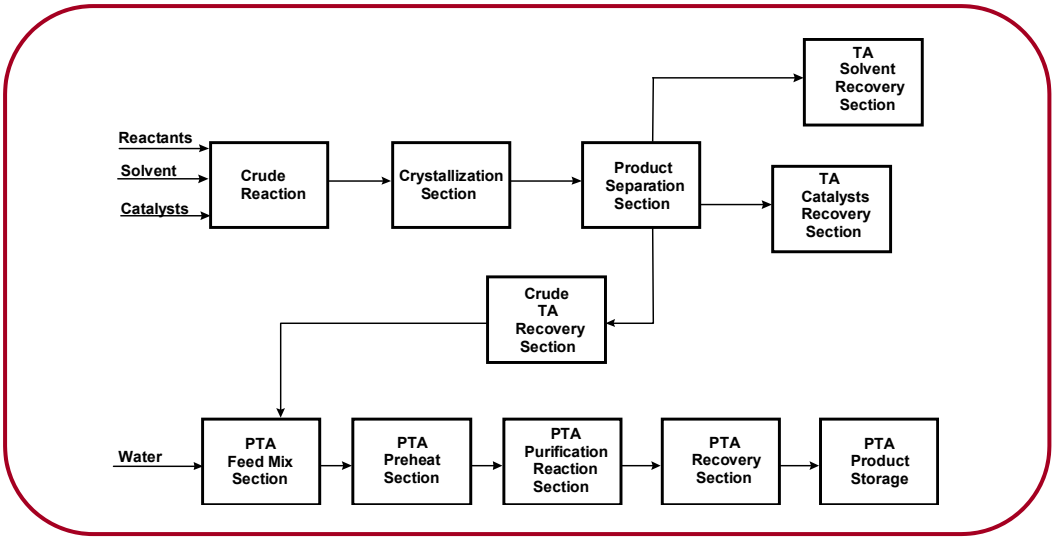
Intelligent Optimization Group

TA/PTA - Advanced Process Control



Description *Intelli*Opt's Advanced Process Control (APC) technology comprehensively covers the process areas of feed mix, oxidation reactors, dehydrator, hot oil heater, slurry feed mix and PTA hydrogenation reactor, to improve profitability while maintaining product quality and honoring process operating limits.

Control Schemes The TA/PTA unit APC applications are composed of DCS based advanced regulatory controls, combined with GMAXC™ based Multivariable Predictive Control (MVPC) of the TA oxidation reactors. Typical control strategies include:

- TA Feed Preparation Control: Maintain the catalyst concentration in the feed, and the feed drum level.
- TA Oxidation Reactors MVPC: Maintain the product qualities (4CBA and Transparency), excess oxygen, burn rate and reactor temperatures by simultaneously adjusting the feed rate, air rate, reactor level, reactor pressure and water withdrawal rate
- Dehydrator APC: Maintain the water concentration in the bottoms acid stream, and minimize acid loss in the overhead.
- Hot Oil Heater Control: Maintain the heater outlet temperature and excess oxygen at its optimal setpoint.
- PTA Slurry Feed Control: Maintain slurry drum level and percent solids in slurry feed.
- PTA Feed Preheat Energy Minimization: Maximize energy recovery from process streams while maintaining reactor feed temperature.
- Crystallizer Level Control: Valve flushing logic with user selectable frequency and severity to avoid line pluggage.
- PTA Hydrogenation Reactor Control: Maintain desired conversion of 4CBA by proper control of reactor level, pressure and hydrogen concentrations.

GMAXC Controller *GMAXC*/MVPC, an integrated matrix approach is utilized to control all targets simultaneously in both the steady state and transient states by adjusting the manipulated variables, monitoring and respecting process constraints, and incorporating the effect of measured process disturbances. The algorithm uses dynamic response models to predict the responses of controlled variables.

The control moves in the manipulated variables are calculated to minimize steady-state and transient deviations of controlled variable from their targets. Optimization is integrated with the control problem formulation to generate a least cost solution in terms of manipulated variable costs.

Computer Platform The GMAXC software can be implemented on Rack-Mounted Industrial Computers (RIC) with Windows™ operating system. A simplified fill-in-the-blanks type spreadsheet approach is used for configuring the OPC/DDE interface between the DCS/PLC and the GMAXC/PC. This low cost investment can lead to payback periods of 6 to 12 months.

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Frequently Asked Questions:

- **What are the advantages of using Multivariable Predictive Control technology over conventional regulatory schemes**

  The MVPC technology is more suited for processes involving many variables, multiple interactions and significant response delays between inputs and outputs. The MVPC controller incorporates both feedback and feedforward type control actions in controlling both the present and predicted trajectories of the controlled variables. Constraint pushing and cost optimization can also be easily added to the control matrix. While it is possible to configure several DCS blocks with feedforwards, ratios, etc., MVPC provides an elegant approach that can reduce lifetime maintenance costs and generate higher benefits. The GMAXC/MVPC controller is also available as a function block in the Moore APACS DCS.

- **How does GMAXC compare with other Multivariable Predictive Controllers**

  The MVPC technology is over 20 years old. But, despite this long history and a wide base of implementation, MVPC technology typically takes about six months to implement and can cost several hundred thousand dollars per installation. With the recent advances in hardware and software, GMAXC offers the MVPC technology at a commodity level for rapid implementation by in-house or third party personnel. The main advantages are in the areas of model identification, DCS interface and overall ease of usage. In some cases, the GMAXC controller has been implemented in weeks, and these automated plants operate unmanned during week-ends and night shifts (see "Advance Process Control in Record Time", Shawn Wilhelm and David Seiver, CONTROL, May 1999).

- **How long does it take to implement GMAXC/MVPC for a TA/PTA Plant**

  For a typical TA/PTA plant, we can offer a complete online GMAXC/MVPC solution in about 3 to 6 months time, subject to plant testing availability for dynamic models identification.

- **What is Plant Testing and how long does it take**

  In plant testing, the independent process variables (e.g. feed rate, air flow rate, reactor pressure, etc.) are perturbed by about ±3% to study their interactions with dependent variables (e.g., product qualities, vent oxygen, burn rate, etc.). Typically, it takes about 12 hours for each set of 5 independent variables, and the total plant testing is expected to take about 36 to 48 hours.

- **Are Product Analyzers necessary**

  With the availability of Neural Network technology, it is possible to develop online inferential predictions for 4CBA and Transparency. Lab analysis can be used on a periodic basis to update the models.

- **What are the minimum Hardware and Software investments**

  Assuming the availability of a DCS system, the hardware requirement is an average Pentium PC with Ethernet connectivity to the DCS system. The software requirements are GMAXC, DCS DDE/OPC Server and GMAXC DDE/OPC Client.

- **References**

  "APC Improves TA/PTA Plant Profits", Hydrocarbon Processing, October 1997 – TEMEX, Mexico
  SamNam Petrochemicals Ltd., Korea, TA/PTA and QTA Plants