NAPCON

NAPCON OPTIMIZER

NAPCON™ Optimizer maximizes profit directly through plant-wide economic optimization. NAPCON Optimizer is based on a dynamic real-time optimization concept, a state-of-the-art optimization technology. It is an ideal solution to ensure competitiveness at any market situation.

NAPCON IMPROVE

- **NAPCON CONTROLLER**
- **NAPCON OPTIMIZER**

NAPCON OPTIMIZER BENEFITS

- NAPCON Optimizer offers superior profit maximization performance by running optimization on a minute-by-minute basis during both steady-state and transient phases.
- NAPCON Optimizer maximizes profit through plant-wide economic optimization that takes into consideration product prices, raw material and utility costs.
- Sustainability objectives, such as energy efficiency, decarbonization targets or emissions reduction, can be included in the plant-wide objective function.
- Early start; NAPCON Optimizer starts to earn its economic benefits and maximize profit already during the commissioning of the application, as NAPCON Optimizer works well even if only a part of the optimization matrix is on.
- NAPCON Optimizer is a platform independent solution allowing utilization of existing advanced process control (APC) applications.

NAPCON OPTIMIZER KEY FEATURES

- Economic optimization inherits all benefits and advantages of advanced process control.
- NAPCON Optimizer works on top of advanced process control applications. It gives new target values for APC controlled variables and possibly new set points directly to certain DCS controllers.
- NAPCON Optimizer maximizes production profits by economic optimization. It coordinates existing Advanced Process Control applications provided either by NAPCON or other vendors.
- The optimization objective function is adjustable, allowing flexible prioritization between economic optimization, production objectives, sustainability, control targets and constraints. The objective function consists of product revenue, feedstock costs, utility costs and other relevant production costs and revenues.
- Optimization is continuously performed both during steady-state and process transients. A typical optimization execution cycle is 1 to 2 minutes.
- Optimization is carried out within the envelope set by current process constraints and other limits.
- NAPCON Optimizer is applicable to both linear and non-linear processes.

PLANT-WIDE OPTIMIZATION
CASE EXAMPLE

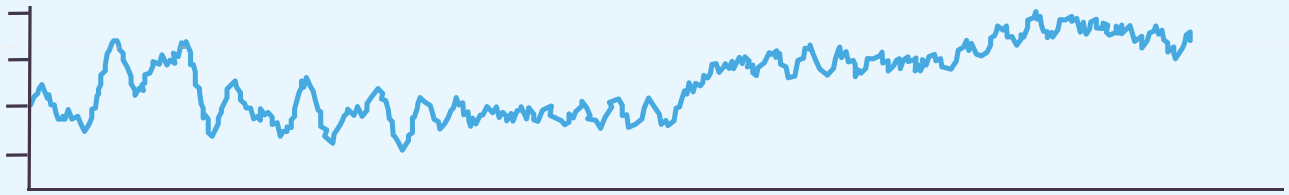
Plant-wide optimization is a concept for plants where the production maximization of a single unit leads to suboptimal performance of other units. This is a case for most plants producing multiple products or having a reactor as a part of the production process.

Plant-wide optimization is especially powerful for plants where constraints or bottlenecks cannot be relieved locally. This means that a change of process parameters in a single unit doesn't help, but changes need to be made in upstream units.

An example of such a plant is olefins production at a naphtha cracker. If e.g. the overhead system of a deethanizer column is constrained in the cold section of a cracker, the best action may not be to react with column reboiling and reflux nor by reducing the total feed flow rate to the plant. Instead, the plant-wide optimum may be to adjust the severity in the upstream cracking furnaces. In such a case, NAPCON Optimizer will change the reaction conditions, and thus modify the composition of the reactor effluent. It will find the best solution to simultaenously resolve the downstream constraint and to keep the profit on a high level.

Another example could be a cracked naphtha hydrodesulphurization unit on a petroleum refinery. Plant-wide optimization with NAPCON Optimizer allows real-time optimization of the sulfur content of the light and heavy naphtha fractions, the total sulfur content and the octane loss.

NAPCON Optimizer adjusts APC targets to maximize the economic objective function of the entire plant. The optimization is performed within an operating envelope set by current process constraints and other limits.



PLC OR DCS
OPERATOR CONTROL

NAPCON CONTROLLER
VARIATIONS MINIMIZED

NAPCON CONTROLLER
PROCESS ON UPPER LIMIT,
10–15 % MORE PROFIT

NAPCON OPTIMIZER
MAXIUM ACHIEVABLE PROFIT,
5 - 10 % MORE PROFIT

*"First we tried to keep the specs by **manually** adjusting temperature and flow rate set points on our product"*

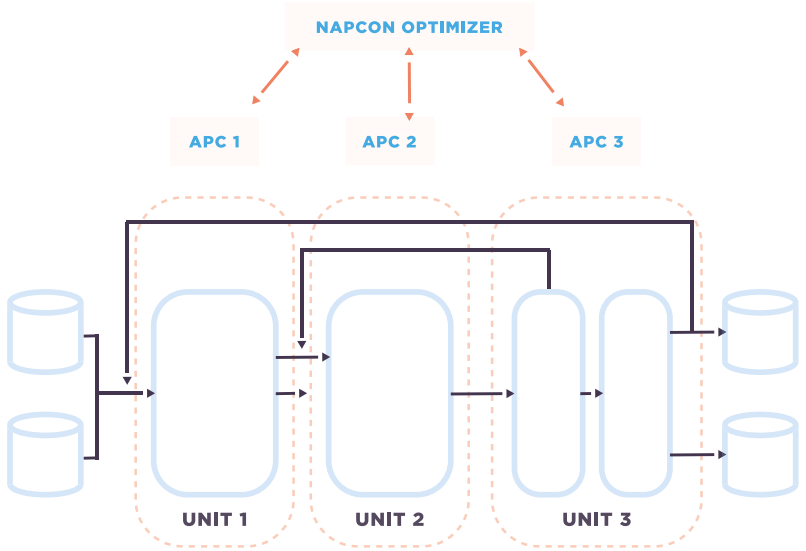
*"Then we installed **NAPCON Controller.** Product variations reduced dramatically and we could move closer to the specs! This paid off by improved energy efficiency, better yields and higher throughputs."*

*"The ultimate benefits were gained when we mounted **NAPCON Optimizer** to coordinate the APCs and to take care of plant wide optimization. It manipulates the process conditions to get maximum profits."*

Economic optimization inherits all benefits and advantages of advanced process control. In the core of the NAPCON Optimizer, there is a configurable optimization problem that is formed and solved at each optimization cycle. The optimization problem expands the advanced process control problem stated by the model predictive control (MPC) algorithm by introducing an adjustable economic objective function in addition to standard MPC objectives.

Economic optimization, production objectives, process control targets (such as product quality) and various constraints and limits are conveniently integrated to NAPCON Optimizer's optimization problem utilizing versatile variable types and tuning parameters that are easily accessible through NAPCON's user friendly tools. Optimization is based on dynamic models between manipulable process variables and optimization objectives.

Efficient handling of process constraints and other limitations is essential for economic optimization. NAPCON Optimizer supports several different constraint types, thus enabling solution design that best fits for the process in question. In NAPCON Optimizer, all constraints are constantly monitored, but only the currently most limiting ones affect to the solution at each control cycle. The constraining values are adjustable as required based on process state and operative situation.



- Maximizes the economic objective function
- Coordinates the local APCs
- Releases constraints on unit APCs
- Takes care of overall plant-wide constraints

- Manipulates APC targets
- Manipulates APC constraints
- Manipulates DCS set points

Most chemical plants are complex facilities with challenging dynamics and long delays. It can be seen in practice in the way the the actions taken in the upstream units dictate the process state in the downstream units. The key to operate such a plant in a productive and consequent way is firstly to run individual units in an optimal way with advanced process control (APC) solutions. Secondly, in order to run the entire facility optimally, the APC solutions must work in unison. NAPCON Optimizer is in the plant automation hierarchy on a higher level than the APCs. It takes care of plant-wide optimization by coordinating the APCs.

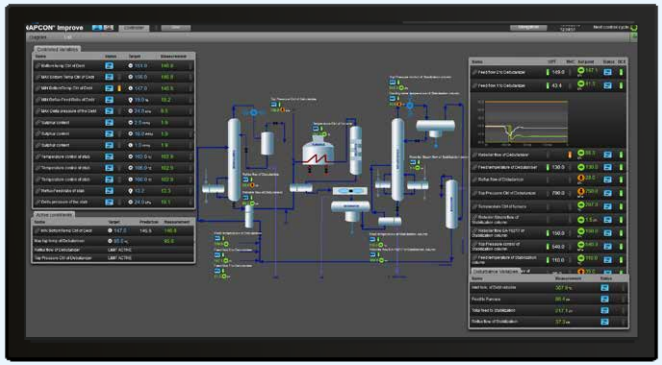
NAPCON Optimizer has versatile variable types to facilitate plant-wide optimization

- Economic objective function, in most cases plant gross margin before fixed costs, spanning product revenue, feedstock costs, utility costs and other production costs and revenues
- Several controlled variable (CV) types: maximization and minimization, target, asymmetric, dead band, asynchronous analyzer with fault checking to name but a few
- Several maximum and minimum constraint types
- Feedforward disturbance variables (DV) to compensate for measured and estimated disturbances
- Manipulated variables (MV); new values calculated at each execution cycle are sent to underlying APC solutions and DCS as new target values or set points to push the entire production facility to the optimum
- Online MV optimization if extra degrees of freedom are available
- Online model adaptation

NAPCON OPTIMIZER USABILITY AND CONFIGURATION

The usability of NAPCON Optimizer has been designed with panel operator's work flow in mind. The most convenient way to operate NAPCON Optimizer is through web displays. Web technology allows integration of NAPCON Optimizer user interface with the operating environment of existing advanced process control solutions (NAPCON Controller or other APCs) and the underlying process control system (DCS). As plant-wide optimization applications are highly complex by nature, the user interface facilitates focusing on the most important topics that need operator attention. Its objective is also to provide an overview of the application and to allow drill-down.

- There is a separate user interface for configuration, tuning and troubleshooting the NAPCON Optimizer applications.
- NAPCON Controller faceplates show an overview of the application for tuning, providing access to the full spectrum of control parameters.



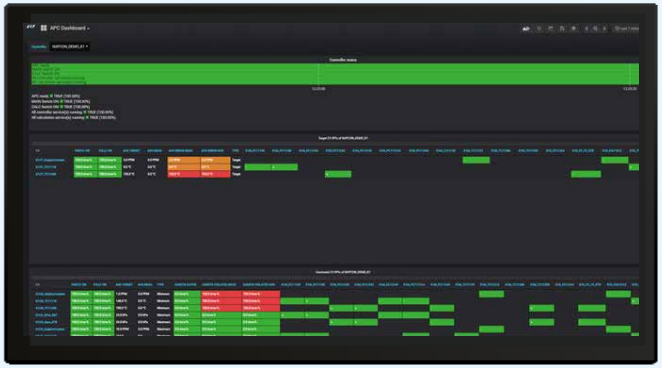
NAPCON Optimizer operator user interface is based on the web technologies. It can be seamlessly integrated to all modern DCS operating environments and facilitates fluent workflow for panel operators.

Same modeling and configuration tools can be used with NAPCON Optimizer as with NAPCON Controller:

- NAPCON Optimizer needs dynamic models on the process, automation and economy. They are identified with NAPCON Modeller with just a few clicks. For maximum robustness of control models, NAPCON modeling tool features regularization, variable bounds and partial model identification. If needed, NAPCON Modeller provides tools to remove outliers and other undesired data features.
- NAPCON Configurator offers an easy configuration process which is facilitated by an intuitive user interface.
- NAPCON Improve Dashboards provide extensive reporting and visualization capabilities for optimization and control performance monitoring. Flexible dashboard architecture allows a straightforward addition of user defined KPIs. Dashboard is based of the latest web technology and offers full customization of the UI elements for great usability.
- Full integration with NAPCON Analytics, a powerful calculation and reporting platform whose features allow to:
  - create on demand calculations and data visualization with a web application to be used for analytics, monitoring, big data etc.
  - support for 3rd party data analysis libraries

NAPCON Optimizer faceplates are convenient engineer user-interfaces to adjust tuning parameters online.

NAPCON Optimizer can be configured with NAPCON Configurator that is integrated with NAPCON Modeller and NAPCON Informer to support seamless workflow for configuration of the applications.



NAPCON Improve Dashboards offer extensive reporting and visualization capabilities for optimization and control performance monitoring. Default KPIs facilitate easy insight on results. Flexible web-based dashboard architecture also enable user-defined KPIs to monitor behavior of NAPCON Optimizer applications

Trend views offer a convenient way to monitor optimization performance. Versatile trending options are available for optimization and control performance as well as for tuning and model parameters.

OPERATIONAL SAFETY AND RELIABILITY

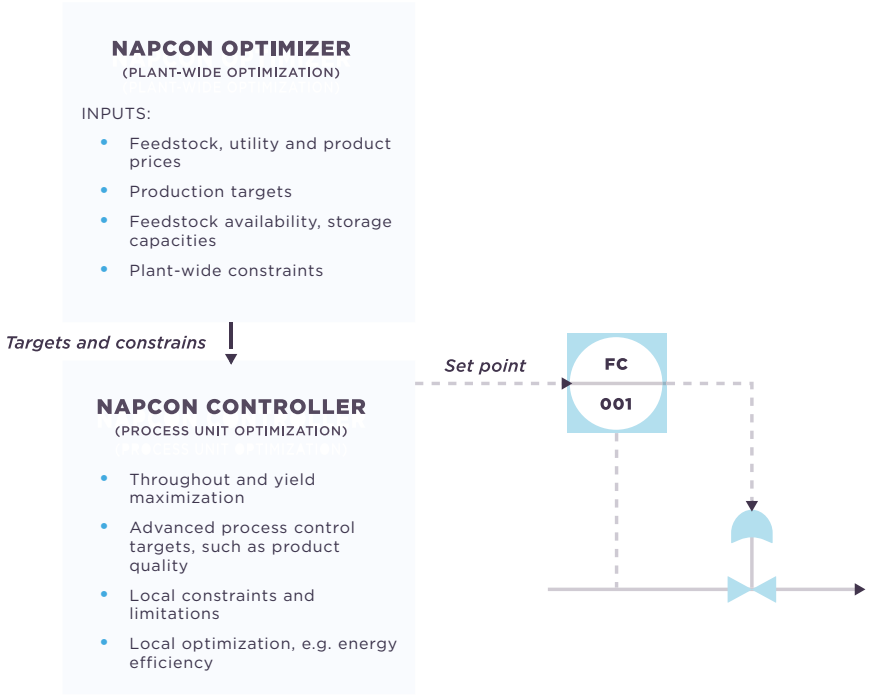
- NAPCON Optimizer interfaces to the underlying process control system (DCS or PLC) through safety loops in order to ensure.
- NAPCON Informer goes above and beyond to ensure reliable operation of NAPCON Optimizer and provides:
    - Excellent scalability with high data throughput
    - Wide support for security features: encrypted OPC UA communication, antivirus software, whitelisting, user identification, encrypted data transport, certificates.

OPTIMIZATION ALGORITHM AND ADVANCED PROCESS CONTROL

NAPCON Optimizer calculates optimal target and constraint values for underlying advanced process controllers as well as optimal set point values for certain basic process controllers in the DCS. The calculation of optimal control moves is based on dynamic process and economy models. Optimality is defined as:

- maximization of the economic objective function consisting of product revenues, feedstock costs, utility costs and other relevant production costs and revenues
- maximization or minimization of certain process variables
- meeting the user-specified advanced process control targets (such as product specifications)
- respecting the constraint values defined for process variables, valve positions and controller outputs
- obeying the limits for rate of change for the manipulated APC target values and DCS set point values, as well as the minimum and maximum limits of manipulated variables

Optimal values are calculated on every execution cycle, typically once in every one or two minutes. A new optimization problem is formed on each cycle, reflecting the current process state, process history and predictions on future states. The resulting sparse optimization problem is solved at each execution cycle with an efficient interior point NLP optimization algorithm.



NAPCON Optimizer works on a higher level than NAPCON Controller and other APCs. NAPCON Optimizer calculates new optimal target and constraint values for APC applications on each execution cycle. The objective is plant-wide optimization of an economic objective function while respecting plant-wide constraints and production targets. The cycle length is adjustable, but typically one or two minutes.

PLATFORM – NAPCON INFORMER

NAPCON Informer is the process information management system that forms the platform for NAPCON Optimizer. NAPCON Informer has several key tasks for enabling NAPCON Optimizer application to run:

- It coordinates the execution of various NAPCON Optimizer applications, required on-line calculation applications, and other supporting applications.
- It takes care of communication with other systems. OPC UA protocol is used for the communication. The most important is the communication with the process control system (DCS).
- Process measurements, NAPCON calculation results and its tuning and other parameter values are stored in NAPCON Informer database.
- NAPCON Information Manager offers an engineering user-interface for NAPCON Optimizer.

NAPCON Informer consists internally of two components, which are:

1. NAPCON UA Server

- Standard OPC UA Server
- OPC UA compliant information modelling
- Information models for various variable types needed by NAPCON Optimizer
- Storage of current values of OPC UA nodes (measurements, configuration parameters, meta data etc.)
- Dynamic modification of the OPC UA address space
- Built on Microsoft .NET technology

2. NAPCON History Database

- Store historical data for process data, alarms and events for further use, e.g. trending, reporting, data analysis and troubleshooting
- PostgreSQL database technology. Object-relational database optimized for time-series storage
- Several schemes for data compression
- Buffered input to even out momentary high loads of data transmissions.

NAPCON Informer has many excellent features that improve the usability, reliability and security on NAPCON Optimizer applications

- Excellent scalability with high data throughput capability
- Security features that are built into OPC UA: message encryption and signing, user and application identification
- Application monitoring & logging for efficient maintenance
- Automated scheduled backup on remote PCs.
- Independent user operations via Windows Service based components
- Windows 64 bit platforms

WEB-BASED OPERATOR USER-INTERFACE

NAPCON Improve Operator Interface is implemented with browser-based web technologies. This makes the user-interface platform-independent, and allows its installation on the operating stations of all modern process control systems (SCADA or DCS).

Supported browsers are Chrome, Firefox and Edge. The user interface does not require an Inter-net connection.

NAPCON Improve Operator Interface is directly linked with NAPCON Informer database. There is also an easy-to-use tool for designing and configuring NAPCON Optimizer user-interfaces, called NAPCON Improve Operator Interface Designer. This tool links directly with NAPCON Informer database, too.

ON-LINE PROCESS CALCULATIONS

On-line process calculations form a vital part of all plant-wide dynamic real-time optimization applications. They can range from simple mathematical operations (such as calculation of the difference between two temperature measurements) to computation of virtual analyzers or inferentials to estimate important product properties in real-time (such as composition, distillation end point or humidity of a powder product).

NAPCON suite includes three different types of on-line calculations:

- Simple mathematical calculations can be directly implemented to the database in NAPCON Information Manager.
- NAPCON CalculationFrame enables definition of most complex calculation using C# programming language.
- NAPCON has rigorous on-line calculation packages for typical process industry units, TISLA package for distillation column calculations and NAPCON PPP for reactors

REQUIREMENTS

NAPCON Controller and supporting software components are installed on a server in a DMZ area in the plant automation network.

Hardware requirements (typical APC application with 10 manipulated variables):

- CPU with 6 core or more
- Memory at least 16 GB RAM
- Hard disk requirements depend on desired extent and length of stored process history.
- Part of our delivery scope is to define hardware that is best matched for user needs.

Operating systems:

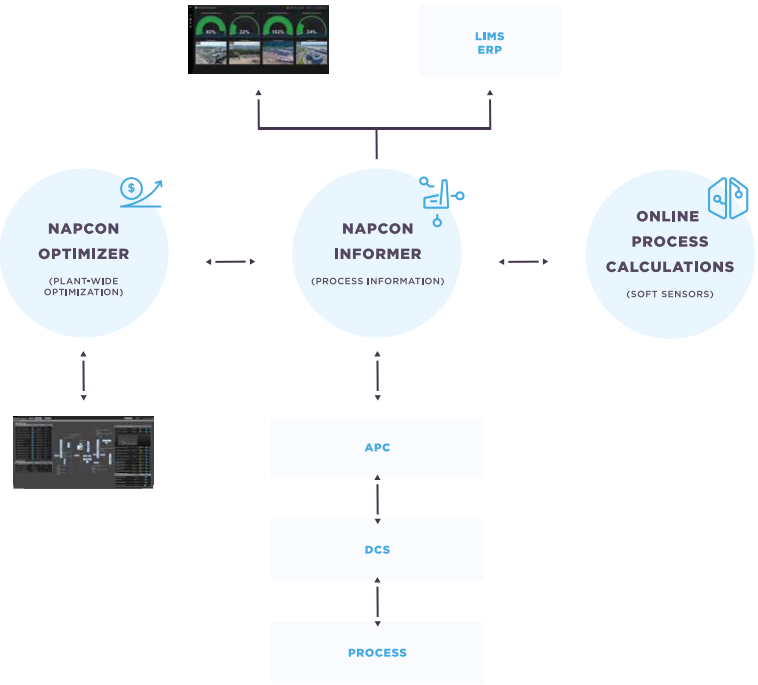
- Windows Server 2019
- Windows Server 2022
- Windows 10

NAPCON recommends virtualization, but can naturally be directly installed on a physical server. E.g. VMware and Hyper-V are supported virtualization platforms.

NAPCON can be connected to a process control system (DCS or PLC) that supports OPC UA communication either native or with OPC UA gateway.

COMMUNICATION

- NAPCON Optimizer operates on ISA95 level 3 on top of a process control system (DCS) and advanced process control solutions. The interaction with DCS ensures process and function safety, and enables operation at maximum level of cyber security.
- The communication between NAPCON Optimizer and underlying systems (APC & DCS) is run through NAPCON Informer which is OPC UA certified database, providing the following features:
  - OPC UA interface certified by OPC Foundation. Certified profiles:
    - Standard Server / Data Access Server / Method Server
  - Two-way connectivity to external systems (eg. DCS) using OPC UA protocol
  - Configurable history data collection
  - OPC UA standard access to current and history data
  - OPC UA standard diagnostics
  - Transfer of rich data utilizing OPC UA information models (eg. APC configuration, measurements, etc)
  - OPC UA built-in security features (message encryption and signing, user and application authentication)
- NAPCON Optimizer can be linked together with several NAPCON Controller solutions, and also with APC solutions from other vendors, through secure OPC UA interface featured by NAPCON Informer.
- Full integration with NAPCON Analytics provides custom online process calculation and soft-sensing capabilities.



NAPCON

UNDERSTAND

NAPCON Understand solutions will turn the data provided by your plant into relevant information that helps to optimize your company's production.

NAPCON Informer
NAPCON Analytics

IMPROVE

NAPCON Improve solutions will bring out the maximum potential of your operations and helps you to ensure that your investments meet your strategic goals.

NAPCON Controller
NAPCON Optimizer

TRAIN

NAPCON Train solutions will bring the real life plant into the virtual world, making training operators and testing the limits of your plant safe and exciting.

NAPCON Simulator
NAPCON Games

WWW.NAPCONSUITE.COM
NAPCON@NESTE.COM
+358 (0)10 458 11