

PRAGMATIC AI-DRIVEN PROCESS CONTROL FOR INTELLIGENT MANUFACTURING



AI

DIGITAL

CURRENT INDUSTRY

...

- AI and analytics help manufacturers improve **efficiency**, **quality**, and **competitiveness**
- Key uses include **predictive maintenance**, **quality control**, **energy savings**, and **production planning**



AI ADOPTION

- Most AI solutions analyze historical data offline rather than control processes in real time
- AI is often used for recommendations, not direct real-time process control

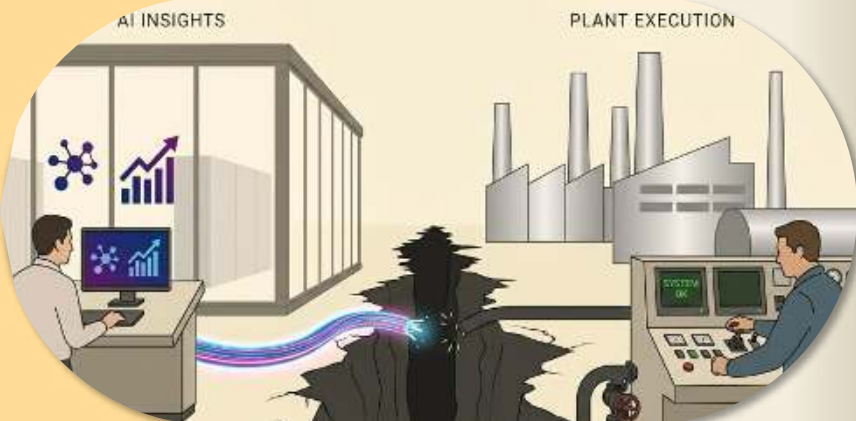


LIMITED DIRECT IMPACT ON REAL-TIME OPERATIONS

- AI insights are often disconnected from control systems, limiting real-time action
- Safety and integration concerns can lead to delays, manual intervention, and lost value

KEY CHALLENGES

01



Gap between AI Insights & Plant Action

More plants are piloting AI every year — for predictive maintenance, quality checks, and scheduling optimization. The technology is no longer experimental.

Standalone AI Cannot Drive Real-Time Optimization

Current AI models generate dashboards and alerts, but a human operator still decides what to do. The AI watches — it does not act.

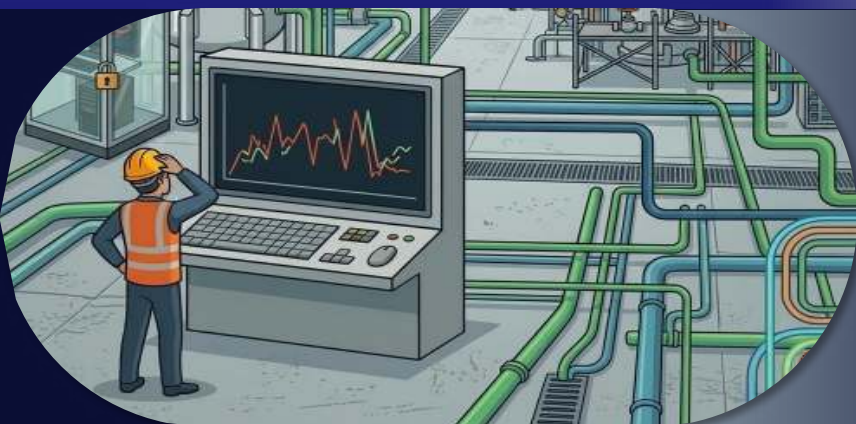


02

Even when AI has control, rigid rules fail in complex conditions

With rising variability, fixed rules fail. Without adaptation, AI still drives inefficiency and upsets.

03



The Missing Link:

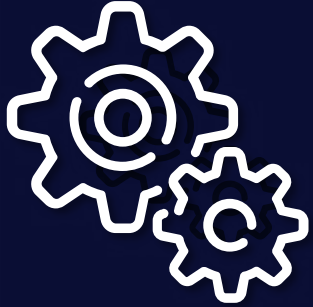
AI Must Be Embedded within APC and Process Control

1

2

3

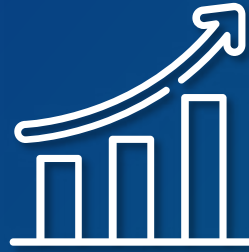
AI FOR SMARTER PROCESS CONTROL



1

AI as An Extension of APC

APC has been running plants for decades. The proposal is to enhance it with AI — not discard it. AI handles the complex, variable parts that traditional APC struggles with.



Enhancement Not Replacement

AI suggests adjustments to help operators optimize plant operation further among multiple units / sections . Operators keep their familiar control – AI adds capability on providing higher advisory level .

2



Integrated within Existing Control Layers

The AI models live within the APC/DCS infrastructure, so they can directly or advisory to adjust setpoints, respond to upsets and act without waiting for human intervention or follow smart alert with AI guidance

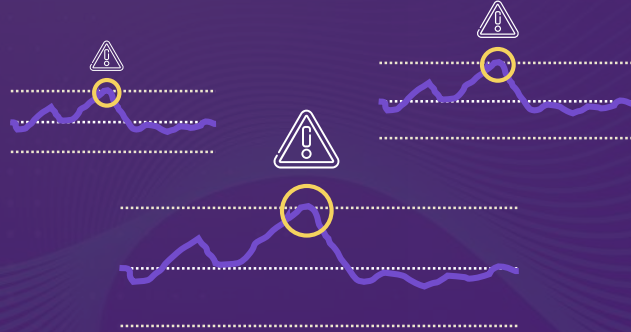


AI Embedded Mode



Advisory Mode

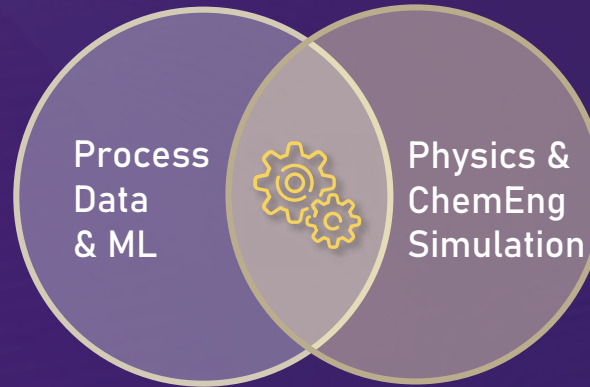
HOW AI ADD VALUES FOR SMARTER PROCESS CONTROL



Alert ➡ Action Taken ➡ Feedback
Multi-Role / Complex Logic / Case Specific

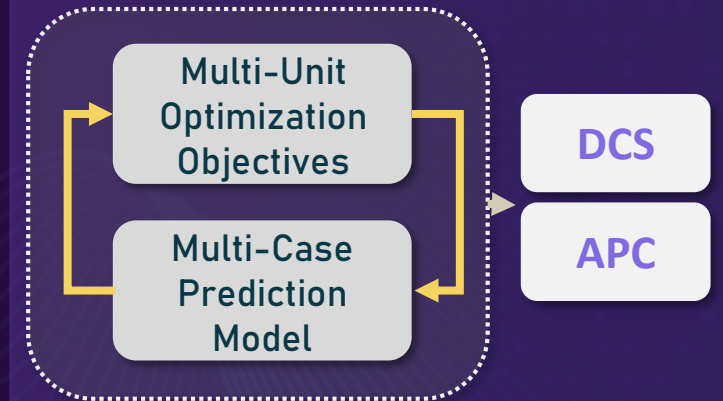
Advanced Multi-Unit Constraint Management

Optimizes multiple units within safety and process constraints, ensuring stable operation and maximum efficiency under dynamically changing conditions or costs.



Engineering Knowledge Embedded in Intelligence

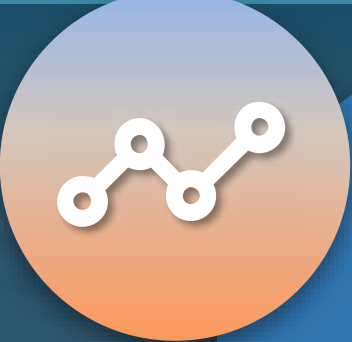
Combines process expertise, engineering principles, process knowledge, and plant operational practices to deliver reliable and trusted decisions.



AI for Complex Process Dynamic Model

Extends traditional process models by learning complex nonlinear behavior from plant data, enabling more accurate prediction and adaptive optimization.

DEMONSTRATED BENEFITS



Improved Operational Stability

Reduction of Control Performance Variation



Optimized Raw Materials

Reduction of Raw Material
e.g. Catalyst Consumption



Energy Efficiency Improvement

Reduction of Steam Usage



Increased Throughput

Increasing in Production Yield
Reduction of Batch Time
Run higher Partial Pressure or Feed
against constraints



Enhanced Product Quality

React to the Quality Disturbance faster e.g. accumulated impurity overtime, catalyst or product specific mode

AI APPLICATION ENHANCEMENT FOR PROCESS INDUSTRIES

01

ADAPTIVE APC

- Upstream variability impacts downstream units
- Challenges: cracking temperature, conversion, impurities vs product output
- AI-APCs are improved by multi-unit optimization strategy for dynamic load change stability, product quality, and energy efficiency
- Petrochemicals - olefins and vinyl chain

02

NON-LINEAR APC

- Polymer processes are highly nonlinear and grade-dependent
- Challenges: melt index control, grade changes, catalyst shifts
- AI-APC suggested further optimization target for product yield and quality, raw material consumption, and energy efficiency for specific reactor vs catalyst conditions including downstream condition
- Polymers, PE and PP Production

03

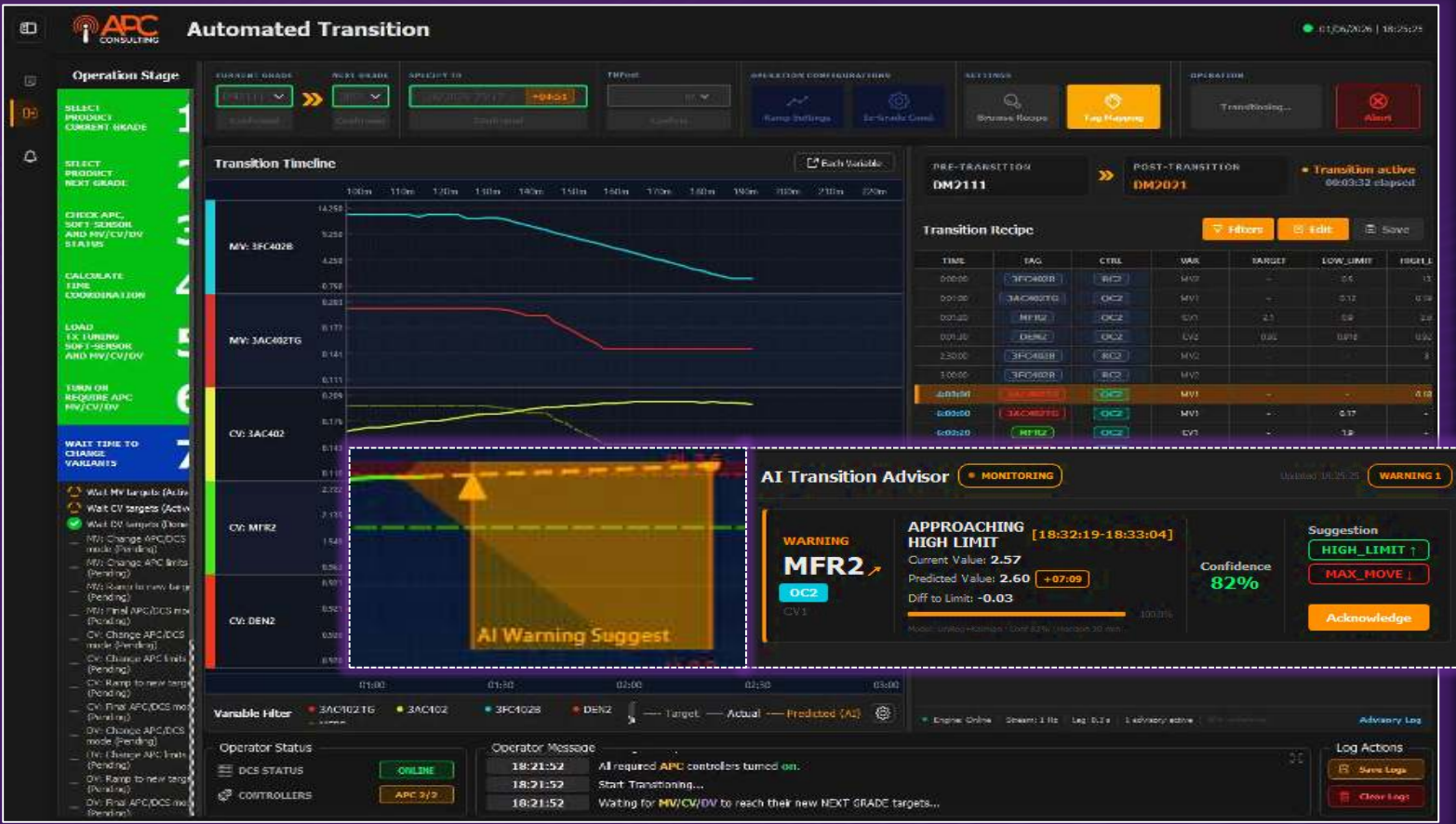
BATCH OPTIMAL CTRL

- Batch variability from recipes, materials, and scale-up
- Traditional APC cannot handle fast and model change across batch production steps / recipes
- AI-Batch Analyzer continue to suggest temp profiles / condenser / jacket temp in batch step to further reduces time, improves yield, and minimizes idle time
- PVC, Latex, ABS, Specialty Polymer Production, Catalyst Production

Example of AI-Enables Process Application

AI Transition Advisor for Automated Transition

Real-time prediction analysis that detecting limit breaches and target deviations, guiding operators with parameter suggestions before process issues occur



Real-Time Prediction

Uses historical data and trends to predict process variables and forecast future behavior in real time



Abnormality Detection

Detects limit breaches and setpoint deviations, providing real-time alerts and dashboard highlights



AI Transition Advisor

Detects optimal transition patterns and suggests operator actions to minimize deviation from optimal pattern

Example of AI-Enables Process Application

AI Transition Advisor for Automated Transition

Grade Transition

With APC
Automated control, High precision

2 - MATERIAL TYPE

PP — Polypropylene (DM Series)

3 - OPTIMIZATION GOAL

Quality First
Minimize MFR/Density off-spec

Fast Switch
Minimize transition time

Lower Cost
Reduce catalyst & hydrogen waste

Reduce Waste
Reduce off-spec propylene

4 - ADDITIONAL NOTES TO AI

AI Assistant

Provide special context for this transition

Hello! Any special details about this transition pair you would like AI to know?

Ramp down hydrogen feed slowly

Understood. I have adjusted the RC recipe to include the requested condition.

Type a message to AI...

Cancel

Next →

Compare

PRE

POST

PRE — DM2111 → POST — DM2021

RC [MV] (PRE)

Name	Description	Operator Low limit	Op
3FC402B	Secondary Propylene Feed	0.5	
3FC411A	Auxiliary Feed Flow	0.5	
3FC401A	Primary Monomer Feed	10	
3FC409	Recycle Gas Flow	0	

RC [MV] (POST)

Name	Description	Operator Low limit	Op
3FC402B	Secondary Propylene Feed	0.5	
3FC411A	Auxiliary Feed Flow	0.5	
3FC401A	Primary Monomer Feed	10	
3FC409	Recycle Gas Flow	0	

RC [CV] (PRE)

Name	Description	Operator Low limit	Op
3PC400	Reactor Pressure	0.7	
3PC416	Separator Pressure	1.9	

RC [CV] (POST)

Name	Description	Operator Low limit	Op
3PC400	Reactor Pressure	0.7	
3PC416	Separator Pressure	1.9	

QC [MV] (PRE)

Name	Description	Operator Low limit	Op
3AC402TG	Hydrogen Target	0.1	
3AC404TG	Comonomer Target	0.3	

QC [MV] (POST)

Name	Description	Operator Low limit	Op
3AC402TG	Hydrogen Target	0.1	
3AC404TG	Comonomer Target	0.3	

QC [CV] (PRE)

QC [CV] (POST)

AI-Driven Template Generation

Uses our core analytics model to evaluate historical data, automatically identifying the "Golden Transition" pattern to generate optimized recipe templates

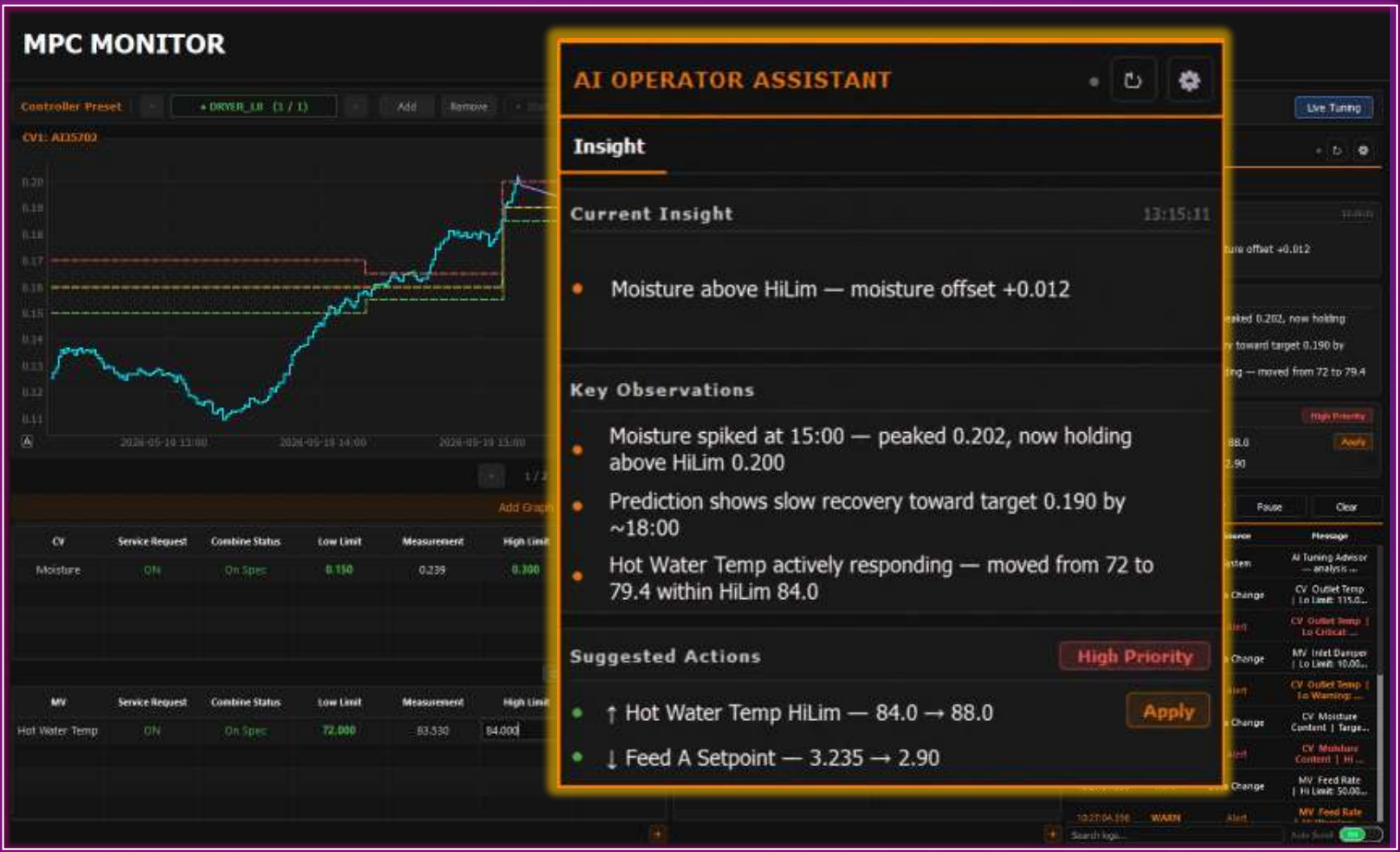
Context-Aware AI Assistant

Allows engineers to input specific operational contexts, constraints, or custom adjustments to refine the template before generation

Example of AI-Enables Process Application

AI Operator Assistant Panel for Process MPC

Real-time AI insights that detect disturbances, highlight key issues, and recommend actions—enabling faster decisions and stable, optimized operations.



Process Disturbance Detection

Continuously monitors process variables to detect disturbances, abnormal conditions, and performance degradation in real time



Real-time Operational Insights

Provides AI-generated insights into current process behavior, highlighting potential causes and operational impacts



Key Process Observations

Automatically identifies critical process events, trends, and deviations that require operator attention



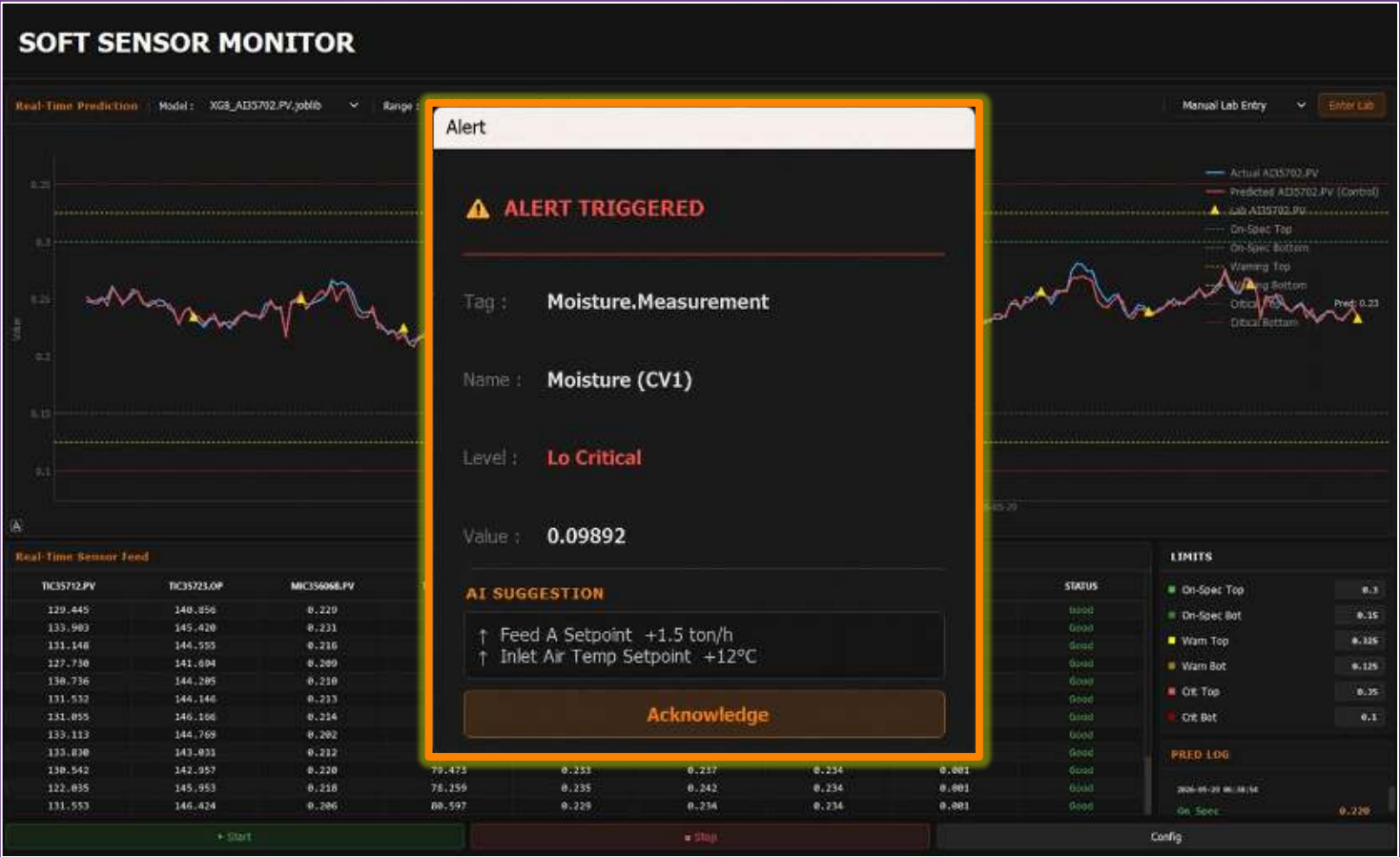
Operator Suggested Actions

Recommends corrective actions and parameter adjustments to help operators maintain stable and optimal operation

Example of AI-Enables Process Application

AI Alert for AI/ML Soft Sensor

Deliver smart alerts with built-in root-cause analysis and AI-driven operator guidance for faster and effective responses



Real-Time Alert Detection

Detects abnormal conditions, limit violations, and process upsets in real time



Root Cause Analysis

Identifies the most likely causes of alerts using process relationships and historical data



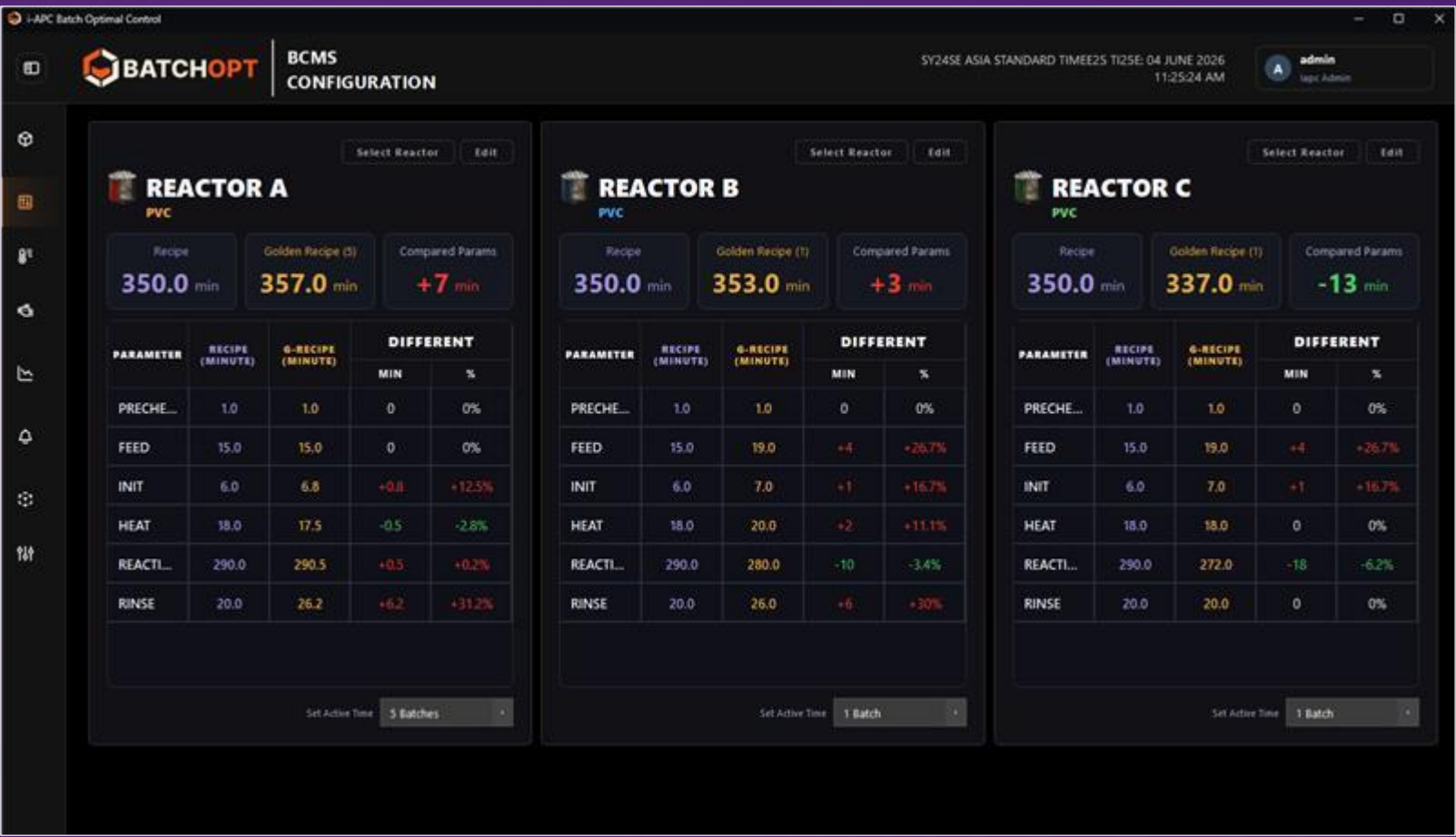
AI-Guided Recommendations

Provides actionable suggestions to help operators respond faster and maintain process stability

Example of AI-Enables Process Application

Smart Batch Analyzer

AI learns from historical operating plant data to return the most time-efficient recipe for the current month with actual best-performing batch in similar conditions.



Seasonal Pattern Recognition

Finds batches from the same season across years, not just the same calendar month



Percentile-based Golden Transition Selection

Matched batches by total duration consistently efficient, not a fluke outlier



Zero Disruption to Live Operations

No automatic changes are applied to the running system

Pragmatic Use Cases

PP Spheripol

HDPE Mitsui / Nissan / Excene Slurry

LDPE LyondellBasell Lupotech

LDPE Autoclave ICI Exxon

PP Spherizone

LLDPE/HDPE Unipol Gasphase

Biomass Utility / Power Plant

EDC Production / VCM Production





LAMP AUTOCLAVE | LAMP TUBULAR | PP OPTIMIZER | PP SPACER | LLOPE UNIFIL | HOPE KITSET CX | BUSINESS POWER | LSP UTILITY | PMS BATCH



DIGITAL TWIN - APC

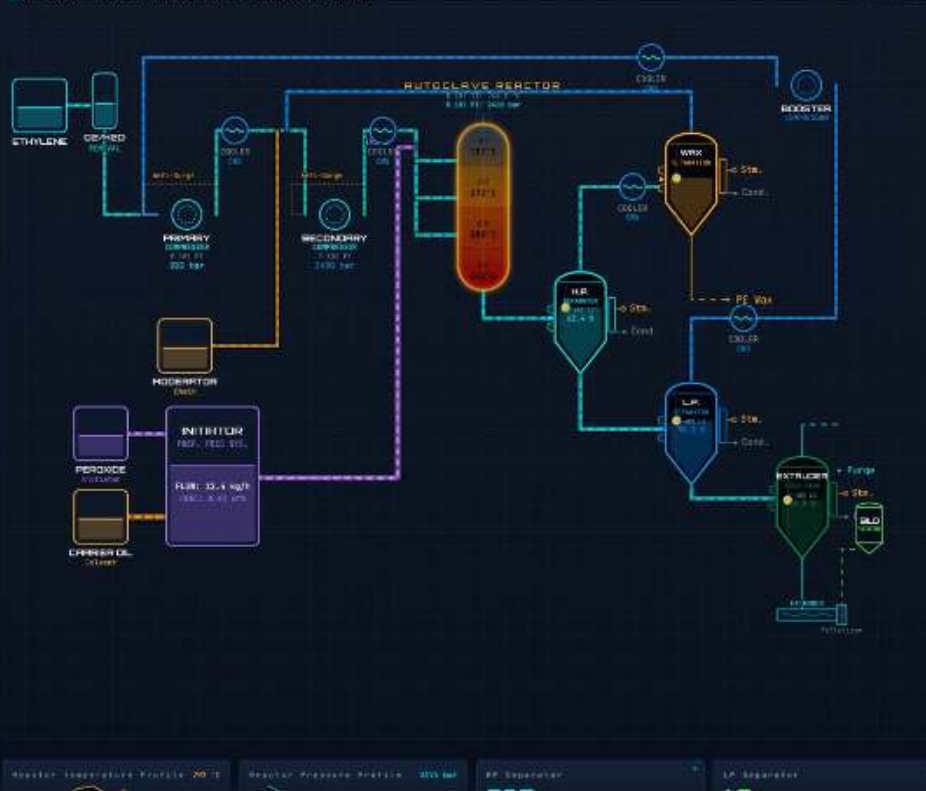
TARGET PARAMETERS

Targets validated by APC constraints & safety limits

PARAMETER	TARGET	TARGET	Δ	UNIT
- PRESETTED -				
Production Rate	42.8 t/h	35.4 t/h	▼ -7.4	t/h
Ethylene Feed	04.2 t/h	06.8 t/h	▲ +2.6	t/h
Recycle Gas Flow	342 t/h	338 t/h	▼ -4	t/h
Chain Moderator	1.22 t/h	1.38 t/h	▼ -0.16	t/h
- PROCESS -				
Reactor Pressure	2400 bar	2480 bar	▲ +80	bar
Primary Comp Glash	210 bar	284 bar	▲ +74	bar
Secondary Comp Glash	2400 bar	2520 bar	▲ +120	bar
Dosier Glash	540 bar	540 bar	▲ +0	bar
IP Separator	210 bar	236 bar	▼ -24	bar
LP Separator	5.3 bar	2.9 bar	▼ -2.4	bar
- THERMOCHEM -				
Reactor Zone 1	368 °C	364 °C	▲ +4	°C
Reactor Zone 2	365 °C	372 °C	▲ +7	°C
Reactor Zone 3	370 °C	374 °C	▲ +4	°C
Cooler Outlet	39 °C	39 °C	▲ +0	°C
Max Separator	338 °C	314 °C	▼ -24	°C
- REACTION / QUALITY -				
Peroxide Injection	40 t/h	32 t/h	▲ +8	t/h
Melt Index	2.1 t/h	2.0 t/h	▲ +0.1	t/h
Density	0.922 g/cm³	0.925 g/cm³	▲ +0.003	g/cm³
Vinyl Content	0.18 wt%	0.17 wt%	▲ +0.01	wt%
Product Quality Index	96.40	97.80	▲ +1.4	

- OPTIMIZER -

LAMP AUTOCLAVE - PROCESS FLOW DIAGRAM (PFD) SCHEMATIC



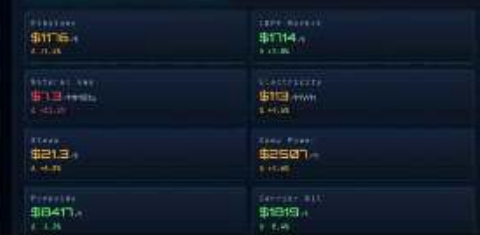
AI OPTIMIZATION

THROUGHPUT STRATEGY



REAL-TIME MONITORING

ECONOMIC OPTIMIZER





LEPE AUTOCLAVE | LEPE TUBELAR | PP SPHERIZONE | PP SPHERISPAL | LLEPE UNIPOL | HOPE RETSU2 CK | DEONASS POWER | LOP STEELITY | PFC BATCH

HOPE PRODUCTION
50.4 t/h
▲ +1.0% vs
plan

PLANT DEC
94.1%
▲ +0.4% vs

PAPER 1: YOUNG
\$325.8
▲ + 0.1

SPEC. SHEET
0.7 mm/m²
▲ +2.4%

CATALYST EFF.
18.4 kg/kg
▲ +1.2%

APC SERVICE
ACTIVE

TWIN SYNCHRONIZATION
96%
▲ +1.0

CLIPPER LOOP
RUNNING

ECONOMIC MODE
MAX MARGIN

VALVE DIAG.
2.56 kg/L
▲ STABLE

APC OUTTIER
ON

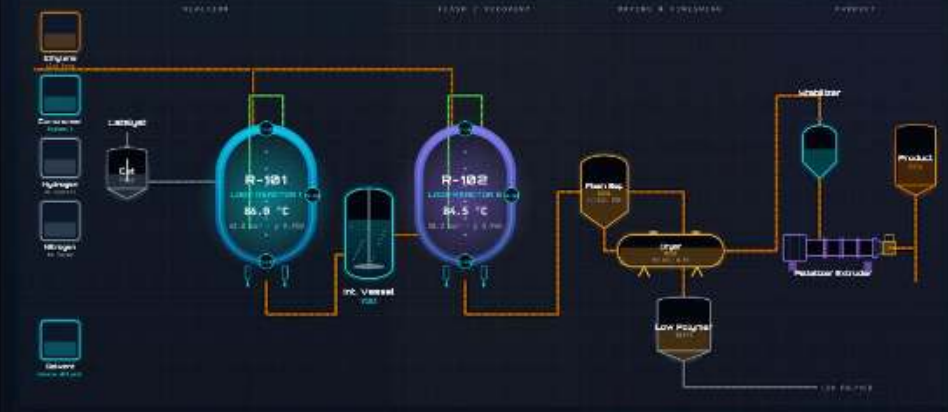
TWIN CONFORMANCE
98.5%
▲ +1.0

DIGITAL TWIN - APC TARGET PARAMETERS

Targets validated by APC constraints & safety limits

Parameter	Current	Target	Δ	Unit	APC
- PRODUCTION					
Production Rate	48.4 t/h	50.4 t/h	-15.2	%	APPLY
Ethylene Feed	32.4 t/h	35.4 t/h	-4.0	%	APPLY
Comonomer Feed	1.82 t/h	1.8 t/h	-0.02	%	APPLY
Hydrogen Feed	32 t/h	28 t/h	-4	%	APPLY
Catalyst Feed	7.6 t/h	22 t/h	-14.4	%	APPLY
Diluent Flow	180 t/h	180 t/h	-4	%	APPLY
- REACTOR CONDITIONS					
Reactor Pressure	62 bar	64 bar	-2	%	APPLY
Loop Velocity	6.2 t/h	6.8 t/h	-0.6	%	APPLY
Slurry Density	0.54 g/cc	0.58 g/cc	-0.04	%	APPLY
Solids Concentration	52%	55%	-3%	%	APPLY
Reactor Temp.	86.4°C	87.2°C	-0.8	%	APPLY
Reactor AT	1.6%	1.2%	-0.4	%	APPLY
Settling Lag Level	60%	65%	-5%	%	APPLY
- RECOVERY					
Flash Sep. Pressure	6.4 bar	6.1 bar	-0.3	%	APPLY
Recovery Comp. Load	78%	72%	-6	%	APPLY
Diluent Recovery	97.2%	98.4%	-1.2	%	APPLY
Comonomer Recovery	94.4%	96.2%	-1.8	%	APPLY
- PRODUCT QUALITY					
Melt Index (MI)	0.95 g/min	0.98 g/min	-0.03	%	APPLY
Density	0.952 g/cm ³	0.950 g/cm ³	+0.002	%	APPLY
Maxmo RptUp	1.4%	1.2%	-0.2	%	APPLY
- UTILITIES					

HOPE RETSU2 CK - SLURRY LOOP REACTOR SCHEMATIC



APC / DIGITAL TWIN COORDINATION

APC OPTIMIZER	DIGITAL TWIN	CLIPPER LOOP	FEEDBACK MODE	CONSTRAINT MGR	ANAL CONFORMANCE	HOPE COMP. APC	SAFETY PERMISS
ACTIVE	SYNCED	RUNNING	ENABLED	ACTIVE	95.3%	ACTIVE	OK
VALVE DIAG	Active						

REAL TIME CORP LOSS
SYSTEM ACTIVITY MONITOR

10000000 | APC Spectralnet Ltd.: Secondary Comp Load @ 50% (High Limit)

ANTHROPUS GRANT FACTORY - HOPE RETSU2 CK

APC OPTIMIZER | DIGITAL TWIN | CLIPPER LOOP | FEEDBACK MODE | CONSTRAINT MGR | ANAL CONFORMANCE | HOPE COMP. APC | SAFETY PERMISS

ACTIVE | SYNCED | RUNNING | ENABLED | ACTIVE | 95.3% | ACTIVE | OK

THROUGHPUT STRATEGY

Max Margin
1000 t/h | 4100 t/h
▲ +10.2%

Max Production
1000 t/h | 4100 t/h
▲ +10.2%

Save Energy
1000 t/h | 4100 t/h
▲ +10.2%

Reactor Stack
1000 t/h | 4100 t/h
▲ +10.2%

Quality Price
1000 t/h | 4100 t/h
▲ +10.2%

Slurry Optm
1000 t/h | 4100 t/h
▲ +10.2%

Silicon Power
1000 t/h | 4100 t/h
▲ +10.2%

Utility Cost
1000 t/h | 4100 t/h
▲ +10.2%

MAX MARGIN - ACTIVE

THROUGHPUT (t/h)

1000 t/h | 4100 t/h

APPLY MODE TO APC

REAL-TIME ECONOMIC OPTIMIZER

PRODUCTION	PRODUCTION
\$1101 t/h ▲ +10.2%	\$1640 t/h ▲ +10.2%
HOPEST \$3.15 kg ▲ +10.2%	HOPEST \$1561 t/h ▲ +10.2%
ELECTRICITY \$90 t/h ▲ +10.2%	VALVE DIAG \$0.10 t/h ▲ +10.2%
SAFETY \$40 t/h ▲ +10.2%	DILUENT \$0.62 t/h ▲ +10.2%
RACON TREND - 24h \$3370 t	

THROUGHPUT STRATEGY

Max Margin
1000 t/h | 4100 t/h
▲ +10.2%

Max Production
1000 t/h | 4100 t/h
▲ +10.2%

Save Energy
1000 t/h | 4100 t/h
▲ +10.2%

Reactor Stack
1000 t/h | 4100 t/h
▲ +10.2%

Quality Price
1000 t/h | 4100 t/h
▲ +10.2%

Slurry Optm
1000 t/h | 4100 t/h
▲ +10.2%

Silicon Power
1000 t/h | 4100 t/h
▲ +10.2%

Utility Cost
1000 t/h | 4100 t/h
▲ +10.2%

MAX MARGIN - ACTIVE

THROUGHPUT (t/h)

1000 t/h | 4100 t/h

APPLY MODE TO APC

THROUGHPUT STRATEGY

Max Margin
1000 t/h | 4100 t/h
▲ +10.2%

Max Production
1000 t/h | 4100 t/h
▲ +10.2%

Save Energy
1000 t/h | 4100 t/h
▲ +10.2%

Reactor Stack
1000 t/h | 4100 t/h
▲ +10.2%

Quality Price
1000 t/h | 4100 t/h
▲ +10.2%

Slurry Optm
1000 t/h | 4100 t/h
▲ +10.2%

Silicon Power
1000 t/h | 4100 t/h
▲ +10.2%

Utility Cost
1000 t/h | 4100 t/h
▲ +10.2%

MAX MARGIN - ACTIVE

THROUGHPUT (t/h)

1000 t/h | 4100 t/h

APPLY MODE TO APC



LLRP AUTOLAVE | LLRP TUBULAR | PP SPECI2000 | PP SPECI201 | LLRP UNIFOL | HDPE RETSUD 24 | HDPESS POREX | LSP UTILITY | PVE BATCH



DIGITAL TWIN - APC TARGET PARAMETERS

Targets validated by APC continuous & safety limits

PARAMETER	CURRENT	TARGET	Δ	COMP
- PRODUCTION				
Production Rate	40.5 t/h	35.4 t/h	+5.1	94%
Ethylene Feed	33.2 t/h	37.5 t/h	-4.3	94%
Comonomer (Hexene)	330 kg/h	320 kg/h	+10	92%
Hydrogen Feed	533 km	482 km	+51	94%
Catalyst Feed	1.7 km	1.6 km	+0.1	93%
- PRESSURE				
Reactor Pressure	23 bar	23.4 bar	-0.4	94%
Cycle Gas P	22.5 bar	23.8 bar	-0.3	94%
Discharge Tank	0.4 bar	1.2 bar	-0.2	94%
Vent Recovery	1.2 bar	1.1 bar	+0.1	94%
- TEMPERATURE				
Bed Temperature	87°C	89°C	-2	94%
Cycle Gas Cooler Out	42°C	48°C	-6	94%
Recycle Gas	68°C	38°C	+3	92%
Purge System	78°C	76°C	+2	94%
- REACTION / QUALITY				
Melt Index	2.14 g/min	2 g/min	+0.1	94%
Density	0.918 g/cm³	0.92 g/cm³	-0.002	94%
Isobut/CO Ratio	0.035 km	0.037 km	-0.002	93%
Bed Level	76%	75%	+1%	94%
Fluidization Vel.	0.62 m/s	0.65 m/s	-0.03	92%
Quality Tds	97.6%	98.4%	-0.8	94%
- UTILITIES				
Compressor Power	12.8 kw	11.1 kw	+1.5	94%

LLRP UNIFOL GAS-IN-PLACE FLUIDIZED BED REACTOR SCHEMATIC

FLUIDIZED BED REACTOR R-301

FEED PURIFICATION



FINISHING



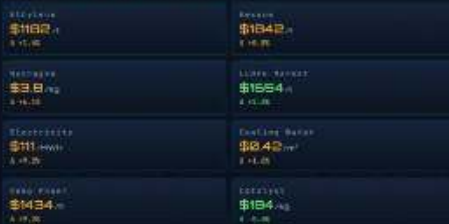
Fluidization Temp: 4.5 | Bed Temperature: 86.5 | Catalyst Feed: 16.4 kg/h | Hydrogen: 5.0 km | Melt Quality: 94.5 km



K3 OPTIMIZATION THROUGHPUT STRATEGY



REAL-TIME ECONOMICS ECONOMIC OPTIMIZER



 CHINA SOUTHERN TRADING COMPANY 中国对外经济贸易总公司	
GENERAL MANAGER: CHEN YUEN CHANG 总经理: 陈允昌	
DEPUTY GENERAL MANAGER: CHEN YUEN CHANG 副总经理: 陈允昌	
MANAGING DIRECTOR: CHEN YUEN CHANG 经理: 陈允昌	
DEPUTY MANAGING DIRECTOR: CHEN YUEN CHANG 副经理: 陈允昌	
CHIEF ACCOUNTANT: CHEN YUEN CHANG 首席会计师: 陈允昌	
CHIEF CLERK: CHEN YUEN CHANG 首席文员: 陈允昌	
CHIEF TRANSPORT OFFICER: CHEN YUEN CHANG 首席运输官员: 陈允昌	
CHIEF CUSTOMS OFFICER: CHEN YUEN CHANG 首席海关官员: 陈允昌	
CHIEF INSPECTION OFFICER: CHEN YUEN CHANG 首席检验官员: 陈允昌	
CHIEF PORT OFFICER: CHEN YUEN CHANG 首席港口官员: 陈允昌	
CHIEF SHIPPING OFFICER: CHEN YUEN CHANG 首席航运官员: 陈允昌	
CHIEF TRADING OFFICER: CHEN YUEN CHANG 首席贸易官员: 陈允昌	
CHIEF FINANCIAL OFFICER: CHEN YUEN CHANG 首席财务官员: 陈允昌	
CHIEF LEGAL OFFICER: CHEN YUEN CHANG 首席法律官员: 陈允昌	
CHIEF TECHNICAL OFFICER: CHEN YUEN CHANG 首席技术官员: 陈允昌	
CHIEF QUALITY CONTROL OFFICER: CHEN YUEN CHANG 首席质量控制官员: 陈允昌	
CHIEF SAFETY OFFICER: CHEN YUEN CHANG 首席安全官员: 陈允昌	
CHIEF ENVIRONMENTAL OFFICER: CHEN YUEN CHANG 首席环境官员: 陈允昌	
CHIEF SOCIAL AFFAIRS OFFICER: CHEN YUEN CHANG 首席社会事务官员: 陈允昌	
CHIEF PUBLIC RELATIONS OFFICER: CHEN YUEN CHANG 首席公共关系官员: 陈允昌	
CHIEF INFORMATION OFFICER: CHEN YUEN CHANG 首席信息官员: 陈允昌	
CHIEF RESEARCH OFFICER: CHEN YUEN CHANG 首席研究官员: 陈允昌	
CHIEF DEVELOPMENT OFFICER: CHEN YUEN CHANG 首席开发官员: 陈允昌	
CHIEF INNOVATION OFFICER: CHEN YUEN CHANG 首席创新官员: 陈允昌	
CHIEF SUSTAINABILITY OFFICER: CHEN YUEN CHANG 首席可持续发展官员: 陈允昌	
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LEVE: NUTLEDGE • LOPE: TUGLAW • PP: SPHERIZONE • PP: SPHERIZONE • LLOPE: UNIPOL • KOPS: NUTLEDGE • BIRNASS: POWER • LSP: UTILITY • PVC: BATCH

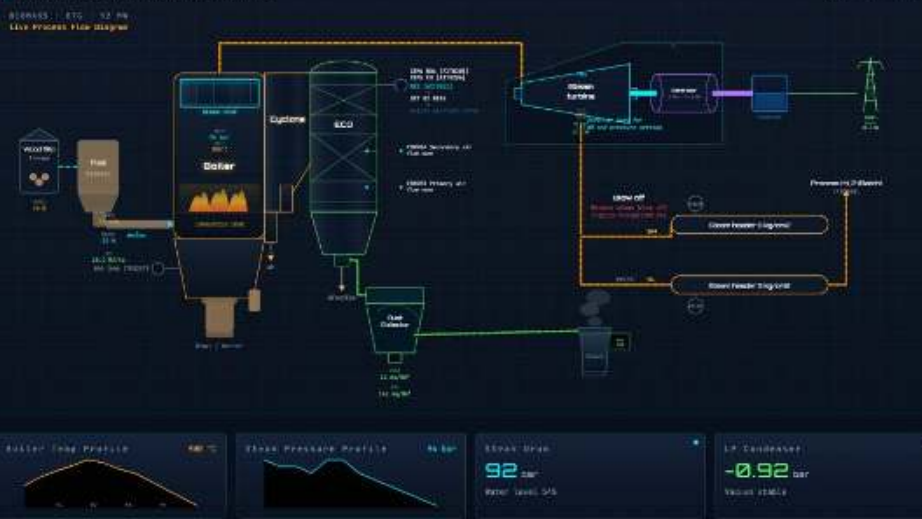


TARGET PARAMETERS

Targets calculated by APC controllers & safety limits

PARAMETER	CURRENT	TARGET	Δ	UNIT	APPLY
POWER GENERATION					
Turbine Load	28.3	32.8	▲ +4.5	MW	APPLY
Boiler Master Load	88%	92%	▲ +4%	%	APPLY
Net Power Export	22.4	20.2	▲ +1.4	MW	APPLY
Steam Flow	128 t/h	127 t/h	▲ +1	t/h	APPLY
COMBUSTION					
Furnace Temp	318°C	323°C	▲ +5	°C	APPLY
Excess Oxygen	4.3%	5.9%	▲ +0.9	%	APPLY
Fuel Feed	42 t/h	48 t/h	▲ +6	t/h	APPLY
Air/Fuel Ratio	6.4	5.8	▲ +0.6	%	APPLY
Draft Pressure	7 mmHg	-10 mmHg	▲ -7	mmHg	APPLY
STEAM SYSTEM					
Main Steam P	92 bar	89 bar	▲ -3	bar	APPLY
Main Steam T	540°C	515°C	▲ -25	°C	APPLY
Reheat Temp	538°C	540°C	▲ +2	°C	APPLY
Condenser Vac	0.02 bar	-0.04 bar	▲ -0.06	bar	APPLY
ENVIRONMENTAL					
Stack G2	5.5%	4.7%	▲ -0.8	%	APPLY
NOx	42 mg/m³	38 mg/m³	▲ -4	mg/m³	APPLY
CO	48 mg/m³	38 mg/m³	▲ -10	mg/m³	APPLY
Dust	12 mg/m³	11 mg/m³	▲ -1	mg/m³	APPLY
UTILITY & FEED					
Feedwater Flow	137 t/h	140 t/h	▲ +3	t/h	APPLY
Cooling Water	6.8 t/h	6.4 t/h	▲ -0.4	t/h	APPLY
ID Fan Speed	78%	74%	▲ -4	%	APPLY

BIRNASS POWER PLANT - DTG PROCESS FLOW



APC & DIGITAL TWIN COORDINATION

APC OFFLINE	DIGITAL TWIN	CLOSED LOOP	ECONOMIC MODE	CONSTRAINT MGR	RISK CONSEQUENCE	WELDER COMP. APC	SAFETY ENVELOPE
ACTIVE	SYNCH	RUNNING	ENABLED	ACTIVE	98%	ACTIVE	OK
CONNECTION BY: Active							

REAL TIME COST LOGS

SYSTEM ACTIVITY MONITOR
CHOOSE: APC Constraint 1st: Secondary Cond Load @ 90% (High Limit)
CHOOSE: APC Constraint 2nd: Secondary Cond Load @ 90% (High Limit)

AT OPTIMIZATION THROUGHPUT STRATEGY

Max Profit	Max Export
▲ +12.2%	▲ +12.2%
Save Fuel	Less Emission
▲ -1.2%	▲ -1.2%
Max Boiler Off	Grid Response
▲ -0.5%	▲ -0.5%
Stable Cost	Low Steam
▲ -0.1%	▲ -0.1%
Utility Cost	Custom
▲ -0.1%	▲ -0.1%

MAX PROFIT - ACTIVE

THROUGHPUT TARGET: 28.3 MW

APPLY MODE TO APC

REAL-TIME ECONOMICS ECONOMIC OPTIMIZER

Revenue	Profitability
\$119.4	\$119.4
Cost	Cost
\$119.4	\$119.4
Feedwater	Feedwater
\$119.4	\$119.4
Carbon	Carbon
\$119.4	\$119.4

DIGITAL TWIN INTEGRATED APC/DCS/AUTOMATION

MODEL DEPLOYMENT APPROACH

Legacy First-Principal Approach

- Complex commercial ChemEng Simulation software — high cost
- Extensive molecular structure data required (MWD, Mn, Mw, PDI)
- Complicated kinetic parameter fitting methodology
- Prone to model-plant mismatch from unmeasured disturbances
- Difficult to deploy and maintain for online DT applications
- Better than data modeling approach only



Practical New Digital Twin Approach

- Simplified polymerization kinetics embedded in DT framework
- No molecular structure data needed — focus on production rate & consumption
- AI-assisted kinetic parameter fitting and autotuning feature
- Hybrid AI/ML corrects prediction - plant bias in real-time
- No dedicated software licensing — deployable across many processes

HDPE Slurry / Loop

Mitsui CX / Hostalen / INEOS
Innovene S / CP Chem MarTech
/ Borstar

Gas-Phase PE

Unipol / Univation / INEOS
Innovene G / Borstar

PP Slurry / Loop

Spheripol / Hypol /
Innovene PP / Borstar

Gas-Phase PP

Unipol / Grace PP / Novolen
/ Spherizone / Borstar

LDPE Autoclave

Exxon / LYB / ICI

LDPE Tubular

LYB / Exxon / STM /

> 12+
Process Types

AI/ML
Hybrid Model

Model Auto
Tuning

INTEGRATED AI SOLUTION PLATFORM

Automated Recipe /Sequencer Workflow



Grade Transition / Utilities / Heating / Cooling / Equipment Mode Switching / Startup / Shutdown

- Equipped with AI Analytics for Performance Monitoring
- Model Deviation
- Uncertainties handling to adjust recipe
- sequence automation workflow
- Golden batch
- Transition analyzer



Digital Twin

OptAssist Dashboard

- 1st Principal Model
- Simplified Reaction Kinetics
- Mass-Energy Balance
- Hybrid with AI/ML Model correcting model vs prediction bias
- multi-unit optimization recommendation via AI/ML/LLM through real-time process specific dashboard

AI / ML Soft Sensor Batch OPT



Batch process/ temperature control/ batch time optimization/ feed or utility constraints

- Comparable Bias Adjustment
- Real-time quality estimation
- Process Condition Optimization Guidelines



APC / DCS / Automation

Reaction / Purification / Recovery / Downstream

- Linear and Non-linear Dynamic Model
- Step response model, State Space model, Non-linear model
- Economic & Energy Optimization

DIGITAL TWIN INTEGRATED APC/DCS/AUTOMATION BENEFITS



Digital twin combines physics and AI for real-time corrections



Optimizes cross-unit constraints to improve efficiency



AI analytics monitors performance and corrects bias



Flexible, scalable AI deployment across all units



Closes gaps across multiple APC operations



Adjusts APC/DCS settings to optimize performance



Targets optimized using specified hist data, models, and feedback



Advanced APC expertise boosts productivity and energy efficiency

Data Readiness and Coverage

Many plants find that historical data contains gaps, inconsistent tags, or limited operating-range coverage. Modern AI Smart Process Control approaches can often start with available data and progressively improve model performance as additional operational knowledge and plant data are incorporated. Otherwise, data generation from trusted 1st principal model to be considered.

Operator Engagement and Adoption

Successful AI deployment depends on operator confidence and acceptance. Providing transparent recommendations, involving operations teams throughout development, and demonstrating measurable early benefits help accelerate adoption and sustainable performance improvements.

System Connectivity and Integration

Connecting AI models to legacy DCS systems — many of which are 10–20 years old and not designed for external software — requires careful engineering, testing, and often custom middleware.

Cybersecurity and Deployment Architecture

Depending on site requirements, AI solutions can be deployed fully on-premise, within private networks, or through hybrid architectures. Proper cybersecurity design ensures secure, reliable, and scalable operation while meeting plant IT and OT governance requirements.

DEPLOYMENT CONSIDERATIONS





As processes change over months and years — new equipment, new grades, catalyst changes — models must be retrained on updated data to stay accurate and relevant. 1st Principle model with autotune help to minimize the model deviation overtime.

MODEL MAINTENANCE AND RETRAINING

SUSTAINABLE LONG-TERM OPERATION

A governance plan — including scheduled reviews, retraining triggers, and assigned ownership — ensures the system stays effective for years, not just during the honeymoon period after launch.

PERFORMANCE MONITORING

Continuous tracking of model prediction error and controller performance flags degradation early — before quality or efficiency problems become visible on the plant floor

LIFECYCLE MANAGEMENT

Deploying AI is only the beginning. Long-term value requires continuous model governance and performance management

APC & DIGITALIZATION EXPANSION

- Linear and Non-linear Advanced Process Control (APC)
- Process Control Optimization
- Industrial Analytics
- Digital Transformation Consulting

2018

SOLUTION DEV GROWTH

- Batch Optimal Control
- Loop Performance MS (LPMS)
- Batch Constraint MS (BCMS)
- Process MPC for Downstream Unit
- New Plant Stabilization
- Rapid APC Deployment

2022

PRAMATIC AI

i-APC Consulting Co., Ltd. has officially registered middle east branch in **Oman** and secured projects in gulf countries.

2026



2017

COMPANY FOUNDED

i-APC Consulting Co., Ltd. officially established in Bangkok, Thailand together with Insight Advanced Process Control LLC in Houston, Texas

2021

INDUSTRY 4.0 & AI/ML DIRECTION

- AI/ML Soft Sensor
- Big Data Analytics
- Predictive Analytics
- Online Property Prediction
- Non-Petro Process Industries

2025

INTELLIGENT MANUFACTURING

- AI-Assisted Automated Sequencer
- Digital Twin-Supported APC/DCS
- Automated Sequencer / Transition
- Simplified Recipe Initialization
- New plant APC

INTEGRATED AI SOLUTION PLATFORM



AI must be embedded, not isolated

Integrate AI directly into control systems and daily workflows to enable real-time insights, faster decisions, and continuous optimization



Leverage proven APC foundation

Build on existing APC infrastructure to ensure stable performance, scalability, and smoother AI adoption



Focus on measurable plant value

Prioritize use cases that deliver clear impact higher throughput, improved quality, reduced variability, and lower off-spec production



Secure AI, On Your Terms

Run AI within your own infrastructure to maintain cybersecurity, protect operational data, and ensure uninterrupted operation.

CORE
DEPLOYMENT
PRINCIPLES



ENABLE A SUSTAINED
COMPETITIVE ADVANTAGE

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*i-APC is uniquely positioned with flexible
supporting teams and experienced experts to
deliver innovative solutions.*