tr>
<td>Consolidated Net Sales*</td>
<td>2,036 billion JPY (~15 billion USD)</td>
</tr>
<tr>
<td>Subsidiaries*</td>
<td>201</td>
</tr>
<tr>
<td>Employees* (Consolidated Companies)</td>
<td>57,609</td>
</tr>
</tbody>
</table>

*As of Dec 31, 2022

---

### AGC Inc. Business Units

- Architectural Glass Business
- Automotive Business
- Electronics Business
- Chemicals Business
- Life Science Business
- Ceramics Business / Others
AGC Chemicals Company

Company Vision

Essential Chemicals Business
- Chlor-alkali Business
- Urethane Business

Performance Chemicals Business
- Gas & Solvents Business
- Fluorochemicals Business
Overview of the Presentation
AGC Chemicals combines AVEVA™ PI System™ with process digital twin to optimize operations

Challenge

- VCM plants are difficult to operate, and production losses due to unplanned shutdowns occur.
- Plant operations have multiple trade-offs and are difficult to optimize manually.

Solution

- The digital twin, which combines first-principles models with statistical models, is developed to provide unprecedented process monitoring and operational optimization.

Results

- The status of the process, which could not be monitored before, has been visualized, allowing the staff to understand the situation accurately and make decisions based on the data.
- As a preliminary study for adding the optimization module to our digital twin, it is confirmed that fuel gas efficiency is improved by 6%, resulting in energy cost savings of approximately $400,000 per year.
AGC Chemicals DX Strategy and AVEVA PI System
AGC Chemical’s Smart Plant Framework

<table>
<thead>
<tr>
<th>WHAT</th>
<th>WHY</th>
<th>HOW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transforming</strong></td>
<td>Data-driven Optimization</td>
<td>Exploitation of existing assets</td>
</tr>
<tr>
<td><strong>Understanding</strong></td>
<td>Data-driven Analysis &amp; Prediction</td>
<td>Cost Competency</td>
</tr>
<tr>
<td><strong>Digital Foundation</strong></td>
<td>Data collection &amp; storing Improving work efficiency</td>
<td>Resilient Operation</td>
</tr>
</tbody>
</table>

**WHY**
- Exploitation of existing assets Cost Competency
- Prompt Situational Awareness / Decision Making / Actions Resilient Operation

**HOW**
- Operation Process Digital Twin RTO APC
- Schedule Production Planning Scheduler
- Maintenance Planning Risk & Cost-based Maintenance Predictive Maintenance
- Simulation (Process / Fluid)
- Data Analysis (ML/AI)
- Visualization with BI tools
- ETL tools
- Advanced Use of Platform Systems
- Resilient Operation

**Data Collection**
- Process Data
- Asset Data
- Activity Data
- Quality Data
- Other Data
- Data Collection (Sensing & Network)
Enterprise Program Agreement was signed in 2021
Why is Enterprise Program needed?

**Selected as a Global standard PIMS**
- AVEVA PI System was selected as the standard PIMS for AGC Chemicals on a global basis.
- In addition, “Integrated PIMS” was developed to consolidate operational data from all sites on the headquarter cloud environment.

**Expanding the scope of data collection**
- Expand the scope of data collection in the existing data sources such as DCS (ON/OFF signals, controller modes, etc.).
- Start collecting data from new data sources such as IoT sensing (vibration, analog meter readings, etc.).

Need to increase the number of Tags

AVEVA PI System is also key enabler for process digital twin development
Concept of Process Digital Twin
What is “digital twin”?

• A **digital twin** is a digital representation of a physical object that is built with the data obtained from the real world

• In particular, the one reproducing the behavior of process plants is called **Process Digital Twin** in AGC
AGC Chemical’s Smart Plant Framework

**WHAT**
- Transforming
- Understanding
- Visualizing
- Digital Foundation

**WHY**
- Exploitation of existing assets
- Cost Competency
- Prompt Situational Awareness / Decision Making / Actions
- Resilient Operation

**HOW**
- Operation
  - Process Digital Twin
  - RTO
  - APC
- Schedule
  - Production Planning
  - Scheduler
- Maintenance Planning
  - Risk & Cost-based
  - Predictive Maintenance

**WHAT**
- Data-driven Optimization
- Data-driven Analysis & Prediction

**WHY**
- Exploitation of existing assets
- Cost Competency
- Prompt Situational Awareness / Decision Making / Actions
- Resilient Operation

**HOW**
- Operation
  - Process Digital Twin
  - RTO
  - APC
- Schedule
  - Production Planning
  - Scheduler
- Maintenance Planning
  - Risk & Cost-based
  - Predictive Maintenance

**HOW**
- Advanced Use of Platform Systems
- Simulation (Process / Fluid)
- Data Analysis (ML/AI)
- Visualization with BI tools
- ETL tools

**WHAT**
- Introduction & Utilization of common platform
- Data collection & storing

**WHY**
- Improving work efficiency
- Resilient Operation

**HOW**
- Process Data
- Asset Data
- Activity Data
- Quality Data
- Other Data
- Data Collection (Sensing & Network)
What is operational optimization?

**Temperature & Reaction**

---

: Conversion rate
What percentage of the raw material reacts?

---

: Selectivity
What percentage of the product is the desired product?

---

: Yield
What percentage of the raw material will be the desired product?
Conversion rate $\times$ Selectivity
What is operational optimization?

**Temperature & Reaction**

- **Conversion rate**
  What percentage of the raw material reacts?

- **Selectivity**
  What percentage of the product is the desired product?

- **Yield**
  What percentage of the raw material will be the desired product?
  Conversion rate X Selection rate

Real plants are not so simple!

Then, how to optimize?
Process Digital Twin

Real-Time Optimization (RTO)!

One of the goal of DX (Digital Transformation) for the continuous process plant
Today’s presentation focus

PI System

Business system
(ERP, etc.)

Cost Information

Process Digital Twin

Representation

Optimization

Real plant

Operational data

Optimal Variables

Operational data

Predicted Value

Optimal Variables

Under Construction!
Process Digital Twin Development
Chlor-Alkali Business

- Caustic soda and chlorine are produced from electrolysis of salt.
- Caustic soda is used in a wide range of applications as a typical alkaline product for industrial use.
- Chlorine is processed with ethylene to produce vinyl chloride monomer (VCM) and VCM is processed into polyvinyl chloride (PVC).
Target Process

- P.T. Asahimas Chemical
- VCM Plant
  - Direct Chlorination Unit: Produce Ethylene Dichloride (EDC)
  - Oxychlorination Unit: Produce EDC
  - EDC Purification Unit
  - **EDC Cracking Unit: Produce VCM**
  - VCM Purification Unit

VCM is produced by EDC vapor at Cracking Furnace

EDC $\rightarrow$ VCM + HCl

Endothermic Reaction, Require Energy
Process Digital Twin Development

Process Digital Twin

Representation
Optimization

Real plant

Process Simulator
Reproduce actual plant behavior based on physical property estimation and chemical engineering principle
Process Digital Twin Development

Real plant

Operational data

PI System

Operational data

Predicted Value

Process Digital Twin

Representation

Optimization

PI System

Utilized in many ways:
- as Infrastructure
- as User Interface
- to cover the Last Mile
How PI System helped in Process Digital Twin Development
PI System in Process Digital Twin

AVEVA PI System

1. As Infrastructure
2. As User Interface
3. To cover the Last Mile
No Risk!

✓ The process simulator was able to obtain the real-time data from the plant without any operation risk since PI System works as the bridge.

Benefit of Enterprise Program

No Limit!

✓ Although the number of calculated tags increased, Enterprise Program allowed us to carry out the project without worrying about the number of tags.
  • Temperature profile in columns
  • Composition at any point
  • etc.
PI System as User Interface

• We didn’t have to develop any dedicated user interface since we already had PI Vision.

Add to Existing Display!
✓ It was also possible to add calculated results on the existing displays

Create New Display!
✓ Each user can edit the newly-developed insightful displays as they want to see.

It’s possible because we are already familiar with PI Vision!
Column Temperature Profile
Calculated Tag Management by AF
✓ Huge amount of newly generated calculated tags are organized and managed using PI Asset Framework.

Processed Data Creation by AF
✓ AF Analysis was used to generate processed data necessary for simulation
  • Moving average
  • Running time

Abnormality Detection by Notification
✓ Notifications tell staff in case plant value and calculated value have significant deviation.
Benefits and Further Use of Process Digital Twin
Benefits of Process Digital Twin

Reduce the potential trouble

✓ It reduces the potential troubles by showing process insights such as temperature profile in columns and composition at any point.

Efficient Operation

✓ It helps realize efficient operation
✓ (e.g.) Composition at column outlet and tray performance are now visible, we can minimize the steam amount.

Optimize Maintenance Timing

✓ It generates the chance of optimizing maintenance timing. Since the asset performance is now visible, we can schedule the best maintenance timing.
Future use of Process Digital Twin

• AGC is going to add an optimization module to further leverage the process digital twin.
• While a typical RTO only covers operations that are automatically controlled by DCS, our study also includes the manual adjustment of the cracker because it is one of the greatest energy consumers.
Preliminary study for optimization

• As a preliminary study, the energy-saving effect of changing the heat distribution in the cracker was investigated in offline simulation.

• Results suggest a potential 6% improvement in fuel efficiency

Cost Reduction
Approx. 400k USD/year

CO2 Reduction
Approx. 3500 Ton/year
Summary

• RTO using Process Digital Twin is the one of the DX goal of continuous process.
• AGC Chemicals have partially realized Process Digital Twin in one of their plants.
• PI System plays an essential role in many ways in the system.
  • As infrastructure
  • As user interface
  • To cover the last mile
• Even though the system is not complete yet, it generates huge amount of value.
  • Reduce the potential troubles
  • Generate the chance of saving energy
  • Generate the chance of optimizing maintenance timing
• Preliminary study for the introduction of the optimization module was conducted and its potential was confirmed.
Kosuke Nakai
Leader of Applied Technology Groupe, DX Office
• AGC Inc.
• kosuke.nakai@agc.com

Ryosuke Kobayashi
Applied Technology Groupe, DX Office
• AGC Inc.
• ryosuke.kobayashi@agc.com
Questions?
Please wait for the microphone.
State your name and company.

Please remember to...
Navigate to this session in the mobile app to complete the survey.

Thank you!
ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life’s essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world’s most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com