Introduction to TBB Co., Ltd.

October 1, 2026

TBB PROCESS AUTOMATION

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TBB Co., Ltd. General

- **Mission TBB :** TBB stands for 'To Be a Blessing,' expressing the commitment to be a blessing (helpful) to employees, customers, and neighbors.

- **Main Products :** License - Factory automation software PROMONICON sales
  Service (Project) - System Integration (SI), High-Precision Control Systems, Automation Systems, Central Control Systems (CMS), Execution of Recipe Management System (RMS) Implementation Project
- **Date of Establishment** : July 18, 2022

- **Industrial Sectors** : semiconductors, (petro)chemicals, environment, steel, energy, research and development (national research institutes, universities, corporate research institutes), etc.

- **Website and Contact** : www.tbb-automation.com, suwhansung@knu.ac.kr, +82-10-8912-6572(CEO, Su Whan Sung)

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TBB Co., Ltd. Customer

▪ Domestic Customers

(Petro)Chemical – Kolon, LG Chem, LG Chem Research Institute, LG CNS, Youngjin Chemical, Youngjin Housing, ECMiner, Hyolim Industrial, Myeongil, PSCK, Korea Institute of Energy Research, KIST

Semiconductors, Energy, Environment – Hanwha/Momentum, S-Tech, LG Siltron, SK Siltron, Woongjin Energy, Selig, Solmix, GQL, Wonik, Bumhan Industries, VINA FCM, NEOTOP, Hyojin E&HY, CARBONENERGY, SYNOPEX, Korea Institute of Energy Technology

Steel – Samwoo Eco, POSCO PNR

▪ International Customers

Semiconductors, Energy – ZingSemi, WaferWorks, SICREAT, EZWIN

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Introduction to the CEO

Su Whan Sung (Ph.D.)



Education

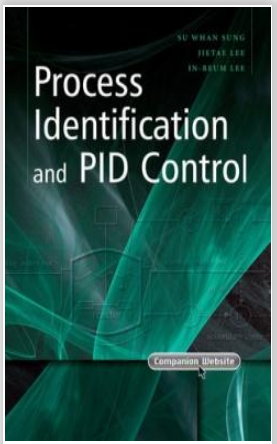
1994 – 1997	**Ph.D.** Chemical Engineering, POSTECH, Republic of Korea
1992 – 1994	**M.S.** Chemical Engineering, POSTECH, Republic of Korea
1988 – 1992	**B.S.** Chemical Engineering, Kyungpook National University (KNU), Republic of Korea

Career

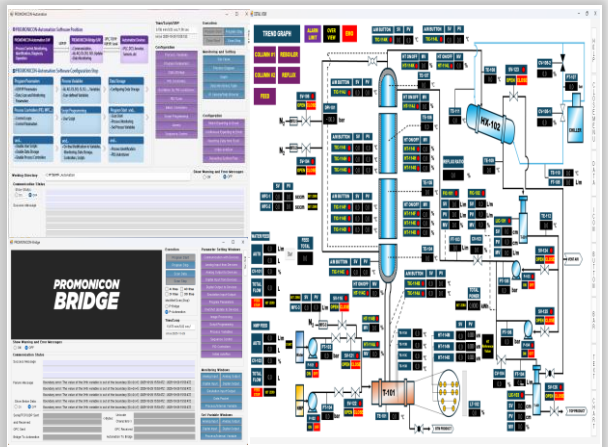
2014 – present	**CEO** TBB Inc.
2005 – present	**Professor** School of Chemical Engineering and Applied Chemistry, Kyungpook National University (KNU), Republic of Korea
2003 – 2005	**Senior Researcher.** LG Chem. LTD/Research park, Republic of Korea
2000 – 2002	**Research Professor.** Chemical Engineering, KAIST, Republic of Korea

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Introduction to the CEO



Textbook on process control



Development of All-in-One Factory Automation Software (PROMONICON)

Factory Automation Expert

- **Papers, books, patents, technology transfer, and startup achievements** : Over 100 SCI papers, 2 books, 6 patent registrations, 8 technology transfers, 1 startup
- **Research and development areas** : Factory Automation Solutions, Advanced Control and Modeling, Central Control System (CMS), Recipe Management System (RMS), System Integration (SI)

Automation Experience in Key Industries

- Development, commercialization, and multi-field application of all-in-one factory automation software (PROMONICON)
- Development and mass production application of automation systems for multi-product, small-batch polymer production factories
- Development of precision control and recipe management systems for silicon single-crystal grower and mass production application
- Development and mass production application of Air-Knife automatic control system for galvanizing processes
- Approximately 35 years of experiences in developing and applying numerous advanced control logic and automation systems

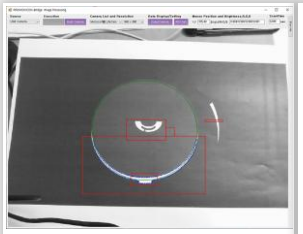
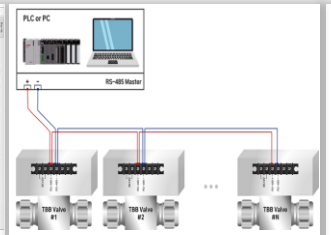
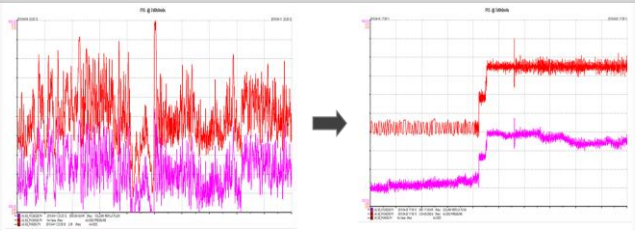


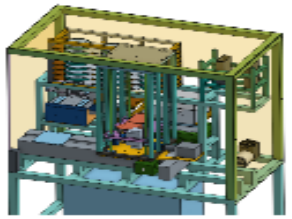
Image Analysis



TBB Control Valve



Tuning petrochemical process controllers



Special Robot Fabrication



Automation of multi-product, small-batch polymer processes

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Main Product

PROMONICON (Process Monitoring and Control)

Easy Configuration, Advanced Functions, and Open Connectivity

PROMONICON is an **all-in-one automation software** that provides from basic to advanced functions, required for developing automation systems.

ALL-IN-ONE AUTOMATION SOFTWARE

PROMONICON

Interface	SCADA/HMI	Advanced Control Logics	Sequence Control
Signal Processing	Image Processing	Simulator	Optimization

PROMONICON

Features

TBB PROCESS AUTOMATION



Open Connectivity

Compatible with a wide array of devices and systems such as PLC, DCS, SCADA, inverters, MES, etc.

Basic SCADA Features

Control functions, process diagram, real-time graph, alarming, data storage, reporting, and remote operation, etc.

Advanced SCADA Features

Image processing, advanced controllers, virtual processes, etc. to extend SCADA capabilities

Flexible Development Environment

Useful to develop complex control logics to meet your specific requirements

Online Implementation of Logics/Scripts

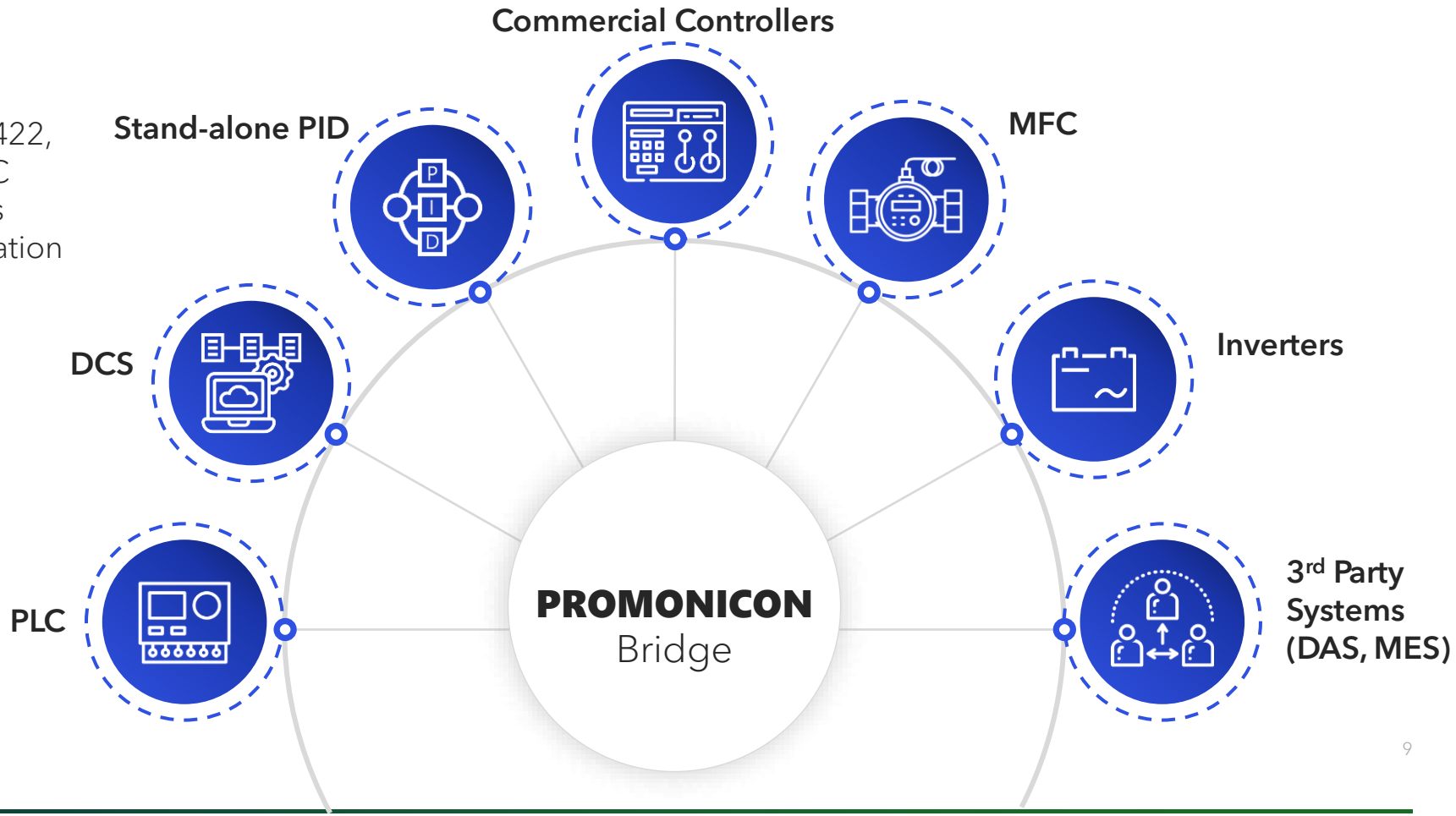
Useful to add, modify, or delete operation/control logics in an online manner and without aborting the system

Open Connectivity

With PROMONICON, it is easy to connect your automation system to many kinds of automation devices such as PLC, DCS, SCADA, stand-alone PID, commercial controllers, MFC, inverter, and third-party systems like data acquisition system (DAS) and manufacturing execution system (MES).

PROMONICON supports many kinds of communication types like OPC, RS232C (RS422, RS485), UDP/IP, TCP/IP, file in/out, and ODBC (Open Database Connectivity). Also, it allows users to implement user-defined communication protocols.

With open connectivity, PROMONICON streamlines data exchange, enhancing the efficiency of your automation systems.



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01 Process Diagram
02 Graph
03 Reporting
04 Data Logging
05 Remote Operation Concept

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Basic SCADA Features

Conventional Control Functions

PROMONICON includes control functions such as PID control, split-range control, gain-scheduling, cascade control, and sequence control. These functions can be easily configured and implemented.

Graphs

Graph plots process variables in a real-time manner. Users can easily add or remove lines and set the properties such as axis scales, data to be displayed, y axis (left/right), line thickness/color, and legend (title/position).

Alarming

Alarms can be easily configured to ensure timely notifications of process abnormalities.

Report

PROMONICON can easily generate reports manually or automatically in Excel format.

Remote Operation

PROMONICON allows operators to access to remote process monitoring and control systems through Ethernet or Internet.

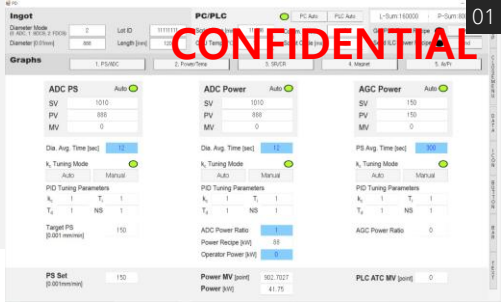
Data Logger

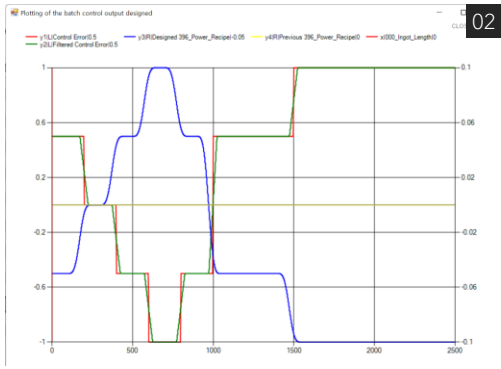
Data logger can be implemented both manually and automatically. Automatic data logging can be executed through ‘Script Programming’ or ‘Sequence Control’.

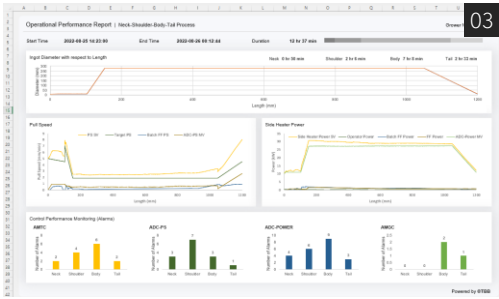
Process Diagram

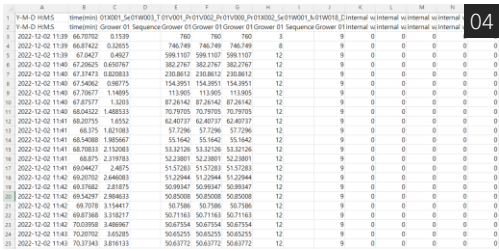
A kind of HMI (Human-Machine Interface) that allows operators to monitor the status and operate the process. It is easy for users to configure the diagram with a variety of functions such as:

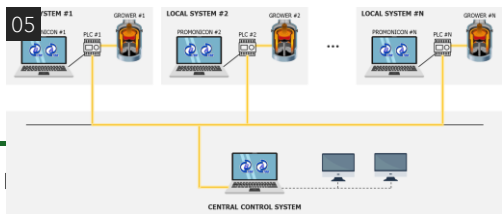
- Loading the background process diagram images
- Displaying current status of the automation system in the forms of data link, icon, and progress bar
- Directly setting process variables by clicking data links
- Executing script programs by clicking buttons











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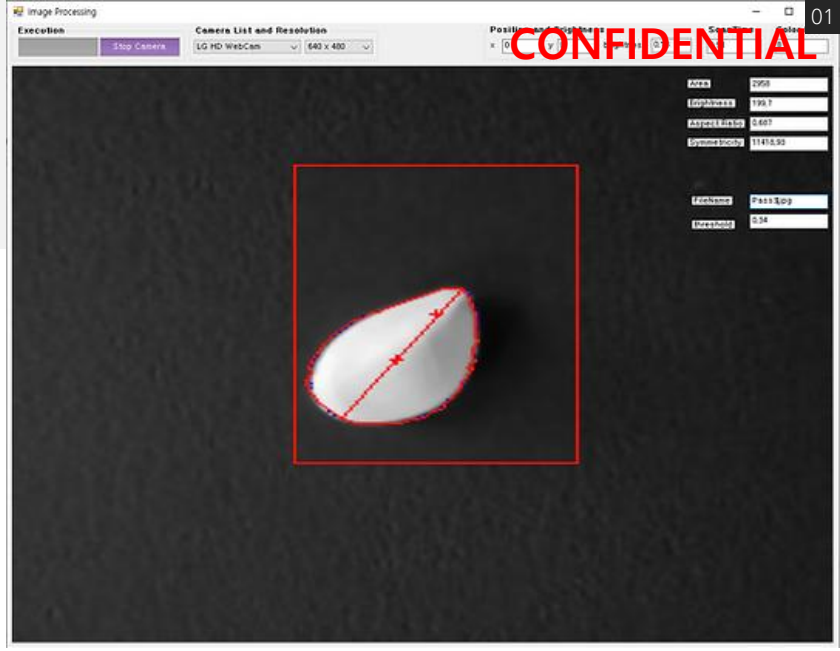
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Advanced SCADA Features

Image Processing

PROMONICON provides the image processing module, which takes the images of an object and extracts useful data from the images.

01

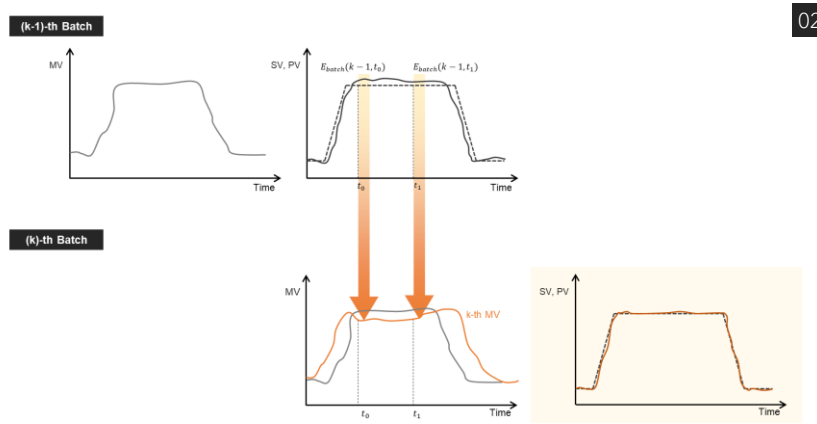


Advanced Control Functions

PROMONICON supports advanced control techniques such as:

- PID auto-tuning
- PIDA (PID-Acceleration) control, Two-SV PIDA control, TBB0 advanced control, cascade anti-windup
- Iterative Learning Control (ILC) and Run-to-Run(R2R) for advanced batch control
- Model Predictive Control (MPC), Recipe-based Control
- Process optimization based on successive LP (Linear Programming)

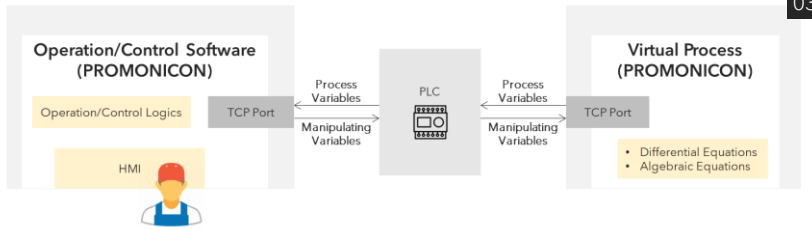
02



Virtual Process

With PROMONICON, you can build virtual processes (which are based on transfer functions or operation data), which can be linked to operation/control logic. It is useful to debug and validate operation/control logics, or to construct model-based controllers. Also, this module can be applied to develop an OTS (Operator Training System).

03



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Advanced SCADA Features

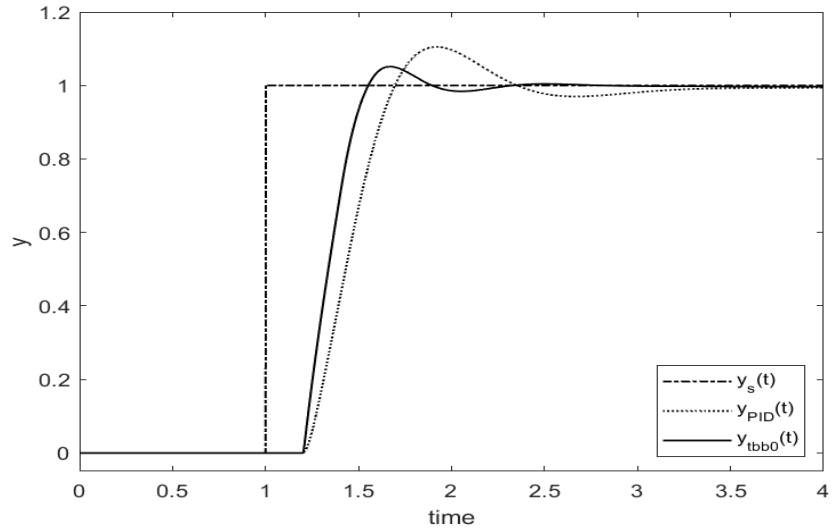
Advanced Control Functions

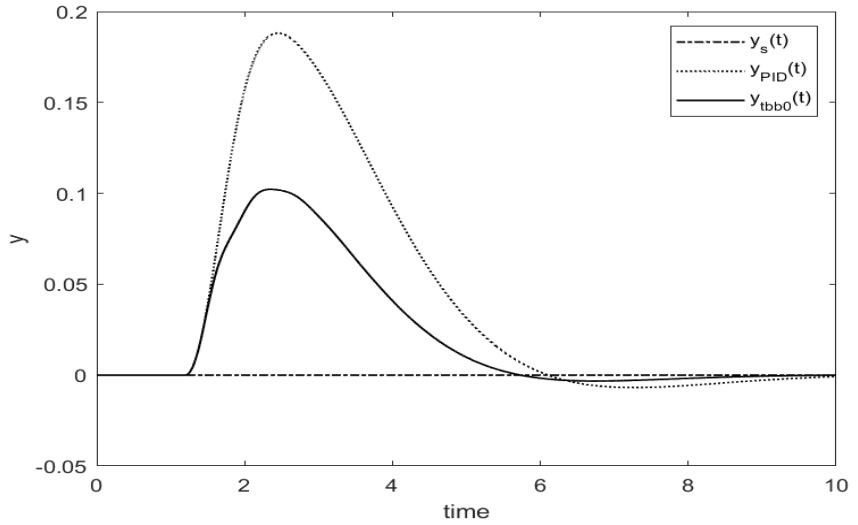
Predictive Two-SV PIDA, TBB0 Control, Model Predictive Control, Recipe-Based Control.

help_script.htm

C:/Users/PC/Desktop/P_automation_Advanced_2023_05_16/promonicon1/bin/Release/help/help_script.htm

	value of the 3-th system variable,0.1 are set to Kc,Ti,Td,ns1,ns2 for the 1-th PIDA controller. That is, $[0],$[1],&[2],$[3],0.1 directly change the tuning parameters of 1-th PIDA controller. Candidates for n is an integer value from 0 to 999. Candidates for Kc,Ti,Td,ns are $[xxx] and &[xxx].
tbb0_control|n|SV,PV,MV,AM,Min,Max,ST,Tf,ns1,ns2	Configuring the TBB0 controller n: TBB0 controller number (0 to 999), SV: set value variable, setpoint variable, PV: process variable, controlled variable, process output variable, MV: manipulated variable, control output variable, process input variable, AM: auto/manu mode variable, Min: minimum(lower) value of MV, Max: maximum(upper) value of MV, ST: sampling time (sec), Tf: time constant (sec) of the signal low-pass filter (e.g. seconds corresponding to time delay), ns1: noise-suppressing 1 (e.g., 0.05. Usually from 0.05-0.3), ns2: noise-suppressing 2 (e.g., 0.05. Usually from 0.05-0.3). For example, tbb0_control|0|$[0],$[1],&[2],$[3],0,100,$[4],5,0.05,0.05 means that the numeric value of the 0-th system variable, the numeric value of the 1-th system variable, the numeric value of the 2-th internal variable, the numeric value of the 3-th system variable,0, 100, the numeric value of the 4-th system variable, 5, 0.05 and 0.05 are set to SV, PV, MV, AM, Min, Max, ST, Tf, ns1, ns2 for the 0-th TBB0 controller. If the second order plus time delay model (T: time constant(min), X: damping factor, D: time delay(min)) is given, Tf (sec) is recommended as follows: R=D/T Tf0=T*(0.5059*R^3 - 0.964*R^2 + 0.6246*R + 0.0121) for R<0.7 Tf0=T*(0.2*R + 0.01) for R>=0.7 WX=(-2.7254*X + 2.1797)*R + (-0.2662*X + 1.2114) for 0.05<=R<0.6 and X<0.8 WX=(5*X - 4)*R + (-5*X + 5) for 0.6<=R<1.0 and X<0.8 WX=1 for X>=0.8 Tf=60*Tf0*WX Candidates for n is an integer value from 0 to 999. Candidates for SV, PV, MV, AM are $[xxx] and &[xxx]. Candidates for Min, Max, ST, Tf, ns1, ns2 are numeric value, $[xxx] and &[xxx].
tbb0_tune1|n|K,T,X,D|Kc1,Ti1,Td1,Ta1|Kc2,Ti2,Td2,Ta2	Tuning method of the TBB0 controller n: TBB0 controller number (0 to 999), K: process gain, T: time constant(min), X: damping factor, D: time delay(min), Kc1: proportional gain 1, Ti1: integral time(sec) 1, Td1: derivative time(sec) 1,Ta1: acceleration time(sec) 1, Kc2: proportional gain 2, Ti2: integral time(sec) 2, Td2: derivative time(sec) 2,Ta2: acceleration time(sec) 2. tbb0_tune1|n|K,T,X,D|Kc1,Ti1,Td1,Ta1 |Kc2,Ti2,Td2,Ta2 is to provide the tuning parameters (Kc1,Ti1,Td1,Ta1 |Kc2,Ti2,Td2,Ta2) of the n-th TBB0 controller on the basis of the second order plus time delay model(K,T,X,D). For example, tbb0_tune1|1|$[0],$[1],1.0,$[3]\|&[0],&[1],&[2],&[3] \|&[5],&[6],&[7],&[8] means that the numeric value of the 0-th system variable, the numeric value of the 1-th system variable, 1.0, the numeric value of the 3-th system variable are set to K,T,X,D(model parameters of the second order plus time delay model). Then, tbb0_tune1\|1\|$[0],$[1],1.0,$[3]|&[0],&[1],&[2],&[3] |&[5],&[6],&[7],&[8] will automatically calculate the tuning parameters of the 1-th TBB0 controller and the parameters calculated will be set to the numeric values of the 0,1,2,3,5,6,7,8-th internal variables. That is, the tuning results are the numeric values of the 0,1,2,3,5,6,7,8-th internal variables. Be careful that the tuning results do not change the tuning parameters of TBB0 controller. Use tbb0_tune2|n|Kc1,Ti1,Td1,Ta1|Kc2,Ti2,Td2,Ta2 to change the tuning parameters of TBB0 controller. Note that tbb0_tune1 calculates the tuning parameters only when the parameters (K,T,X,D) of the second order plus time delay model change. Candidates for n is an integer value from 0 to 999. Candidates for Kc1,Ti1,Td1,ns1,Ta1, Kc2,Ti2,Td2,Ta2,ns2 are $[xxx] and &[xxx]. Candidates for K,T,X,D are numeric value, $[xxx] and &[xxx].
tbb0_tune2|n|Kc1,Ti1,Td1,Ta1|Kc2,Ti2,Td2,Ta2	Direct setting the tuning parameters of the TBB0 controller n: TBB0 controller number (0 to 999), Kc1: proportional gain 1, Ti1: integral time 1 (sec), Td1: derivative time 1 (sec),Ta1: acceleration time 1 (sec), Kc2: proportional gain 2, Ti2: integral time 2 (sec), Td2: derivative time 2 (sec),Ta2: acceleration time 2 (sec). For example, tbb0_tune2|1|$[0],$[1],&[2],$[3] \|$[10],$[11],&[12],$[13] means that the numeric value of the 0-th system variable, the numeric value of the 1-th system variable, the numeric value of the 2-th internal variable, the numeric value of the 3-th system variable, the numeric value of the 10-th system variable, the numeric value of the 11-th system variable, the numeric value of the 12-th internal variable, the numeric value of the 13-th system variable are set to Kc1,Ti1,Td1,Ta1,Kc2,Ti2,Td2 for the 1-th TBB0 controller. That is, $[0],$[1],&[2],$[3] \|$[10],$[11],&[12],$[13] directly change the tuning parameters of 1-th TBB0 controller. Candidates for n is an integer value from 0 to 999. Candidates for Kc1,Ti1,Td1,Ta1, Kc2,Ti2,Td2,Ta2 are numeric value, $[xxx] and &[xxx].



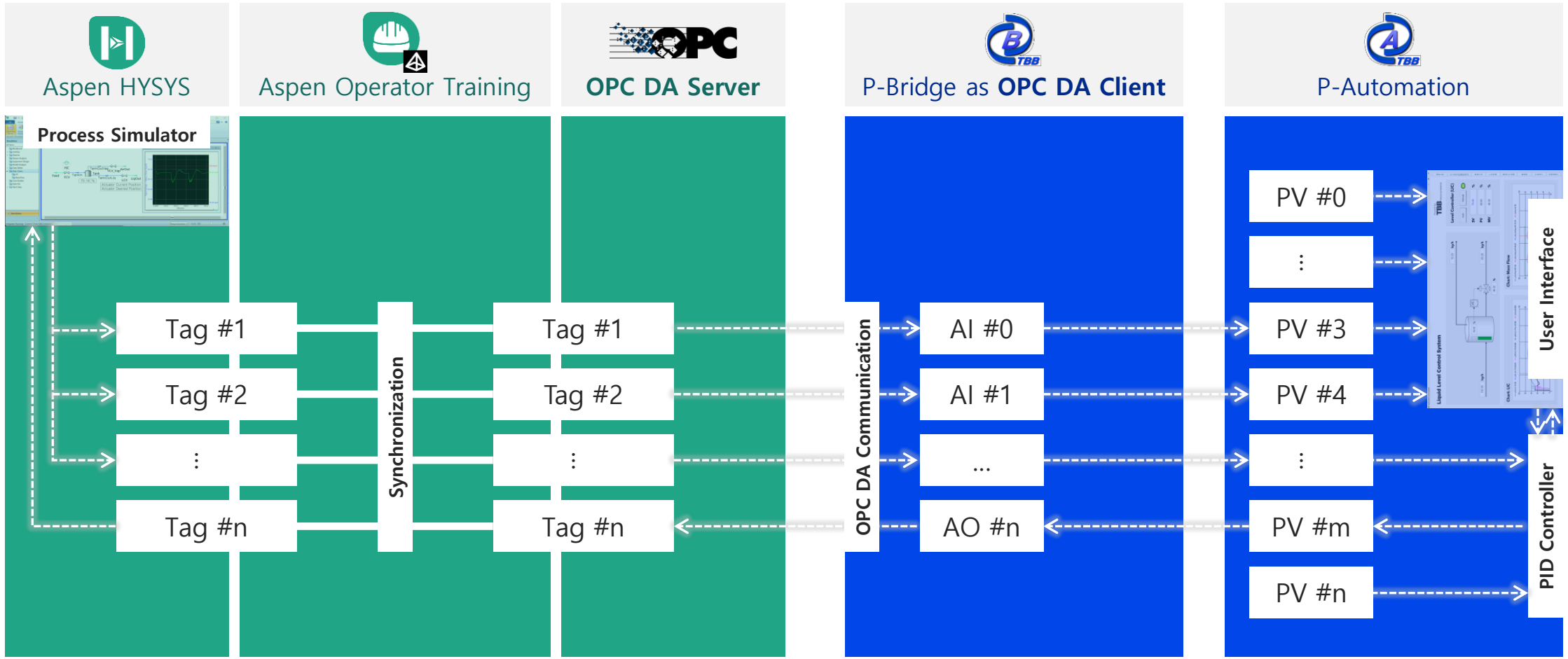


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Advanced SCADA Features

Virtual Process Based On HYSYS

We can build virtual processes(digital twin) with a rigorous process simulator (HYSYS) connected to PROMONICON through OPC.

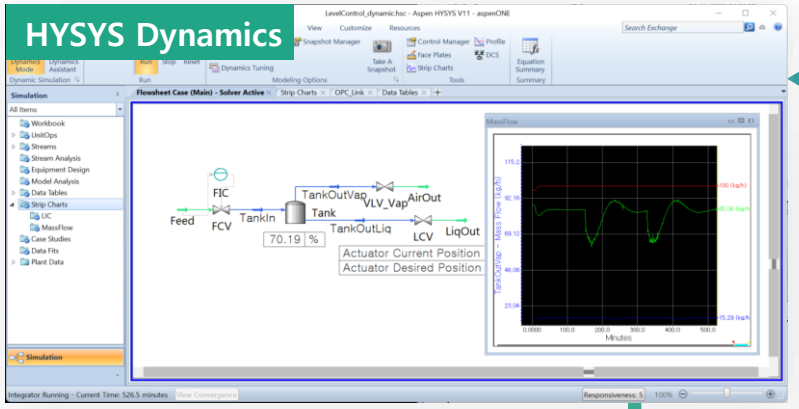


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Advanced SCADA Features

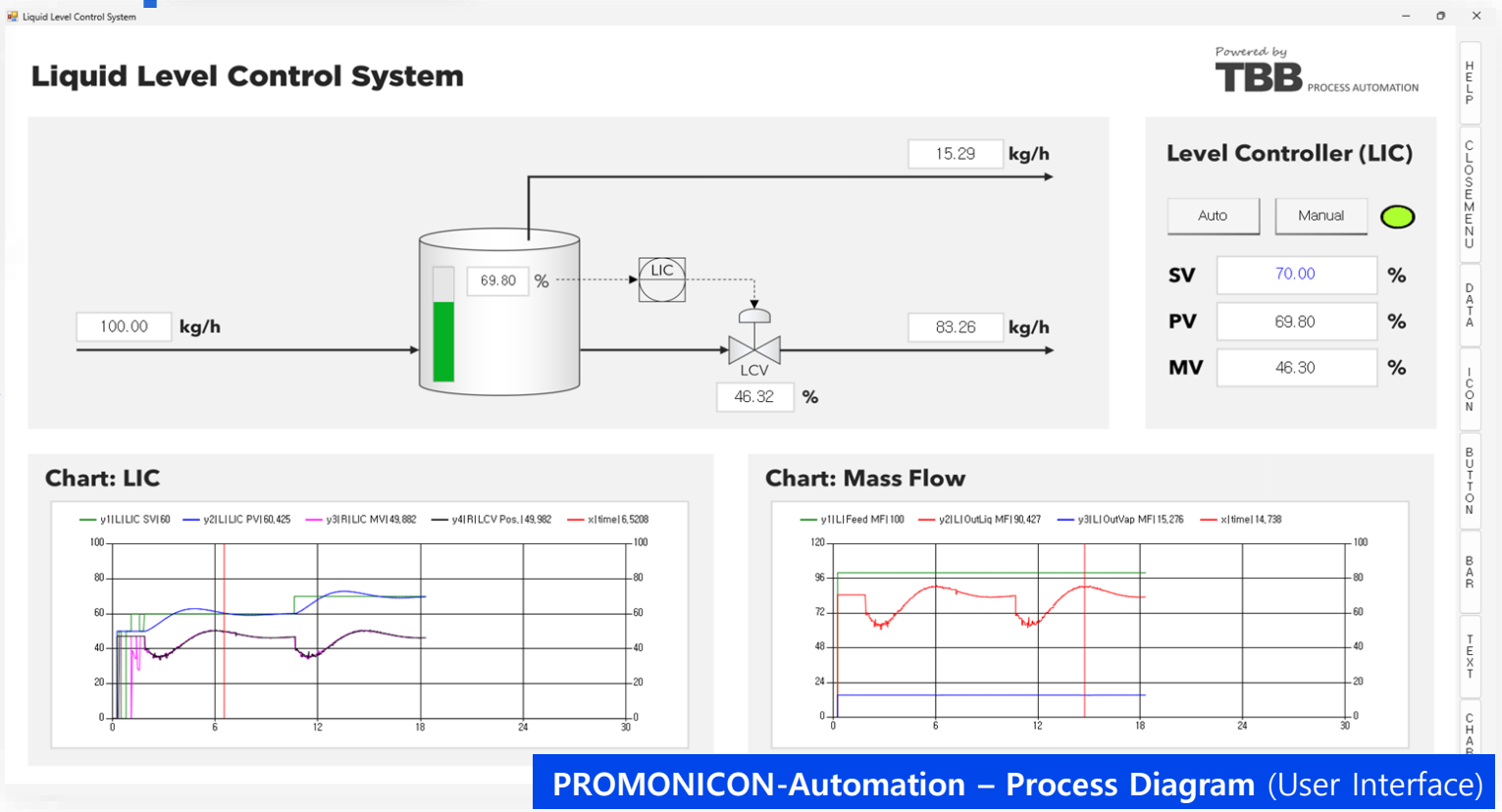
Virtual Process Based On HYSYS

We can build virtual processes(digital twin) with a rigorous process simulator (HYSYS) connected to PROMONICON through OPC.



Analog Output Data

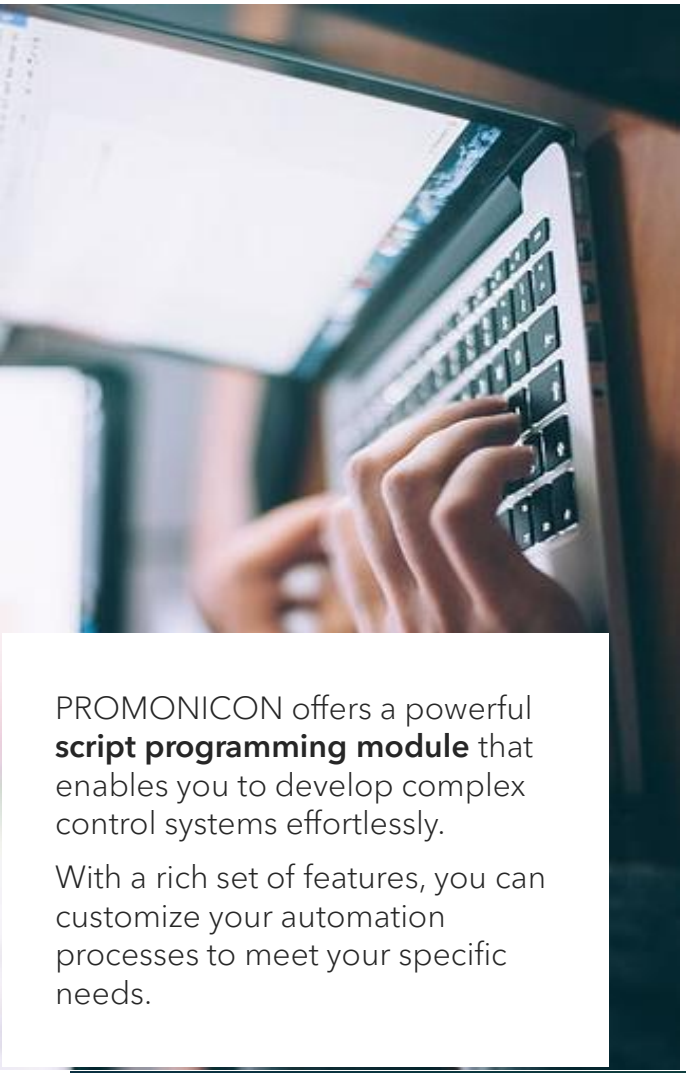
Analog Input Data



PROMONICON-Automation – Process Diagram (User Interface)

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Flexible Development Environment



PROMONICON offers a powerful **script programming module** that enables you to develop complex control systems effortlessly.

With a rich set of features, you can customize your automation processes to meet your specific needs.

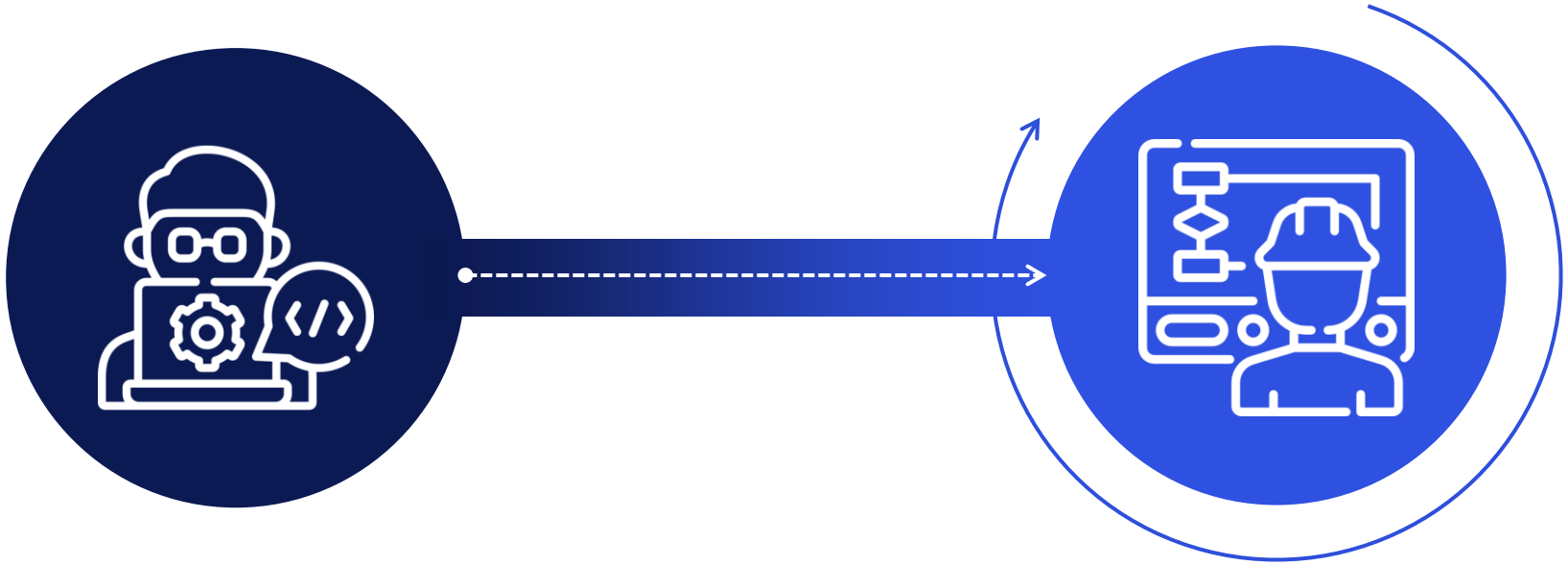
Math Functions	power, trigonometric, logarithm, square root, exponential, min/max, sign, round off/up/down, etc.
Arithmetic/Comparison/Logical Operators	+, -, *, / >, <, <=, >=, ==, != and, or
Control Structures	if statement, loop statement
Integral Function	useful to solve differential equations and construct model-based controllers
Time Delay	useful to delay a signal and construct model-based controllers
Interpolation	useful for gain-scheduling of PID controllers and designing operation scheduling
Importing/Exporting Data from/to csv file	useful to import and export data from/to csv files
Resolution Enhancers	PWM (Pulse-Width-Modulation), DSM (Delta-Sigma-Modulation), and dither functions to overcome low resolution problems of actuators
Signal Filters	low-pass, average, median, std, and polynomial filters to remove noises and disturbances
PID Controller Applications	nonlinear gain-scheduling, setpoint scheduling, and auto/manual scheduling
Model-Based Advanced Controller	advanced control logic implementation on the basis of process models such as Iterative Learning Control (ILC), Model Predictive Controllers (MPC), Smith predictor, Internal Model Control (IMC), Recipe-Based Control etc.
Sequence Control	useful to implement large-scale and complex sequence logics

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Online Implementation of Logics/Scripts

In PROMONICON, you can **add/modify/delete operation/control logics in an online manner**. For examples, there is no need to abort PROMONICON to update the following items:

- Communication with automation devices
- PID controllers
- Scripts
- Process diagrams
- Graphs
- Variable attributes
- Data storage settings
- ...



Online Modification

In Operation

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Differences between PROMONICON and Other SCADA Products

	Other SCADA Products*	PROMONICON
Interface	Compatible with only their own PLC and OPC	Supports communication interfaces with typical PLCs as well as general communication interfaces like OPC, TCP, UDP, and serial comm. with various kinds of automation devices (e.g., inverters, sensors, actuators, controllers, etc.).
HMI Implementation	Only offline HMI implementation	Supports easy HMI implementation in both offline and online manners.
Control Logics	No control logics	Provides basic/advanced control functions: industrial PID/PIDA control, TBB0 control, Iterative Learning Control (ILC), cascade control, gain-scheduling, feedforward control, recipe-based control, model-based control, controller parameters tuner, (cascade) anti-windup, and TBB0 advanced control.
Sequence Logics	No sequence logics	Provides a specialized sequence logic module.
Basic (low-level) Script Programming	Only low-level script coding (based on, such as C, Basic)	Provides low-level script coding (e.g., arithmetic/comparison/logical operators, if and loop statements) and various math functions.
Advanced (high-level) Script Programming	No high-level script coding using advanced functions	Provides many advanced functions (e.g., resolution enhancers, signal filters, transfer function, integral/derivative/delay operator, bits manipulation, interpolation, HMI control, reporting, data storage control, variable initialization, .csv importing/exporting, etc.).
Image Processing	No image processing modules	Provides the image processing module (e.g., image capturing, ROI setting, edge detecting, object (blob) detecting, curve/straight line detecting, circle detecting, similarity measuring, white balancing, RGB-to-grey converting, characteristics value extraction).
Simulation	No simulation modules	Supports various simulation works for operator training systems and virtual processes. (related functions: transfer function, integral, derivative, various math functions, time-delay, etc.)
Optimization	No optimization modules	Provides successive LP (Linear Programming) solver.
Connection to User-made .exe Programs	No connection to user-made .exe programs	Supports easy connection to user-made .exe program with file input-output or typical communication interfaces.
License	Subscription-based license with maintenance fees	Provides permanent license without maintenance/upgrade costs after one-time purchase.

*WinCC, InTouch, Factory talk, Autobase, etc.

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Representative Automation Cases by Industry

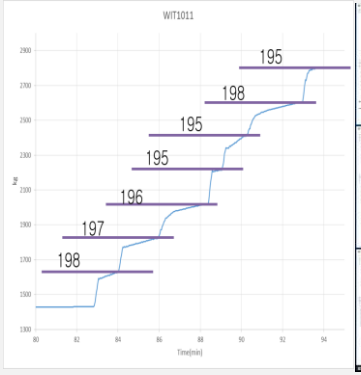
Automation of Multi-Product Polymer Production Plants (Weighing Weight)

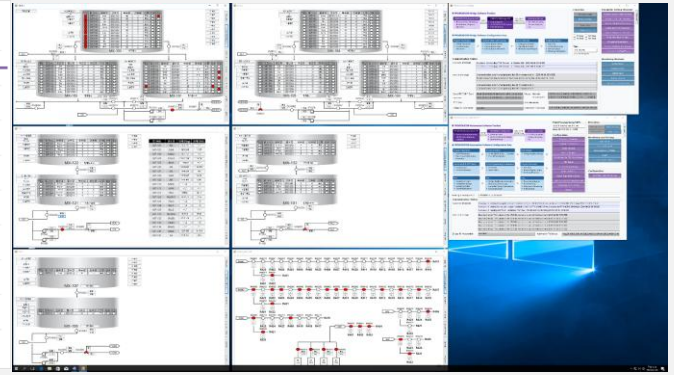
TBB PROCESS AUTOMATION











- Long-Distance Connectivity: Fiber optic cables seamlessly bridge the 300m gap between the PLC CPU and the reaction building's I/O cards.
- High-Capacity I/O System: Manages ~1,200 I/O points with an optimized communication design that processes data within 1 second.
- High-Accuracy Weighing: Combines RS-485 communication for precise load cell data with a hybrid control loop (On/Off Valve + PWM + P-Controller + Limiter).
- Exceptional Accuracy: Limits maximum error to under 2.5 kg through automated offset adjustments.
- Dynamic Response Control: PWM + On/Off valves enable precise convergence speed adjustment.
- Rapid Cycle Times: Complete weighing cycles finish within ~2 minutes, with parameter tuning available to shorten times further.
- Mass Customization: An automated raw material weighing system drives the production of over 100 multi-product polymer grades.
- Automated Documentation: Instant, automatic generation of weighing reports for quality assurance.

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Automation of Multi-Product Polymer Production Plants (Reaction)

TBB PROCESS AUTOMATION



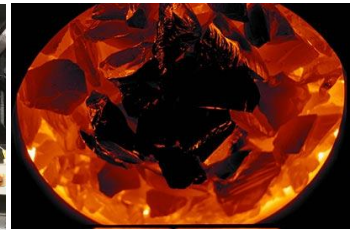
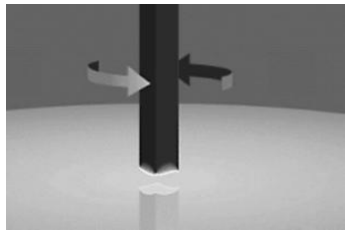
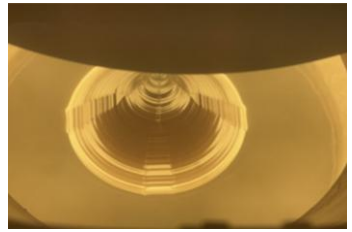
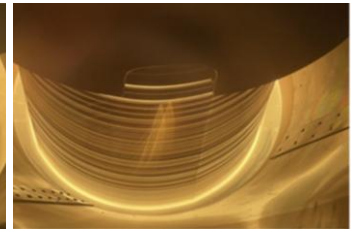
- High Availability: Built on a Redundant PLC architecture to ensure zero downtime.
- Robust Networking: Features high-speed TCP/IP communication between the PLC and PROMONICON.
- Reliable Drive Control: Utilizes RS-485 communication for seamless data flow between the PLC and inverters.
- High-Capacity Processing: Manages ~1,700 I/O points with an optimized design that processes data within 1 second.
- Precise temperature control with on/off valve + PWM + PID controller.
- Approximately 1700 I/O points (optimized communication design processing within 1 second).
- Ultra-Precise Control: Achieves high-precision automatic control of process variables—completely overcoming the limitations of manual operations.
- Thermal Management: Delivers tight, precise temperature control via a hybrid On/Off Valve + PWM + PID controller loop.
- High-Efficiency Scaling: Near-100% automation empowers just two operators to simultaneously manage 23 polymer reactors for mass production.

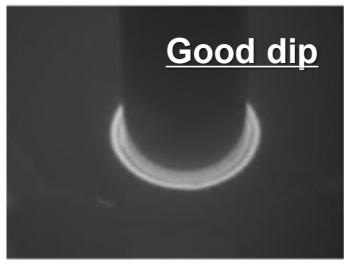
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ACS(Advanced Control System) for CZ Process

TBB PROCESS AUTOMATION

✓ CZ Process sequence

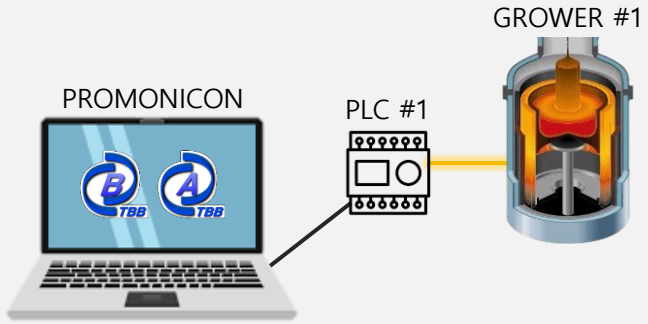
Vacuum	Melting	Stabilization & Dipping	Necking	Crown/Shoulder	Body Growth	Tailing
						
A process to remove oxygen and moisture inside the grower and check for air leaks in the grower before the high-temperature process.	A process to melt high-purity solid silicon into a liquid by applying heat in a crucible in a vacuum atmosphere.	A process to adjust the temperature of the silicon melt to a target temperature near the silicon solidification point and bring seed into contact with the surface of the molten silicon.	A process to eliminate dislocations that might form due to thermal shock or lattice mismatch at the seed-melt interface by pulling the seed upward to a small diameter.	A process of transition from the thin neck to the wider, full-diameter. (tapered, dome-like portion)	A process to make the cylindrical portion of an ingot, which constitutes the bulk of the usable silicon crystal. (the constant diameter and the longest section.)	A process to taper off an ingot diameter gradually, to avoid thermal shock and cracking that could occur if the large-diameter body were abruptly separated from the melt.

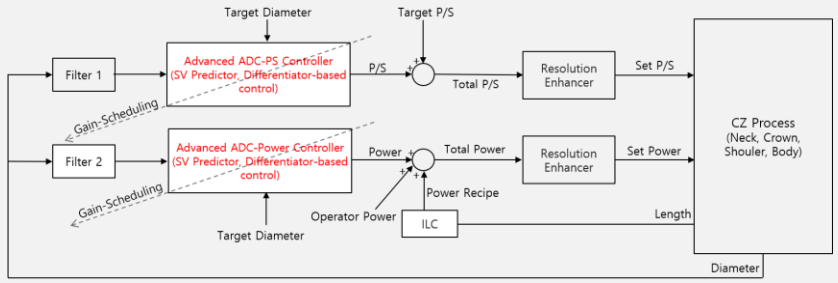


When the seed is in contact with the molten silicon surface, a brightly shining meniscus is created at the boundary, and the shape of the meniscus changes according to the temperature of the molten silicon. Before starting seed pulling, it is necessary to optimize the temperature conditions of the molten silicon. This means that the central temperature of the molten silicon is as close as possible to the target value and the minimum temperature change of the molten silicon in this state, and it can be judged by looking at the shape of the meniscus. When the shape of the meniscus corresponding to the optimal temperature conditions of the molten silicon is secured, it is called a good dip.

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ACS(Advanced Control System) for CZ Process





ACS control logics
- Set point predictor and differentiator-based control
- Run to Run (R2R) advanced control logic based on previous run data
- Resolution enhancer, power control, Iterative Learning Control (ILC), signal filter, gain scheduling

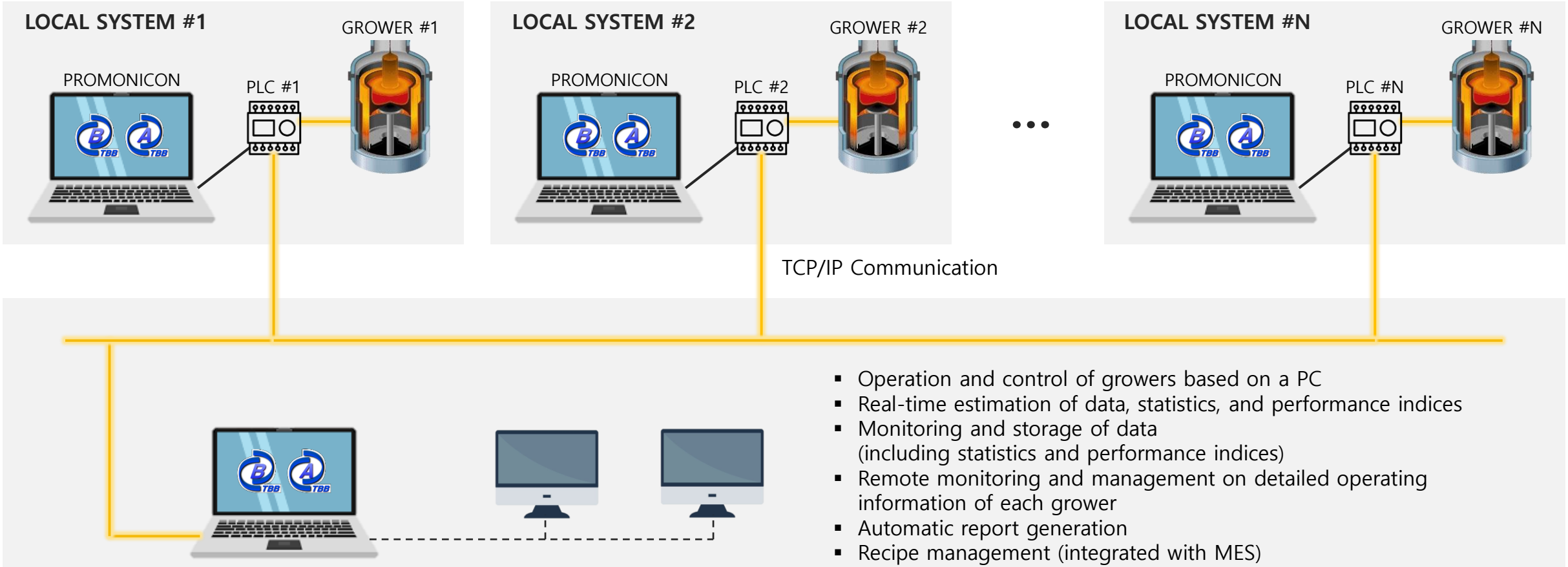
Pulling speed control case
- 2hr average pulling speed deviation under +-0.003mm/min (after 100mm ingot length)
- Instantaneous diameter deviation under +-0.5mm (after 100mm ingot length)
- Instantaneous power deviation under about 0.5 kW

Fixed pulling speed case (Top-tier Performance)
- Instantaneous pulling speed deviation is 0.000 mm/min (after 100mm ingot length)
- Instantaneous diameter deviation under +-0.7mm (after 100mm ingot length)
- Instantaneous power deviation under about 1.0 kW

Application
- Domestic customers : Company S and 8 other companies
- Foreign customers: Company Z and 3 other companies

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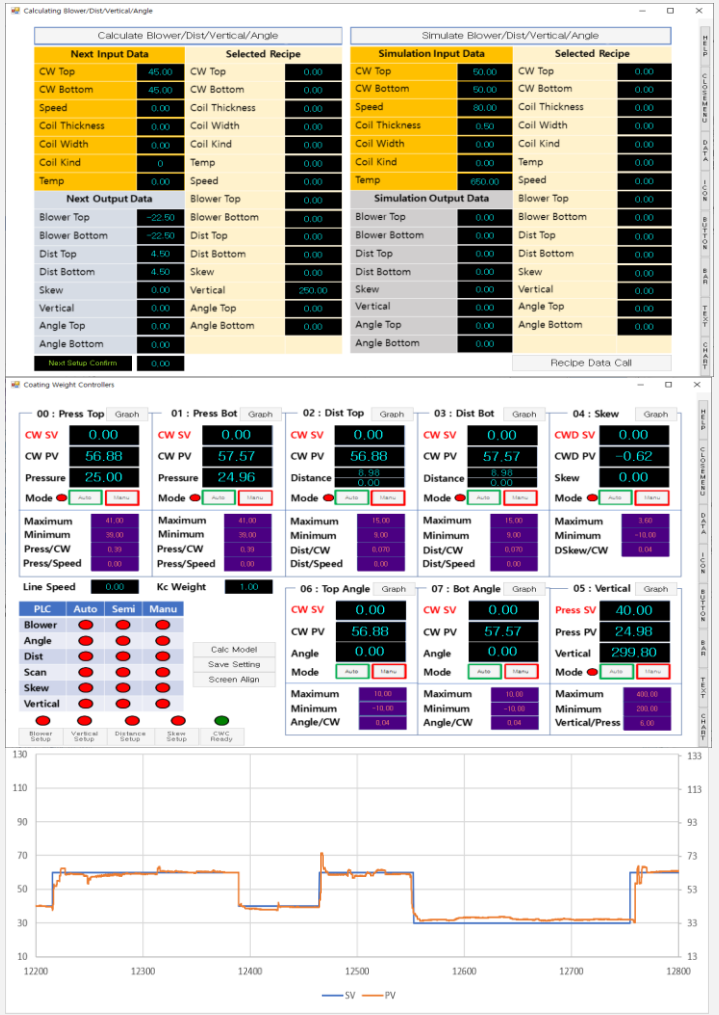
Central Monitoring/Recipe Management System



- Operation and control of growers based on a PC
- Real-time estimation of data, statistics, and performance indices
- Monitoring and storage of data (including statistics and performance indices)
- Remote monitoring and management on detailed operating information of each grower
- Automatic report generation
- Recipe management (integrated with MES)
- Application: Taiwan W Inc. – 3000+ tags for RMS, 300+ data tags/grower, 3000+ alarm tags/grower for CMS

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CWC (Coating Weight Control) System for Zinc Plating Process



1. Recipe-Based AI Control Logic

- Predictive Defect Prevention: Prevents early-stage defects by accurately controlling coating thickness in unmeasured zones.
- Comprehensive Inputs: Target coating weight, steel plate thickness/width, temperature, line speed, etc.
- Multi-Axis Outputs: Blower pressure, distance, height, angle, and skew.
- Pre-Deployment Simulation: Validates and tests control logic via simulation before live application.
- Smart Maintenance: Features automated, continuous recipe updates.

2. Feedback Control Logic

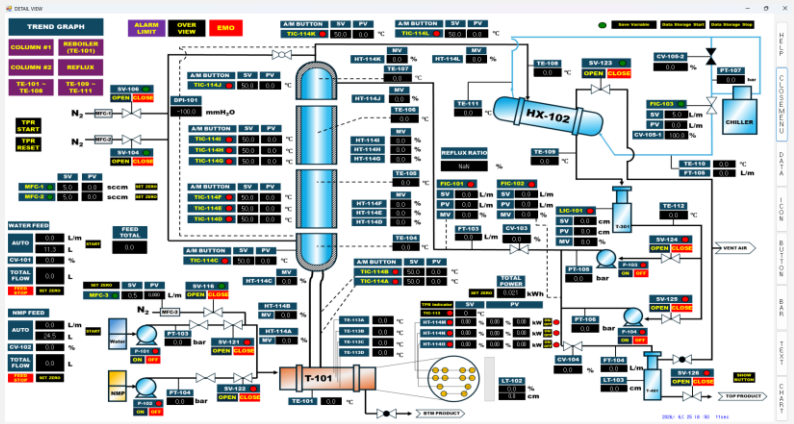
- Real-Time Quality Assurance: Delivers precise coating thickness control within measured zones to eliminate defects and prevent costly over-coating.
- Targeted Inputs: Target coating weight and real-time coating thickness measurements.
- Dynamic Outputs: Continuous optimization of blower pressure, distance, height, angle, and skew.

3. Proven Application Cases

- Strategic Partnership: Co-developed and integrated with Company C, a leading Air Knife equipment manufacturer.
- Domestic Success: Successfully deployed at Company A's domestic manufacturing plant.
- Global Expansion: Scheduled for deployment at production facilities in Vietnam and Russia.

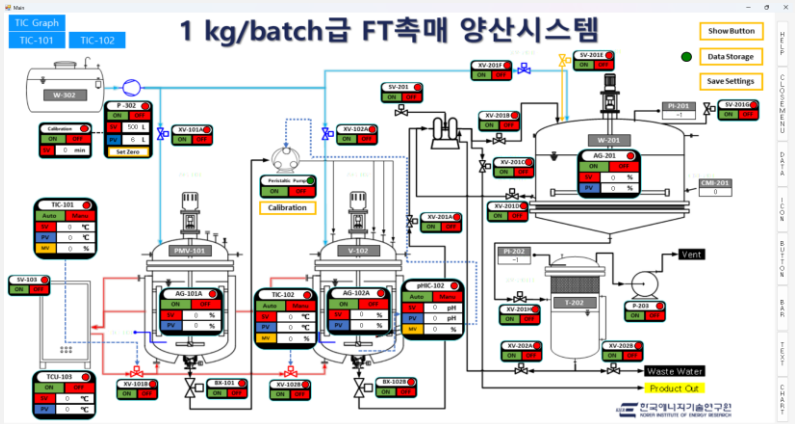
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Carbon Neutrality Demonstration Tasks



Challenges of reboiler electrification transition for carbon neutrality

- Multi-Year Project Led by Korea Institute of Energy Technology.
- Pilot-scale process automation and precision control.
- Application of TBB high-precision control valve.
- Advanced control logic applied (TBB0 Controller).
- Development of image processing-based soft sensors and program registration.

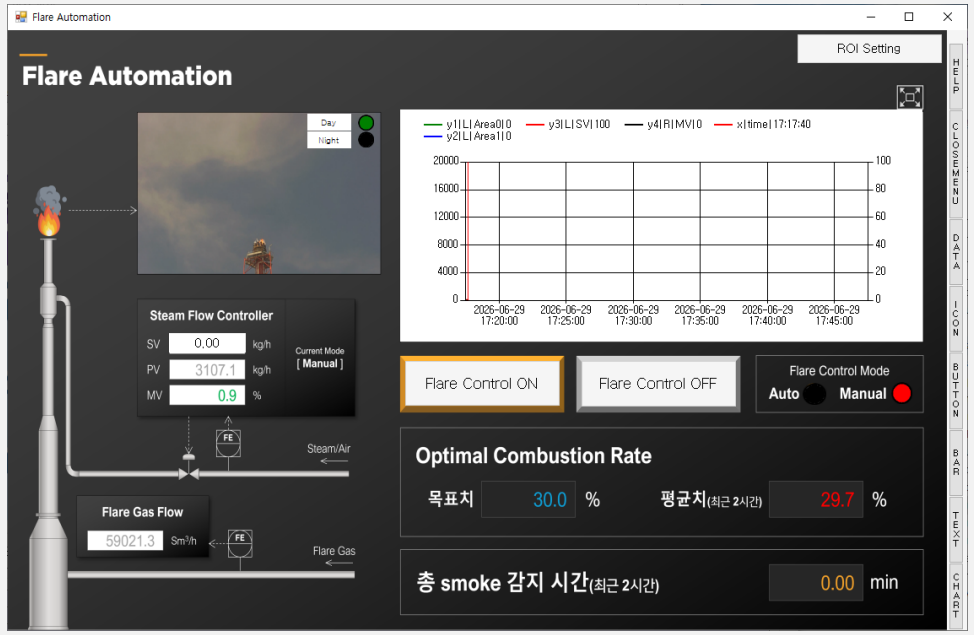


Carbon capture and fuel conversion for carbon neutrality

- Multi-Year Project Led by Korea Institute of Energy Technology.
- Pilot-scale process automation and precision control.
- Application of TBB high-precision control valve.
- System Integration (SI): Reaction + Sampling Robot + GC Analysis + Flow Analysis + Sequence Operation + Control.

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Flare Stack Automation with Image Analysis



Current Status

- Energy Waste: Excessive steam supply leads to unnecessary energy consumption.
- Environmental Risks: Insufficient steam causes incomplete combustion, resulting in black smoke, local complaints, and legal penalties.
- Manual Reliance: Control relies entirely on the operator's subjective experience.

Improvement

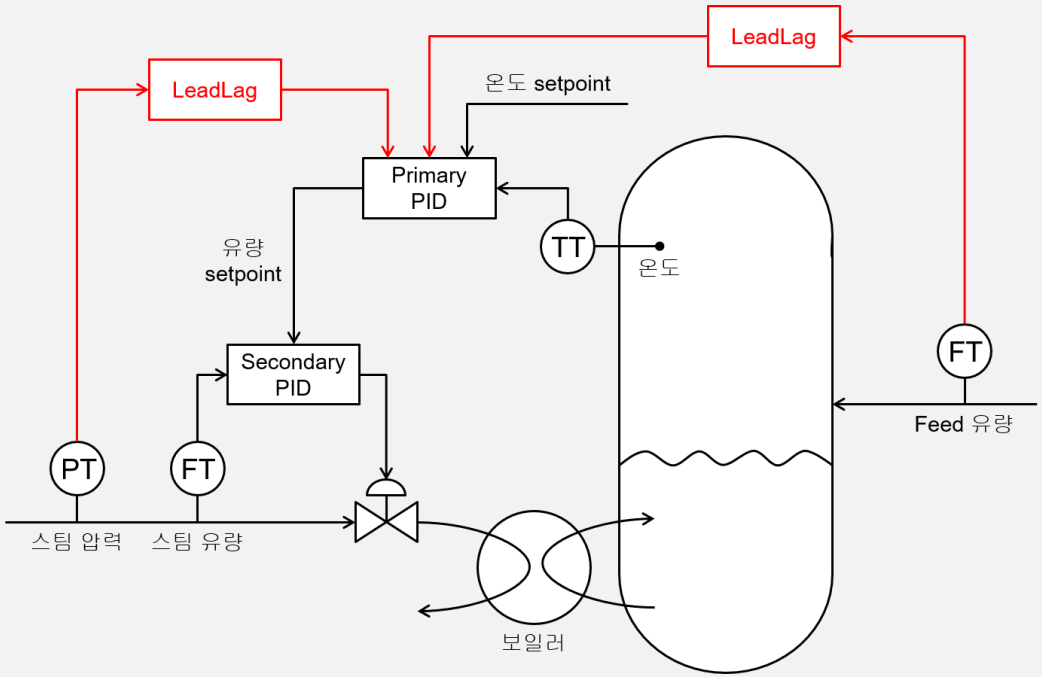
- AI Image Analysis: Real-time evaluation of steam usage appropriateness through flare image analysis.
- Automated Control: Automated adjustment of steam supply based on real-time analysis.

Case Study

- POC in Progress: Currently conducting a Proof of Concept (POC) with L Company.

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FF+FB Control for Solvent Recovery Process



Current Challenges

- Temperature Instability: Sub-optimal temperatures lead to line plugging risks, whereas elevated temperatures result in energy inefficiencies (excessive steam usage).
- FB Control Limitations: Standard Feedback (FB) control exhibits clear latency issues, failing to suppress process disturbances steming from fluctuating steam pressure and feed flow rates.

Technical Improvements

- Integrated Feedforward (FF) Control: Implemented an advanced FF control architecture to enhance responsiveness.
- Feed Flow Disturbances: Preemptively mitigates the impact of feed flow variability before it affects the process temperature.
- Steam Pressure Disturbances: Preemptively compensates for steam pressure fluctuations to maintain tight temperature control.

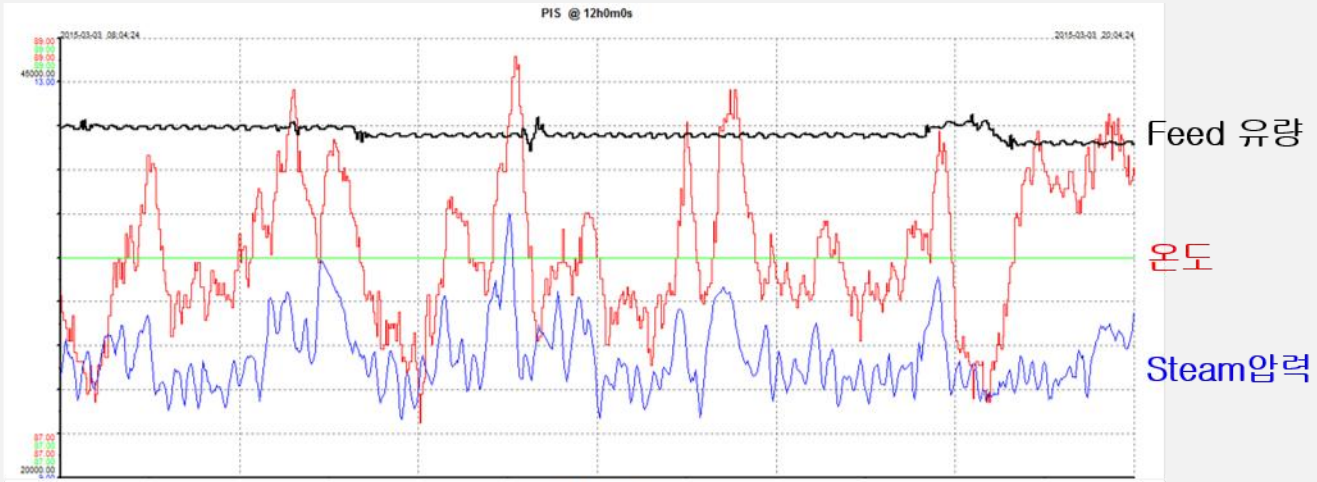
Track Record

- L Company: Deployed and validated in production environment.

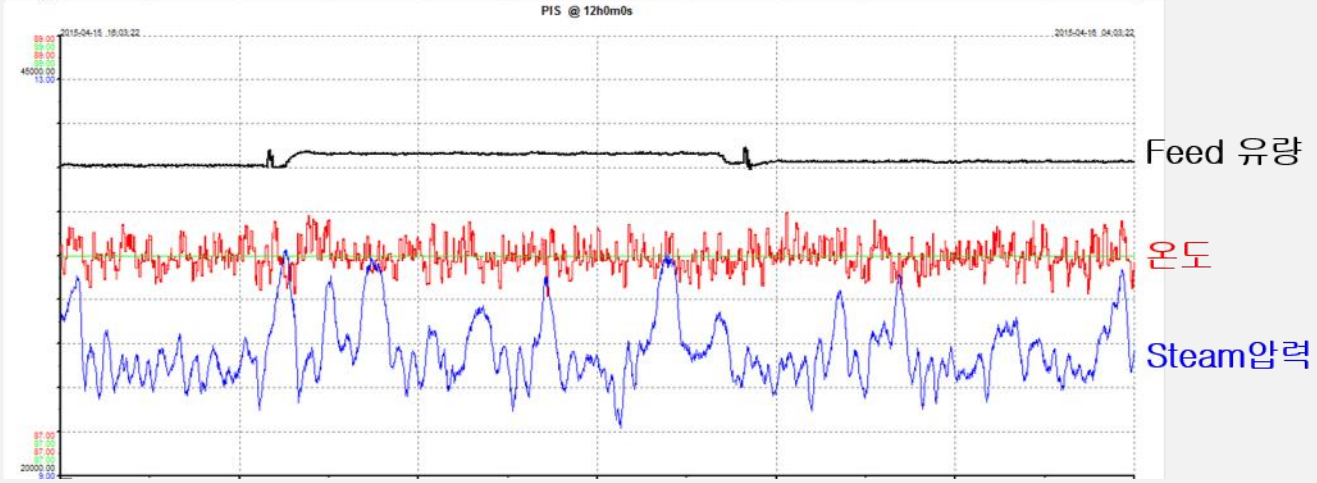
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FF+FB Control for Solvent Recovery Process

Tuning/
Feed Forward
적용 전
(±0.8°C)



Tuning/
Feed Forward
적용 후
(<±0.2°C)



Before Improvement

- Feedback Control: Preemptive response was impossible, limiting temperature control precision to a ±0.8°C deviation.

After Improvement

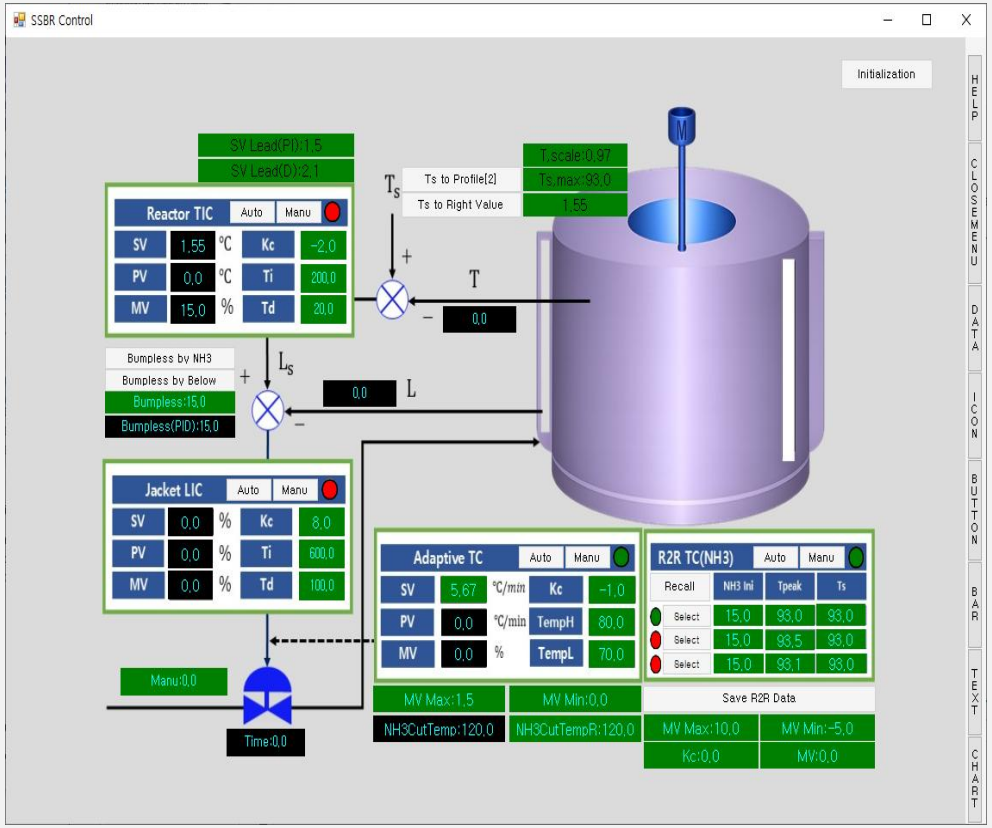
- Proactive Interventions: Implementing FF control enables proactive stabilization against steam pressure and feed flow rate fluctuations, narrowing the temperature deviation to ±0.2°C.
- Energy Savings: This enhanced control stability allows for a reduction in the target temperature, successfully lowering overall steam consumption.

Case Study

- L Company: Proven precision upgrade and energy optimization.

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Advanced Control of Polymer Batch Reactors

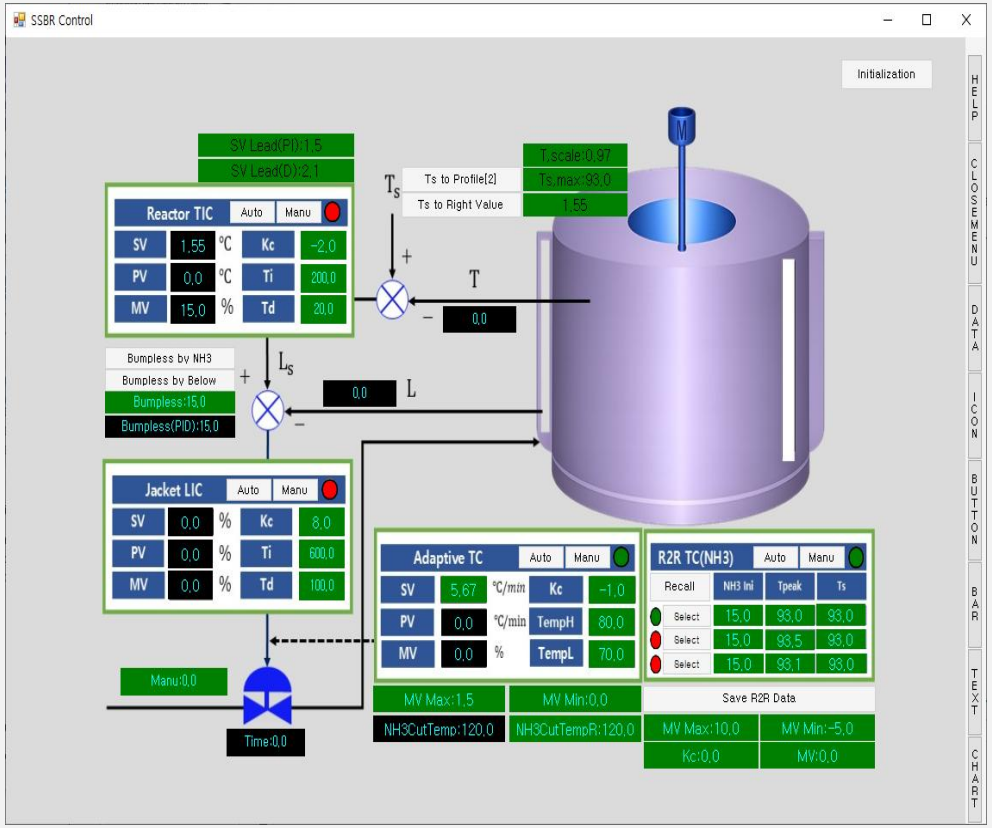


Current Challenges

- Empirical Temperature Control: Regulating reaction temperature overshoot via jacket NH3 level adjustment is performed manually, depending entirely on operator heuristic knowledge.
- Absence of Profile Integration: The existing system lacks the programmatic infrastructure to systematically incorporate the comprehensive temperature profile into control actions.
- Batch-to-Batch Disconnection: There is no structural feedback mechanism to apply learning or optimization metrics from previous runs to subsequent batches.
- Lack of Adaptive Responsiveness: The process operates without adaptive algorithms capable of responding to dynamic fluctuations in the reaction temperature rise rate.
- Inflexible Grade Transitions: Automatic recipe reconfiguration logic is absent, making product grade changes highly inefficient.

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Advanced Control of Polymer Batch Reactors



Proposed Solutions & Technical Advancements

- APC-Driven Automation: Established an Advanced Process Control (APC) framework to replace empirical operations with algorithmic automation.
- Profile-Based Trajectory Control: Implemented a profile-tracking control logic to execute actions based on the continuous temperature trajectory.
- Run-to-Run (R2R) Optimization: Deployed a robust R2R control algorithm that analyzes previous batch histories to optimize current batch parameters.
- Real-time Adaptive Tuning: Integrated an adaptive control layer that automatically compensates for changing reaction dynamics and heat generation rates.
- Preemptive Setpoint Optimization: Developed predictive control logic that intelligently mitigates overshoot before reaching the peak target temperature.
- Automated Recipe Management: Introduced automated recipe design algorithms to streamline transitions across varying product grades.

Track Record

- K Company: Successfully deployed and verified during a joint Proof of Concept (POC) phase.

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Valve Upcycling



Current Challenges

- Barrier to Automation: Raising the plant's automation rate necessitates replacing a vast inventory of conventional manual valves with automated counterparts.
- Operational & Capital Inefficiency: Standard valve replacement demands costly process shutdowns and heavy capital expenditure (CAPEX) for new automatic valves.
- Escalating Installation Costs: The requirement for extensive hardwired cabling infrastructure drives up deployment costs.

Proposed Innovation

- Actuator-Driven Valve Upcycling: A cost-effective automation method that integrates automated actuators onto existing manual valves.
- Non-Disruptive Deployment: Retains existing piping and valve bodies, entirely bypassing operational shutdowns.
- Wireless Connectivity: Features advanced wireless communication support, eliminating the need for expensive and labor-intensive cable laying.
- Economic Optimization: Minimizes both procurement expenses and financial losses from downtime, optimizing total cost of ownership (TCO).

Application Cases

- Korea Institute of Energy Technology has 2 demonstration projects, company I has completed the first phase of POC, and the second phase of the POC is underway.

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TBB Valves

High performances

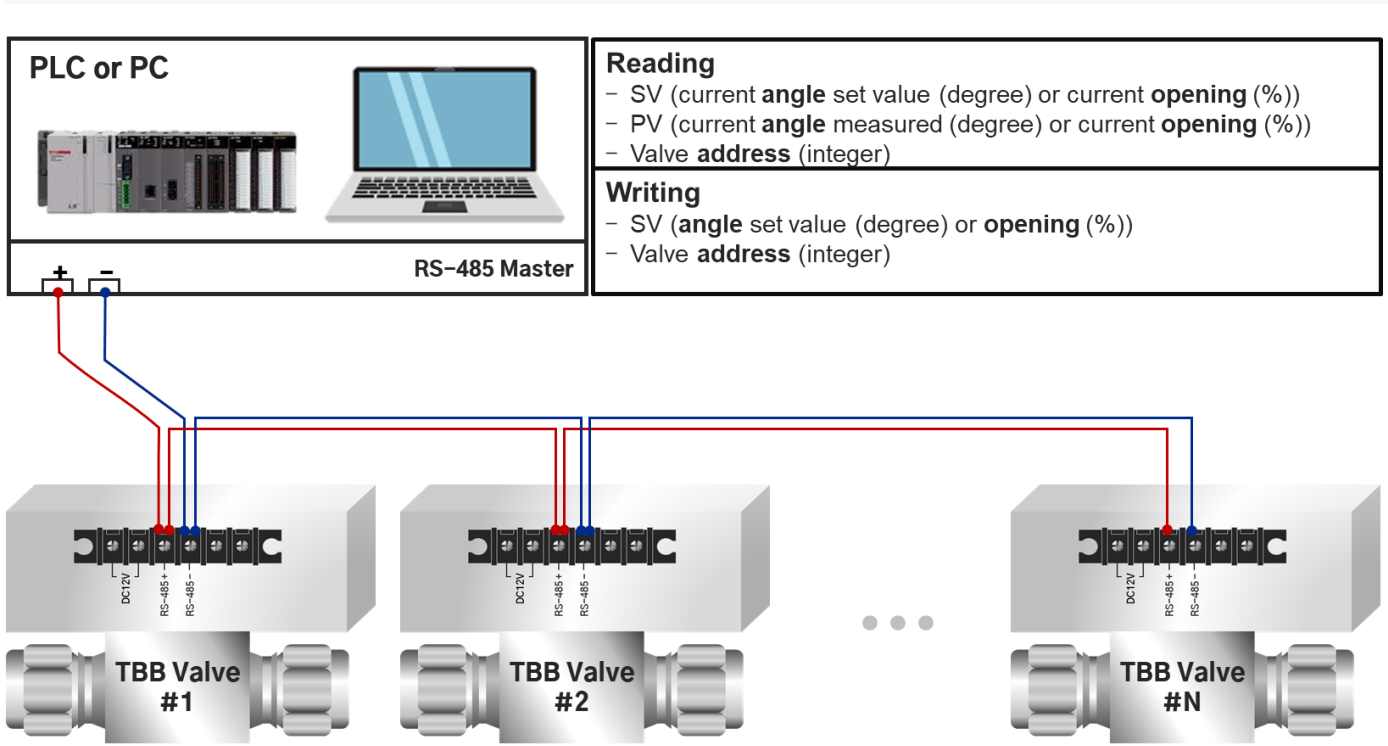
high resolution, low hysteresis, fast response time, and high accuracy by adding low-cost/high resolution encoder, resolution enhancer, specially designed control logic and Modbus RTU communication to existing manual valves.

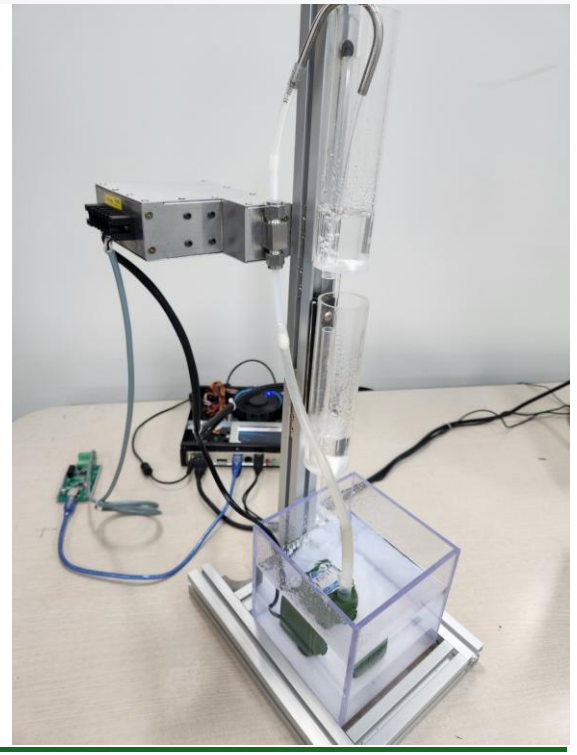
Low-Cost & Fast Delivery

For example, $500 for 1/4" control valve, within 2~4 weeks

Easy & Simple Networking

via Modbus RTU protocol





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