QUALITY MONITORING & CONTROL

QMC Suite of Software Programs, Custom Software & Technical Consulting for the Process Industries

“What do you want to solve today?”

Quality Monitoring & Control
6942 FM 1960 East, Suite 388  Humble, Texas 77346
832.257.3818  Consultant@QMC.net  www.QMC.net
QMC Mission
Quality Monitoring & Control is committed to deliver only the "Very Best" products and services that will contribute to the success within the process industries.

QMC Consulting Services
QMC provides expert consultation for design, development and implementation of technical products and systems analysis. Familiar with field concepts, practices, and procedures, QMC has extensive experience, background and software to resolve highly complex technical issues and accomplish process goals and objectives.

QMC Performance
QMC provides computer programming applications and associated technical consulting for the process industries. Our unified approach and custom programming assists clients to use data effectively, improve energy efficiency, maximize product quality, and maintain optimum control. QMC confidently provides solutions by:

- Understanding the Field
- Experience in Engineering
- Experience in Software Development
- State-of-the-Science Technologies
- Esteemed Associates
- Focus on Data
- Focus on Equipment
- Focus on Process
- Focus on Improvements

QMC Projects
- Fluidized Bed Combustion
- NOx Reduction for Dual Fuel Boiler
- Multi-Compressor Turbine Modeling
- Flow Meter/Sensor Error Verification
- Plant Mass & Accounting Balance
- Dynamic Compressor System
- Compressor Failure Analysis
- Process HAZOPs
- Crude Oil Plant Design
- Neural Net Process Optimization
- Refinery Process Design
- Batch Reactor & Purification
- Ethylene Plant Modeling
- Polymer Plant Dynamics
- Batch Flare Incineration
- Turbo Compressor Surge Control
- Advanced Process Controls
"What do you want to solve today?"

**QMC Suite of Software Programs**

QMC software offers a “unified” approach in a seamless, graphical suite of programs available as Windows based and / or Internet based (ActiveX). QMC provides multi-strategy programs of advanced technologies to maintain any process at optimum conditions. Monitor equipment, sensors, control applications. Evaluate alternates for optimization. Migrate models and data to real-time applications. Integrate models with economics. Graphically pinpoint & remove bad data. Filter and smooth data. Apply transforms. Analyze pipe and flow element systems. Rate, size or develop equipment specifications. Provides statistical analysis. Monitor SPC variables. Tune, configure and optimize multivariable control loops. Measure unit stability, quality, safety, reliability, and profit.

In summary, the “unified approach” of the QMC Suite assists clients to use data effectively, improve energy efficiency, maximize product quality, and maintain optimum control. QMC proudly provides:

- Data Mining & Modeling
- Process Equipment Design
- Flow Meter and Sensor Error
- Steady State Modeling
- Dynamic Process Modeling
- Yaws Physical Properties
- Statistical Process Control
- Power Reactor and Kinetics
- Financial Analysis
- Process Control & Tuning
- Advanced Process Control
- Reciprocating Compressor
- Centrifugal Compressor
- Thermal Network Analyzer
- Units Conversion & more..

**QMC Programming Services**

QMC provides computer programming applications for the process industries from data modeling through dynamic simulations through advanced process control. QMC programming services include conversion of early software programs to the current generation Windows format and to web based (Intranet/Internet) ActiveX application format. Process engineers provide custom programming for all sectors of the chemical industries. The majority of QMC technical staff and associates are accomplished computer programmers with specialties in Visual Basic, Visual C, FORTRAN, JAVA and HTML.

**QMC Staff**

QMC Technical Staff, Associates and Programmers are MSChE or PhD. All are knowledgeable and respected within the industry.
The QMC Suite of Programs provide an easy user interface for young engineers while advanced users find the technology strengths unlimited for a quality driven focus for continuous improvements to the process industries. The QMC Programs are currently in use at several major chemical companies, NASA, and in course curriculum at universities such as Rice and Texas A & M. The QMC programs have also been fully reviewed by the Microsoft Development Programming Group.

The QMC SUITE of complementary tools is user-friendly, powerful, and provides results in many usable formats. Results oriented, the QMC SUITE has been proven to provide a 2%-5% profit improvement, 10%-50% variability reduction, 10%-50% equipment / sensor & controls reliability improvement, and reduced safety and environmental excursions. We do not make these statements lightly, but with the QMC slate of products, technology base and "unified approach", we feel confident that you will agree.
QMC offers complete confidentiality, 100% satisfaction and 24-hour technical support. For our licensed clients, we also provide, at no cost, the free implementation of requested features and/or programs within the scope of user selected QMC software.

We look forward to further discussing our advanced technologies that allow the enhancement of product quality, monitoring and control. We look forward to working with you.

Please visit our web site at www.QMC.net.
QMC SUITE OF PROGRAMS
for Windows

Focus on the Data ..... 

- Interface with Excel seamlessly
- Pinpoint & remove outliers graphically
- Complete statistical analysis
- Choose from over 200 data transforms
- Smooth & plot data in single operation

Focus on the Equipment ..... 

- Perform hydraulic analysis on piping systems
- Size a wide variety of flow meters
- Check vendor design of pumps & compressors
- Rate performance of shell & tube exchangers
- Analyze vapor/liquid separation systems

Focus on the Assessment ..... 

- Monitor for sensor integrity
- Tune control loops with ease
- Configure optimum control loops
- Provide early warning of equipment problems
- Measure unit stability with “QualityIndex”
Focus on the Process ....

- Model your plant quickly & efficiently
- Select neural nets or powerful hybrids for modeling
- Integrate high fidelity models with plant economics
- Create what-if scenarios for technical analysis
- Maintain your plant at optimum conditions

..... and on Your Benefits

- Unlock the latent value of your data historian
- Identify/correct root cause of process instabilities
- Monitor advanced process control applications
- Evaluate tactical alternates to optimize your plant
- Support abnormal situation management initiatives

Data Mining Programs
Engineering Programs
Advanced Process Control Programs
Statistical Process Control Programs
Simulation Programs
Compressor Programs
Optimization Programs
Artificial Intelligence & Expert System Programs
Flow Meter & Sensor Error Detection Programs
Health, Safety & Environmental Programs

GENERAL FEATURES

- Windows 95/98/NT
- Seamless interaction
- Access all programs in Windows environment
- Run multiple programs & projects
- Status reporting
- Migrate models & data between programs
- Screen graphical capabilities
- Start, pause & stop capabilities
- Cut / copy / paste capabilities
- Excel data interface
- Word reports and graphics import

- Interface with email & Explorer
- Menu oriented
- Print, Print setup, Preview & Print screen
- Taskbar access to programs & browser
- QMC Internet:
  - Online Support
  - Download
  - Support User Manual
  - Technical Pages
  - Home Page

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QMC SUITE OF PROGRAMS

QMC DATA MINING PROGRAM for WINDOWS
QMC DATA MINING PROGRAM is a multi-strategy program to maintain any process at optimum conditions. DataMining tools for screening, modeling, auditing, monitoring, control & optimization. Monitor equipment, sensors, control applications. Evaluate optimization alternates. Migrate models & data to real-time. Integrate models with economics. Graphically pinpoint & remove bad data. Data filtering, smoothing & 100+ transforms. Analyze pipe & flow element systems. Rate, size or develop specs for flow, pumps, compressors, heat exchangers, vessels & separators. Provides statistical analysis. Monitor SPC variables. Tune, configure and optimize multivariable control loops. Measure unit stability, quality, safety, reliability, profit. Over 600 programs and features guarantee 2%-5% profit improvement, 10%-50% variability reduction, 10-50% equipment / sensor / controls reliability improvement and reduced safety / environmental excursions.

QMC ENGINEERING PROGRAM for WINDOWS
Engineering environment for all process systems, such as pump and compression, heat transfer, separation, mixing, and reaction. An essential tool for implementation, completion or troubleshooting individual tasks or total process design projects. Programs include unit conversions, flow elements, pumps, compressors, heat exchangers, vessels and separators. Easy interface for sizing, specification, and rating of piping, equipment, instrumentation and controls. Results provide calculations, operating costs, artificial intelligence for design selection, etc. Interfaces with Word, Notepad, WordPad, Excel or email for report generation. Ideal for project personnel or to email specs to vendors. Includes physical properties, electrical, mechanical and standard process engineering conversions. References for calculation basis are provided.

QMC MIMT© PROGRAM (Flow Meter & Sensor Error Detection) for WINDOWS
The QMC MIMT© PROGRAM is an advanced data and measurement error detection program solving linear and non-liner data-reconciliation / gross-error-detection problems. For a given set of measured data, a reconciled data set is generated, i.e., consistent with applicable constraints, such as material balance or model, based requirements. It generates a list of measurements, suspected of gross error, and estimates the correct values of the suspect measurements. Includes total material balances, temperatures, pressures, etc. for chemical processes or plants, steam-metering systems in plants and refineries, and natural gas distribution systems. Applicable to any data set where measured variables are related by a system of linear or non-linear algebraic equations.

QMC DYFLO PROGRAM for WINDOWS
The QMC DYFLO PROGRAM is a dynamic and steady-state process simulator with a full physics based simulator based on a time dependent method. It includes all physical/chemical property calculations with a flow sheet generator interface. Model in a dynamic time domain for tanks, pumps, compressors/expanders, heat exchangers, pipes & valves, control valves, controllers, reactors/combustors, distillation, etc. The QMC DYFLO Program methodology has been successfully used in chemical processes for over 30 years with many benefits for system analysis and robust methods for actual operations evaluation.
QMC SUITE OF PROGRAMS

QMC YAWS PROGRAM for WINDOWS

The QMC YAWS PROGRAM provides engineers and scientists the most accurate information available on how chemicals behave at different temperatures or how chemicals behave under different conditions. The QMC YAWS PROGRAM covers a variety of data for chemical properties and a wide variety of organic and inorganic compounds with experimental values and estimated values. The QMC YAWS PROGRAM software is based on the methods of Dr. Carl L. Yaws, well known for his extensive industrial experience in process evaluation, research, development, and design.

QMC STATISTICAL PROCESS CONTROL PROGRAM (SPC) for WINDOWS

The QMC STATISTICAL PROCESS CONTROL PROGRAM provides statistical evaluation and control for sampling, measurements and flow chart monitoring and analysis of continuous and batch systems. The result is control of processes based upon statistical testing and by addressing trends, followed by decomposition of the process. Intelligent feedback to automated corrective action based upon real-time analysis in processes of all types. Variability is systematically reduced. Closed loop control makes process management a reality. Program includes standard sequential statistical approaches; exploratory analysis; data screening; modeling; optimization; experimental design and multivariable run charts and flow charts.

QMC RECIPROCATING COMPRESSOR PROGRAM for WINDOWS

The QMC RECIPROCATING COMPRESSOR PROGRAM is designed for selecting appropriate driver, compressor frame and cylinders (double acting, single acting, tandem pairs, and blank throws) and evaluating performance for various unloading configurations at multiple operating conditions. Computes gas properties. Flags values for temperature, pressure, speed, horsepower, volumetric efficiency, valve pressure drop, rod load, cross-head pin reversal, etc., when limits exceeded. Engine, frame and cylinder databases may be created. Engine horsepower automatically derated for site elevation, ambient temperature, speed and auxiliaries. Accommodates up to a maximum of 10 throws, 4 services, 5 stages in a single service, and a maximum of 6 stages for all services.

QMC CENTRIFUGAL COMPRESSOR PROGRAM for WINDOWS

The QMC CENTRIFUGAL COMPRESSOR PROGRAM generates a mathematical model of the compressor from input of the manufacturer's compressor data. This provides the basis for the compressor calculations. The program calculates compressor performance at specific conditions and simulates the complete compressor system over a wide range of operations, including, but not limited to, start-up, normal operation at steady and varying load conditions, including anti-surge, normal and emergency shutdowns, and safety valve relieving conditions. A single compressor train with 1 or 2 services with a maximum of 6 stages (compressor sections) total can be simulated.

QMC POWER REACTOR PROGRAM for WINDOWS

The QMC POWER REACTOR PROGRAM is used for reactor design and analysis. Reactor design types include any reaction system configuration to verify reaction kinetics, subsequent simulation, and optimization for varying flows and stoichiometric concentrations, surface / catalytic / metal / side-reactions, and to verify complete kinetic routes. This includes any number of stages and any reactor type: Batch, Semi-Batch, CSTR, Plug Flow, etc. For kinetics, the user needs associated data, reaction mechanism(s), and physico-chemical properties. Values can be regressed as part of the analysis. Reaction mechanism(s) and kinetics can be verified.
QMC SUITE OF PROGRAMS

QMC ADVANCED PROCESS CONTROL (APC) PROGRAM for WINDOWS

The QMC ADVANCED PROCESS CONTROL PROGRAM includes Multivariable Dynamic Matrix Control, Quadratic Matrix Control, Biggest Log-Modulus Tuning Control, Adaptive Control, VB Model Control, Neural Network Control and Polynomial Model Control. Includes data conditioning and systems identification modules.

QMC THERMAL NETWORK ANALYZER (TNA) PROGRAM for WINDOWS

The QMC THERMAL NETWORK ANALYZER PROGRAM is a differential equation analyzer for thermal, radiation, fluid flow, stress, and process systems using a finite difference numerical integration technique. Steady state and transient analysis are provided through an easy block and stream flow sheet graphical interface. The QMC TNA Program provides thermal and fluid component design to full system performance. Based on the NASA SINDA methodology, the time dependent, graphical results provide solution techniques and accuracy levels for precise assessment and confirmation.
# QMC Data Mining Program
for Windows

## Features and Specifications

### Data Screening

**Select Variables**
- Select individual / Select all
- Remove individual / Remove all
- Save to Excel

**Variable Transformations**
- 200 spreadsheet functions
- Multi-functions
- Multi-equations
- Boolean logic
- Point/Click functionality
- Save / Import files

**Variable Statistics**
- All standard statistics
- All correlation analysis

**Graphical DataCut**
- Graphical cut / uncut
- Focus features
- AutoScrolling
- X-Y positioning
- View all variable cuts

**Multi-Graphic DataCut**
- Normalized plotting
- Trending capabilities
- Graphical cut / uncut
- Focus features
- View all variable cuts

### Modeling

**Very Best 1st Order**
- Polynomial Series 1st Order

**Very Best 2nd Order**
- Polynomial Series 2nd Order

**Very Best 3rd Order**
- Polynomial Series 3rd Order

**Very Best 4th Order**
- Polynomial Series 4th Order

**Very Best 5th Order**
- Polynomial Series 5th Order

**Artificial Neural Networks - Linear**
- Polynomial Orthogonal 1st Order

**Artificial Neural Networks - Sine**
- Polynomial Orthogonal 2nd Order

**Artificial Neural Networks - Sinh**
- Polynomial Orthogonal 3rd Order

**Artificial Neural Networks - Tangent**
- Polynomial Orthogonal 4th Order

**Artificial Neural Networks - Tanh**
- Polynomial Orthogonal 5th Order

**Modeling Results Formats**
- QMC Results Screen
  - Step or continuous run
  - Predicted versus actual plot
  - Point relative error
  - Constrained set point values
  - Set new set point values
  - Go to selected data row
  - Run through new data files
  - Lock or unlock set point values
  - Adjustable plot speed

- QMC Sensitivity Screen
  - Calculated numerical derivatives
  - Relative sensitivities
  - Prediction relative error
  - Adjust or constrain set points
  - Open new data sets
  - Lock or unlock values
  - Prediction plot
  - Sensitivity plot
  - Go to selected row
  - Step or continuous run
  - Adjustable graph speed

**QMC Optimization Screen**
- Non-linear optimization
- Specify opt value
- Compare with actual data
- Set specific set points
- Constrain set points
- Predicted versus actual plot
- X-Y positioning
- Lock or unlock values
- Open new data sets
- Go to selected row
- Step or continuous run
- Adjustable graph speed
- Code available

**QMC ModelSolver Results**
- Provide pseudo code
- Calculate results
- Save results
- Print results
- Cut and paste code
- Change values
- User equations

**Excel Results Summary**
- Save log of models
- Current data file
- Relative error percent
- Standard error results
- Dependent variable list
- Independent variable list

**Excel Add Predicted**
- Excel interfacing
- Add predicted
- View current data set
- Comparison with Excel
- Input for Graphics

**Excel Calculations**
- Model formulas
- Statistical analysis
- Predicted versus actual chart
- Model error analysis
- Auto data entry / Auto interface
- Principal component
- Run Excel Solver
- View formula / calculation methods

**Modeling General Features**
- Open Model
- Save Model
- Graphical cut

**Graphical DataCut**
- X-Y Multi-Graphics Data Plot
- Variable Graphic Data AutoCut
- X-Y Plotting
- Run chart plotting
- Focus features
- Graphical cut / uncut
- Variable Run Chart
- Graphical statistics
- Localized run charts
- Focus features
- Graphical cut / uncut
- Variable Distribution Chart
- Normal distribution curve
- X-Y positioning
- Graphical cut / uncut
- Auto scroll
- Focus features

**Variable Graphic Data Filter**
- Multivariable standardized functions
- Localized run chart features
- Double exponential filter
- Data reconciliation / smooth
- Graphical cut / uncut
- Auto scroll
- Focus features

**Variable Graphic Data QI AutoCut**
- Model based data cut
- Statistical cut
- Quality data cut
- Run model basis
- Save model features
- X-Y positioning
- View Quality Index
- Predictive model graphics
- Pseudo code
- Show cut data
- User selection
- Import / Export models

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### Monitoring / Auditing

<table>
<thead>
<tr>
<th>SensorError Meter</th>
<th>SensorFault Meter</th>
<th>QualityIndex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor Sensor Health</td>
<td>Monitor Critical Measurements</td>
<td>Total plant auditing</td>
</tr>
<tr>
<td>1st to 5th Order modeling</td>
<td>Open existing model</td>
<td>Statistical analysis</td>
</tr>
<tr>
<td>Open existing models</td>
<td>Build new models</td>
<td>Focus on key data</td>
</tr>
<tr>
<td>Import new data sets</td>
<td>Save models</td>
<td>Open model</td>
</tr>
<tr>
<td>Sensor relative error plot</td>
<td>Run through data</td>
<td>Build model</td>
</tr>
<tr>
<td>Average &amp; Instantaneous basis</td>
<td>Go to selected row</td>
<td>Run through data</td>
</tr>
<tr>
<td>Show number of good sensors</td>
<td>4 Model analysis</td>
<td>Save model</td>
</tr>
<tr>
<td>Show number suspect sensors</td>
<td>Statistical voting protocol</td>
<td>Go to selected row</td>
</tr>
<tr>
<td>Pareto chart listing</td>
<td>Pareto chart results</td>
<td>Lock or unlock values</td>
</tr>
<tr>
<td>Step or continuous run mode</td>
<td>Relative error analysis</td>
<td>Constrain set points</td>
</tr>
<tr>
<td>Go to selected row</td>
<td>Relative error chart</td>
<td>Constrain targeted values</td>
</tr>
<tr>
<td>Average or current value basis</td>
<td>4 Model predicted versus actual charts</td>
<td>QualityIndex plot</td>
</tr>
<tr>
<td>Relative error analysis</td>
<td>Import new data sets</td>
<td>Contribution plot</td>
</tr>
<tr>
<td>Noise or bias evaluation</td>
<td>Pseudo code results</td>
<td>Predicted versus actual plot</td>
</tr>
<tr>
<td>Pseudo code results</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Equipment Performance Meter includes Valve, Pump, Compressor, Heat Exchanger, Distillation Column, Reaction/Catalyst, Boilers, etc.

- Monitor decay rates
- Efficiency analysis
- Maximum efficiency percent
- Current efficiency percent
- Average efficiency percent
- Efficiency ratio plots
- Minimum efficiency percent
- Build, Open, Save model
- Run through data
- Go to selected row
- Pseudo code results
- Graphics display
- Open new data sets
- X-Y positioning
- Statistical Analysis

### Control

#### StepTuner 1 Graphical Method
- StepTuner 2 Powell’s Method

<table>
<thead>
<tr>
<th>Tuning values</th>
<th>Pseudo code results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportional</td>
<td></td>
</tr>
<tr>
<td>Proportional + integral</td>
<td></td>
</tr>
<tr>
<td>Proportion + integral + derivative</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tuning rules:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ziegler-Nichols</td>
<td></td>
</tr>
<tr>
<td>Cohen-Coon</td>
<td></td>
</tr>
<tr>
<td>Set point ITAE</td>
<td></td>
</tr>
<tr>
<td>Direct synthesis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controller types:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal controller</td>
<td></td>
</tr>
<tr>
<td>Ideal w/derivative action error</td>
<td></td>
</tr>
<tr>
<td>Commercial controller</td>
<td></td>
</tr>
<tr>
<td>Commercial w/derivative action error</td>
<td></td>
</tr>
</tbody>
</table>

#### PulseTuner 1 Powell’s Method
- PulseTuner 2 Advanced Powell’s Method

<table>
<thead>
<tr>
<th>Plots:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportional</td>
<td></td>
</tr>
<tr>
<td>Proportional integral</td>
<td></td>
</tr>
<tr>
<td>Proportional integral derivative</td>
<td></td>
</tr>
</tbody>
</table>

| Open loop           |                  |
| Controlled variable response |          |
| Manipulated variable |                  |
| Controlled variable |                  |
| Import Excel data   |                  |

| Automatic read step test data |                  |
| Data time stamp             |                  |
| Save results                |                  |
| Plot model versus data      |                  |
| Quick view graphics         |                  |
| Pseudo code results         |                  |

### Multi-Control Analysis Relative Gain Array

- Controller pairing analysis
- Interaction analysis
- Save model results
- Pseudo code results
- Multivariable plots
- Save model results
- Pseudo code results
- Graphical control results

### Optimization

#### Golden Section Search
- Hooke-Jeeves Search
- Cauchy’s Gradient
- Newton’s Gradient
- Marquardt’s Gradient

#### Optimization General Features:

- Multivariable Regression:
  - Linear and Non-linear
  - 200 plus transform capabilities
- Save equations
- Graphical quick view results
- Add/Remove regression constants
- Boolean logic capability
- Step by step results analysis
- Graph results with error analysis
- Monitor progress in Excel
- Save results to Excel

### Equation Solver

- Multiple equation calculation
- Calculate equation results
- Open existing files
- Save files
- Print results
- Transfer to Word with table format
- Quick view results
- Cut and paste capabilities
- Document results for other users
- Exchange files with other users
- All common functions
- Advanced calculations
## General Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid &amp; Gas Flow</td>
<td>Maintain log of calculations</td>
</tr>
<tr>
<td>Mass &amp; Volume Flow basis</td>
<td>Full unit's selection</td>
</tr>
<tr>
<td>Interface with Microsoft products</td>
<td>Graphics &amp; plotting</td>
</tr>
<tr>
<td>Save / Open / Copy / Cut / Paste</td>
<td>Report generation &amp; printing</td>
</tr>
<tr>
<td>Case study feature</td>
<td>ANSI Pipe sizes &amp; schedule</td>
</tr>
</tbody>
</table>

## Flow Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>Control Valve - Wing</td>
</tr>
<tr>
<td>Control Valve - ISA</td>
<td>Control Valve - GPA</td>
</tr>
<tr>
<td>Flow Nozzle</td>
<td>Elbow Meter</td>
</tr>
</tbody>
</table>

## Controls

<table>
<thead>
<tr>
<th>Control Station</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Valve Stations</td>
<td>Velocity head basis</td>
</tr>
<tr>
<td>Valve types:</td>
<td>Equivalent length basis</td>
</tr>
<tr>
<td>Glove / Angle</td>
<td>Vapor pressure analysis</td>
</tr>
<tr>
<td>Rotating / Double ported</td>
<td>Valve vena contracta pressure</td>
</tr>
<tr>
<td>Butterfly / Ball</td>
<td>Critical pressure</td>
</tr>
<tr>
<td>Reducer ratio from 1 to 1 to 12 to 1</td>
<td>Velocity analysis</td>
</tr>
<tr>
<td>Complete hydraulic analysis</td>
<td>Critical &amp; non-critical flows</td>
</tr>
<tr>
<td>Pressure profiles</td>
<td>Laminar &amp; turbulent flow regimes</td>
</tr>
<tr>
<td>Incipient cavitation</td>
<td>Bernoulli analysis</td>
</tr>
<tr>
<td>Valve vena contracta pressure</td>
<td>Thermodynamic analysis</td>
</tr>
<tr>
<td>Critical pressure</td>
<td>Kinetic &amp; momentum correction</td>
</tr>
<tr>
<td>Valve vena contracta pressure</td>
<td>Fitting &amp; control valve velocity head</td>
</tr>
<tr>
<td>Critical pressure</td>
<td>Operating costs</td>
</tr>
<tr>
<td>Operating costs</td>
<td>Noise analysis</td>
</tr>
<tr>
<td>Noise analysis</td>
<td>Critical / Cavitation flow</td>
</tr>
</tbody>
</table>

## Pumps

<table>
<thead>
<tr>
<th>Pump Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal</td>
<td>Rotary</td>
</tr>
<tr>
<td>NPSH analysis</td>
<td>Water efficiency</td>
</tr>
<tr>
<td>Pump efficiency analysis</td>
<td>Viscosity efficiency correction</td>
</tr>
<tr>
<td>Fluid horsepower</td>
<td>Water temperature rise</td>
</tr>
<tr>
<td>Pump power</td>
<td>3-phase motor efficiency</td>
</tr>
<tr>
<td>Motor size</td>
<td>Operating costs</td>
</tr>
<tr>
<td>Single / Double suction design</td>
<td>Types</td>
</tr>
<tr>
<td>RPM analysis</td>
<td>Regenerative / Emission / Radial / Axial</td>
</tr>
<tr>
<td>Efficiency at specific speeds</td>
<td>Impeller diameter</td>
</tr>
</tbody>
</table>

## Compressors

<table>
<thead>
<tr>
<th>Compressor Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal</td>
<td>Multi-Stage Centrifugal</td>
</tr>
<tr>
<td>Complete design capabilities</td>
<td>Operating costs</td>
</tr>
<tr>
<td>Specific speed / Specific diameter</td>
<td>Compressor types:</td>
</tr>
<tr>
<td>Compressor efficiency</td>
<td>Centrifugal / Regenerative</td>
</tr>
<tr>
<td>Adiabatic analysis</td>
<td>Emission / Radial / Axial</td>
</tr>
<tr>
<td>Polytropic analysis</td>
<td>Applicable compressor types</td>
</tr>
<tr>
<td>Motor size</td>
<td>Head coefficient</td>
</tr>
<tr>
<td>Motor efficiency</td>
<td>Flow coefficient</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Flow velocity</td>
</tr>
</tbody>
</table>

## Heat Exchangers

<table>
<thead>
<tr>
<th>Exchanger Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell &amp; Tube Parallel Flow</td>
<td>Shell &amp; Tube Counter Flow</td>
</tr>
<tr>
<td>TEMA Shell &amp; Tube specifications</td>
<td>Double Pipe Parallel Flow</td>
</tr>
<tr>
<td>1 x 1 to 6 x 12</td>
<td>Double Pipe Counter Flow</td>
</tr>
<tr>
<td>1/2&quot; - 2&quot; tubes</td>
<td>Shell side pressure drop</td>
</tr>
<tr>
<td>12 - 20 BWG</td>
<td>Tube side pressure drop</td>
</tr>
<tr>
<td>Tube count estimate</td>
<td>Full hydraulic analysis</td>
</tr>
<tr>
<td>Triangular or square pitch</td>
<td>Full thermal analysis</td>
</tr>
<tr>
<td>Fouling coefficients</td>
<td>Clean &amp; fouling coefficients</td>
</tr>
<tr>
<td>Baffle spacing</td>
<td>Shell side coefficient</td>
</tr>
<tr>
<td>Bell / Kern methods</td>
<td>Tube side coefficient</td>
</tr>
<tr>
<td>8 - 120&quot; shell diameters</td>
<td>Tube wall coefficient</td>
</tr>
<tr>
<td>Entropy analysis</td>
<td>Fouling coefficient</td>
</tr>
<tr>
<td></td>
<td>Heat exchanger area</td>
</tr>
<tr>
<td></td>
<td>Heat exchanger weight</td>
</tr>
</tbody>
</table>

## Vessels & Separators

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Drum</td>
<td>Rigorous Vertical</td>
</tr>
<tr>
<td>Vane Inline</td>
<td>Wire Mesh Vertical</td>
</tr>
<tr>
<td>Wire Mesh Horizontal</td>
<td>Vane Vertical</td>
</tr>
<tr>
<td>Vertical Decanter</td>
<td>Horizontal Decanter</td>
</tr>
<tr>
<td>Vapor flood percent</td>
<td>Feed nozzle diameter</td>
</tr>
<tr>
<td>Liquid hold up</td>
<td>Vapor nozzle diameter</td>
</tr>
<tr>
<td>Tank diameter</td>
<td>Operating liquid level height</td>
</tr>
<tr>
<td>Tank height</td>
<td>Dispersion index</td>
</tr>
<tr>
<td>Feed height</td>
<td>Liquid nozzle diameter</td>
</tr>
<tr>
<td></td>
<td>Liquid entainment</td>
</tr>
<tr>
<td></td>
<td>Reynolds number analysis</td>
</tr>
</tbody>
</table>

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QMC MIMT© Program
for Windows
Features and Specifications

GENERAL FEATURES
Flow Meter Error Detection
Linear Sensor Error Detection
Non-Linear Sensor Error Detection
Flow sheet Interface
User Input
Excel Input
Interface with Microsoft Office
Full Reporting and Printing
Save / Open Files
Text and Graphical Display of Results
Complete Drag and Drop
Numerous Equipment Elements
Run-Time / Real-Time Option
Bad Meter Flags

TECHNOLOGY
Gross Error Detection Algorithm
Over 60% Total Error Reduction
Sensor Validation
AICHE Journal Publication
Verifies Mass Balance Integrity
Applicable to:
Mass Balances
Energy Balances
Electrical Balances
Verifies Sensor Integrity
Computationally Efficient
Handles Very Large Systems
Effective and Reliable
20+ years development & application

MEASUREMENT APPLICATIONS
Flow Meter Analysis
Power Grid Analysis
Cash Flow Balances
Temperature Sensors
Pressure Sensors
Delta Pressure Sensors
Component/Concentration Analyzers
Lab Data and Analysis
Densitometers
pH Meters
Vapor Pressure Analysis
Fluid Properties
Polymer Properties
Catalyst Properties
Solids Properties
Materials Properties

INDUSTRIAL APPLICATIONS
Steam Systems
Natural Gas
Utilities
Chemicals
Refinery
Pharmaceuticals
Pipelines
Power
Gas Production
Electrical Distribution
Petrochemicals
Tank Farms
Batch
Semi-Batch
Continuous
Nuclear
Propulsion Systems
Any Process Flow System

UTILIZATION
Flow Meter Error Detection
Sensor Error Detection
Power Meter Error Detection
Yield Analysis
Elemental Analysis, C, H, O, etc.
Cash Flow Analysis
Liquid Level Analysis
System Wide Calibration Verification
Density Validation
Analyzer Accuracy
Lab Analysis Accuracy
Flow / Analyzer / Lab Prediction
Sensor / Measurement Prediction
Data Prediction
Leak Detection
Loss Detection
Environmental Loss Analysis

ADDITIONAL USES
Simulation Verification
Artificial Intelligence
Expert Systems
Neural Network
Data Mining
Biochemical Engineering
Data Acquisition
Data Management
Data Validation
Data Conversion
Control Engineering
Electrical Engineering
Environmental Control
Flow Analysis
Energy Transfer
Flow Optimization
Process Control and Engineering
Regression Analysis
Automation Control
Process Measurement
Process Design
Process Simulation
Process Economics
Process Scheduling
Process Inventory
Flow Systems Reliability
Safety Analysis
Sensor Reliability

FLOW SHEET UNIT OPERATIONS
Pipe Networks
Pumps
Compressors
Mixer
Splitter
Flash
Tanks
Heat Exchangers
Distillation Columns
Valves
PID Controllers
Reactors
Boilers
Condensers
**Features and Specifications**

**Major Features**
- Easy to Use & Understand
- Equations
- Continuous System Simulations
- Dynamic Process Simulations

**Features**
- Algebraic Equations
  - Implicit
  - Partial Substitution
  - Wegstein Method
  - Beatte-Bridgeman
  - Newton-Raphson Convergence
  - Implicit Systems of Higher Order
- Differential Equations
  - Ordinary
  - First-Order Method
  - Simple Euler
  - Error & Increment Size Error
  - Second-Order Integration
  - Subroutines
  - Fourth-Order Runge-Kutta Method
  - Accuracy of Integration
  - Stability of Numerical Integration
  - Variable Step-Size Methods
  - Algebraic Solution

**Continuous System Simulations**
- Arbitrary Function Generation
- Use of Subroutine
- Two-Dimensional Functions
- Mixing with Reaction
- Reversible Reaction
- Simultaneous, Mass & Energy Balances
- Mixing with Reaction
- Reversible Reaction
- Simultaneous, Mass & Energy Balances

**Dynamic Process Simulations**
- Flash
- Adiabatic Flash
- Boiling Operations
- Partial Condenser
- Single-Phase Holdup
- Boiler with Holdup
- Output Editing
- Batch Distillation
- Two-Stage Batch Distillation

**Numerical Solutions**
- Algebraic Equations
- Explicit
- Implicit
- Partial Substitution
- Wegstein Method
- Beatte-Bridgeman
- Newton
- Raphson Convergence
- Implicit Systems of Higher Order
- Arbitrary Function Generation
- Use of Subroutine
- Two-Dimensional Functions
- Mixing with Reaction
- Reversible Reaction
- Simultaneous, Mass & Energy Balances
- Mixing with Reaction
- Reversible Reaction
- Simultaneous, Mass & Energy Balances

**Modeling**
- Simple Hydraulic Tank
- Variable Flow Hydraulic Tank
- Enclosed Tank
- Adiabatic compression in Gas Space
- Mixing Vessel
- Multiple Feeds to Jacketed Vessel
- Boiling
- Continuous-Flow Boiling System

**Unit Operations**
- Pipe Networks
- Pumps
- Compressors
- Mixer
- Splitter
- Flash
- Tanks
- Heat Exchangers
- Distillation Columns
- Valves
- PID Controllers
- Reactors
- Boilers
- Condensers

**Pipe Networks**
- Flash
- Tanks
- Heat Exchangers
- Distillation Columns
- Valves
- PID Controllers
- Reactors
- Boilers
- Condensers

**Distillation Operations**
- Multiple Feeds to Jacketed Vessel
- Boiling
- Continuous-Flow Boiling System

**Fluid Flow**
- Gas Flow Systems
- Hydraulic Transients

**Stage Operations**
- Generalized Column
- Stiffness Aspects
- Stage
- Feed Stage
- Distillation Columns
- Countercurrent Extraction
- Multicomponent Separations
- Generalized Column
- Stiffness Aspects
- Stage
- Feed Stage

**Distributed Systems**
- Countercurrent Heat Exchanger
- Pipeline Gas Flow
- Flasher Design
- Tubular Reactor
- Condensation
- Pure Vapor
- Multicomponent Vapors
- Multicomponent Condensation
- Split Boundaries
- Steady-State heat Exchanger Library
- Tubular Reactor
- Serial Integration

**Partial Differential Equations**
- Transients
- Laminar Flow Velocity Distribution
- Fixed Bed Reactor
- Polymer Kinetics

**Process Control**
- Basic Control Configuration
- Sensing Element
- First-Order Transfer Function
- Second-Order Transfer Function
- Controllers
- Control Elements
- Batch Kettle Reactor Control
- Centrifugal Compressor Stage Control
- Distillation Column Control

**Optimization**
- Golden Section Search
- Quadratic Search
- Cubic Search
- Derivative Search
- Hooke-Jeeves Search
- Cauchy's Gradient
- Newton's Gradient
- Marquardt's Gradient
- Powell's Conjugate Direction
- Direct Search Method
QMC YAWS Program
for Windows
Features and Specifications

MAJOR PROGRAMS
Critical Properties and Acentric Factor
Heat Capacity of Gas
Heat Capacity of Liquid
Heat Capacity of Solid
Enthalpy of Vaporization
Enthalpy of Fusion
Vapor Pressure
Liquid Density
Surface Tension
Refractive Index, Dipole Entropy and
Entropy of Formation of Gas
Enthalpy of Formation
Gibbs Energy of Formation
Solubility Parameter, Liquid Volume, and
Van Der Waals Volume and Area

Solubility in Water and Octanol-Water
Partition Coefficient
Solubility in Water Containing Salt
Solubility in Water as a Function of Temper
Henry Law Constant for Compound in Water
Adsorption on Activated Carbon
Viscosity of Gas
Viscosity of Liquid
Thermal Conductivity of Gas
Thermal Conductivity of Liquid and Solid
Explosive Limits in Air, Flash Point and Auto
Ignition Temperature
Enthalpy of Combustion
Exposure Limits for Safeguarding Health
Coefficient of Thermal Expansion of Liquid

ADDITIONAL FEATURES
Conversion Table
Temperature Conversions
Dimensionless Numbers
Advanced Conversions
Graph Data

Compound List with Henry’s Law Constant
Compound List By Chemical Formula
Compound List By CAS Registry Number
Compound List By Name and Synonym
Calculator

APPLICATIONS
Absorption
Air Pollutants
Chemical Reactions
Coefficients
Columns
Compressors
Condensers
Cooling
Distillation
Energy Balance
Equipment Design
Flow
Fluid flow
Hazard Analysis
Heat
Heat Transfer
Heat Exchangers
Heat Transfer
K-values
Mass Transfer
Momentum
Reactors
Reactions
Relief Systems
Reboilers
Stripping
Safety
Solids
Studies
Storage Vessels
Turbines
Vaporizers
Vent Systems
Vaporizers
Water Pollutants
….and many others

ORGANIC COMPOUNDS
Hydrocarbons
Halogenates
Oxygenates
Nitrogenates
Sulfur Compounds
Silicon Compounds
….and many others

INORGANIC COMPOUNDS
Carbon Oxides
Nitrogen Oxides
Sulfur Oxides
Hydrogen Oxides
Ammonias
Hydrogen Halides
Sulfur acids
Hydroxides
Silicon Halides
Ureas
Cyanides
Hydrides
Sodium Derivatives
Aluminum Derivatives
….and many others

ELEMENTS
Hydrogen
Nitrogen
Oxygen
Helium
Argon
Neon
Chlorine
Bromine
Iodine
Fluorine
Sulfur
Phosphorous
Aluminum
Lead
Tin
Mercury
Sodium
Magnesium
Silicon
Antimony
Boron
Chromium
Cobalt
Titanium
Tantalum
Silver
Gold
Platinum
Radon
Uranium
….and many others
# QMC SPC Program

## Features and Specifications

### Major Features

- Tutorial Introduction
  - (Easy to Use and Understand)
  - Quality Improvement
  - Quality Control Origins
  - Deming’s Paradigm
  - Design of Experiments Methods
- Run Charts
- CUSUM
- Other Sequential Approaches
- Exploratory Data Analysis
- Experimental Design
- Process Optimization
- Multivariate Run Charts
- From Expert Knowledge to Model
- Fishbone Charting
  - Sensitivity of Fishbone Model
  - Model Selection Criteria
- 6 σ Method
  - Model Generation

### Specifications

#### On-Line Tutorial

- Historical Introduction
- Quality Assurance vs. SPC
- Decomposition of the Process
- Pareto’s Maxim
- Case Study
- Deming’s Fourteen Points
- Process in Control (White Balls, Black Balls)
- Basic Paradigm
- Basic Statistical Procedures
- Acceptance / Rejection Sampling

#### Acceptance / Rejection Run Charts

- Basic Testing
- Unequal Lot Sizes
- Open Ended Count Data
- Design of Experiment

#### Mean / Standard Deviation Run Charts

- Mean
- Standard Deviation
- Estimators for Parameters
- Mean Drift
- Upward Drift in Variance
- Individual Measurements

#### CUSUM and Other Sequential Approaches

- Likelihood Ratio Test
- Shift of the Mean CUSUM
- Shewhart CUSUM Chart
- Persistent Shift
- CUSUM Acceptance / Rejection

#### Preliminary Analysis

- Exploratory Data Analysis
  - DataMining
- Variable Transformations
- Variable Statistics
- Multi-Graphical Data Cut
- X-Y Multi-Graphics Data Plot
- Variable Run Chart
- Variable Distribution Chart
- Variable Graphic Data Filter
- Variable Graphic Data AutoCut
- Variable Graphic Data QI AutoCut

#### Modeling

- QMC Very Best Modeling
- Artificial Neural Networks
  - Linear
  - Sin
  - Sinh
  - Tangent
  - Tanh
- Polynomial Modeling
  - Series
  - Gauss
  - Orthogonal
  - Combinatorial

#### Monitoring / Auditing

- Sensor Error Meter
- Sensor Fault Meter
- Equipment Performance Meter
- CUSUM
  - 6 σ Method
  - Quality Index

#### Optimization Approaches

- Simplex Algorithm
- Selection of Objective
- Least Squares
- Simulation Based
- Golden Section Search
- Quadratic Search
- Cubic Search
- Derivative Search
- Hook-Jeeves Search
- Cauchy’s Gradient
- Newton’s Gradient
- Marquardt’s Gradient
- Powell’s Conjugate Direction
- Direct Search Method
- EquationSolver

#### Experimental Designs

- 2p Factorial Design
- Model “Enrichment”
- Rotatable Quadratic Design
- Saturated Design

#### Multivariate Run Charts

- Location Ratio
  - “In Control” Location Estimate
- Location Slippage Rank Test
- Change in Scale Rank Test
- Change in Location Rank Test

#### From Expert Knowledge to Model

- Fishbone / Flowchart
  - Decomposition
  - Sensitivity of Fishbone / Flowchart
  - Model
  - Model Selection Criteria
# QMC Reciprocating Compressor for Windows

## Features and Specifications

### General Reciprocating Features
- Compressor Frame Selection
- Compressor Cylinder Selection
- Compressor Performance Calculations

### Configuration

<table>
<thead>
<tr>
<th>Ten throws</th>
<th>Four Services</th>
<th>Five Stages Single Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Cylinder</td>
<td></td>
<td>Six Stages for All Services</td>
</tr>
<tr>
<td>Tandem Pair Cylinders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Results

**Standard Units:** PsiA, PsiG, DegF, Bhp, Lbs, MMSCFD, Cfm, LbMol/hr, Lb/hr

**Metric Units:** BarA, BarG, KpaA, KpaG, DegC, Kw, Kgf, Nm3/hr, Sm3/hr, KgMol/hr, Kg/hr

- Inlet Gas specification
- Gravity (Natural Gas)
- Component Composition
- Side Stream Stipulation
- Condensation Calculations
- Calculations of Effected Gas Properties
- Suction Pressures Flange
- Suction Pressures Internal
- Discharge Pressures Flange
- Discharge Pressures Internal
- Suction Temperatures
- Discharge Temperatures
- Flow in Required Units
- Rod Loads (Gas Forces)
- Combined Rod Loads
- Bhp
- Out-of-limit results

### Special Features

- Bhp Stipulation
- Maximum Engine Allowable
- Incremental Variables
- Suction Pressure
- Discharge Pressure
- RPM
- Pressure Drops
- Aftercooler Outlet Temp
- Dynamic Calculations

- File Creation/Maintenance
  - Frame Data Files
  - Cylinder Data Files
  - Data Files for Ariel (opt)
  - Data Files for Gemini (opt)

- Cylinder Selection
  - Auto-Selection
  - Manual Selection
  - Keyboard Entry

- Engine Selection
  - Engine Data
  - Calculates Bhp
  - Derated for Elevation
  - Ambient Temperature
  - Auxiliary Power

- Compressor Performance
  - Single-Acting Double Action Cylinders
  - Lifting Cylinder Suction Valves
  - Removing Cylinder Suction Valves
  - Disabling Stage

- Cylinder Clearance
  - Variable Volume Pockets (VVPkt)
  - Valve Spacers
  - Non-Standard Clearance

- Manufacturers' Data
- Modeled Data
- On-Site Performance Data
- Performance Charts
- Thermodynamic Mass Balance Calculations
- Recycle System Balance
QMC Centrifugal Compressor
for Windows
Features and Specifications

GENERAL CENTRIFUGAL FEATURES
Compressor Frame Selection
Compressor Curve Selection
Compressor Performance Calculations

PERFORMANCE CALCULATIONS
Start-Up
Normal Operation
Steady Conditions
Varying Load Conditions
Normal Shutdown
Emergency Shutdown
Safety Valve Relieving

SIMULATION
Compressor Train
One Service
Two Services
Six Compressor Sections

MODELING
Manufacturer’s Performance Curves
Manufacturer’s Data
Section Mathematical Model
Adiabatic Head vs Actual Volumetric Inlet Flow

SYSTEM FEATURES
Inlet Header
Operating Flow Range
Pressure Range
Pressure Controller w/Control Valve
Outlet Header
Operating Flow Range
Pressure Range
Pressure Controller w/Control Valve
Compressor Suction (each stage)
Inlet Pressure Controller and Valve
(1st stage only)
Inlet Excess Pressure Regulator Valve
Cooler (Air or Water Cooled)
Compressor Discharge (each stage)
Pressure Safety Valve/s (PSV)
Silencer for Safety Valve/s
Emergency Vent Valve (blowdown)
Air Cooler
Water Cooler
Anti-Surge Valve

INTERSTAGE OPTIONS
Check Valve
Check Valve with Anti-Surge Overlap
Check Valve Not Installed
Check Valve with Bypass Flow Element
External Balance Gas Flow Connections
Heat Exchanger

SYSTEM CONTROLLERS
Main Unit Controller
Control Mode
No Control
Discharge Pressure Control
Inlet Header Pressure Control
Discharge Header Pressure Control
Inlet Header Pressure Control
Output from above Configuration
Unit Controller to Control
RPM
Anti-Surge Valve
1st Stage Inlet Valve
Ext. Disch. to Suction By-Pass Valve
Anti-Surge Controllers
Auxiliary Controllers
Inlet Header Pressure Controller
Outlet Header Pressure Controller
Final Disch. Temperature Controller
Control Parameters (adjustable)
Reset (Integral)
Gain (Proportional)
Derivative
Induction Motor Driver
Manufacturer Torque/RPM Curve
Default Curve

SPECIFICATIONS
Flow
Lbs/Minute
Actual Cubic ft/min at
Suction Conditions
Adiabatic Head Ft lbs/ft
Adiabatic Efficiency
Bhp
Flow as Fraction of Surge Flow
Flow as Fraction of Choke Flow
Side Flow
Lbs/min +/- Suction of Stage
Lbs/min +/- Discharge of Stage
Net External Balance Gas Flow
At Suction
At Discharge
Pressure Suction PSIA
Pressure Discharge PSIA
Temperature Suction DegF
Temperature Discharge DegF
Compressor Flow lb/min
Compressor ACFM
Anti-Surge Valve Flow lb/min
Safety Valve (PSV) Flow lb/min
RPM
Aftercooler Pressures
Fuel Gas Flow lb/min
Program Mode
Normal Operation Simulation
Change in RPM in 1 Calc Iteration
Elapsed Time in Seconds
(1200 seconds = 20 minutes)
Pressure Inlet Header PSIA
Pressure Discharge (Outlet)
Header PSIA
Flow Inlet Header lb/min
(N/S Not Stipulated)
Flow Discharge Header lb/min
Flow Excess Pressure Control
Inlet Header lb/min
Discharge Header lb/min
# QMC Power Reactor Program

## for Windows

### Features and Specifications

#### Major Features

<table>
<thead>
<tr>
<th>Easy to Use and Understand</th>
<th>Design Optimization</th>
<th>Any Configuration(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built in Reactor Types</td>
<td>Operating Optimization</td>
<td>Data Interface</td>
</tr>
<tr>
<td>User Reactor Types</td>
<td>Mechanism Determination</td>
<td>Advanced Graphics</td>
</tr>
<tr>
<td>Kinetic Estimation</td>
<td>Catalyst Analysis</td>
<td>Flow Sheet Interface</td>
</tr>
<tr>
<td>Reactor Design</td>
<td>Flow Sheet Interface</td>
<td></td>
</tr>
<tr>
<td>Reaction Analysis</td>
<td>Complete User Control</td>
<td></td>
</tr>
<tr>
<td>Operations Analysis</td>
<td>Total Flexibility</td>
<td></td>
</tr>
</tbody>
</table>

#### Reactor Types

<table>
<thead>
<tr>
<th>Batch</th>
<th>Cracking</th>
<th>Intermediate Feeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-Batch</td>
<td>Polymer</td>
<td>Batch Feeds</td>
</tr>
<tr>
<td>CSTR</td>
<td>Dynamic/Continuous</td>
<td>Mixed Feeds</td>
</tr>
<tr>
<td>Plug Flow</td>
<td>Multiple Configurations</td>
<td>Timed Feeds</td>
</tr>
<tr>
<td>Tubular</td>
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<tr>
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<td>Side Streams</td>
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#### Numerical Methods

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<th>Handles DOE Data</th>
<th>Monte Carlo Initiation</th>
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<td>Stable/Proven Optimization</td>
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<td>Mixed Equations</td>
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<tr>
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#### Operating Modes

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<th>Parameter Estimation</th>
<th>Optimization</th>
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</thead>
<tbody>
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<tr>
<td>-Dynamic</td>
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#### Reaction Kinetics

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<th>Particle Age Distribution</th>
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<td>Heterogeneous Kinetics</td>
<td>Bypassing Effects</td>
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<td>Gas Phase</td>
<td>Surface Effects</td>
<td>Catalyst Optimization</td>
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<tr>
<td>Mixed Phase</td>
<td>Catalyst Activity</td>
<td>Complete User Control</td>
</tr>
</tbody>
</table>
QMC APC Program
for Windows
Features and Specifications

**DATA SCREENING**

- **Select Variables**
  - Select individual / Select all
  - Remove individual / Remove all
  - Save to Excel

- **Variable Transformations**
  - 200 spreadsheet functions
  - Multi-functions
  - Multi-equations
  - Boolean logic
  - Point/Click functionality
  - Save / Import files

- **Variable Statistics**
  - All standard statistics
  - All correlation analysis

- **Graphical DataCut**
  - Graphical cut / uncut
  - Focus features
  - Auto Scrolling
  - X-Y positioning
  - View all variable cuts

- **Multi-Graphic DataCut**
  - Normalized plotting
  - Trending capabilities
  - Graphical cut / uncut
  - Focus features
  - View all variable cuts

- **Variable Run Chart**
  - Graphical statistics
  - Localized run charts
  - Global run charts
  - Focus features
  - Graphical cut / uncut

- **Variable Distribution Chart**
  - Normal distribution curve
  - X-Y positioning
  - Auto scroll
  - Focus features
  - Graphical statistics

- **Variable Graphic Data Filter**
  - Multivariable standardized functions
  - Localized run chart features
  - Double exponential filter
  - Data reconciliation / smooth
  - Graphical cut / uncut
  - Auto scroll
  - Focus features
  - Graphical statistics

**CONTROL**

- **StepTuner 1 Graphical Method**
  - Plots: Proportional, Proportional integral, Proportional integral derivative
  - Tuning rules: Ziegler-Nichols, Cohen-Coon, Set point ITAE, Direct synthesis
  - Controller types: Ideal controller, Ideal w/derivative action error, Commercial controller, Commercial w/derivative action error

- **StepTuner 2 Powell's Method**
  - Plots: Controlled variable response, Manipulated variable, Controlled variable
  - Import Excel data
  - Automatic read step test data
  - Data time stamp
  - Save results
  - Plot model versus data
  - Quick view graphics
  - Pseudo code results

- **PulseTuner 1 Powell's Method**
  - Plots: Controlled variable start row, Response value end row

- **PulseTuner 2 Advanced Powell's Method**
  - Plots: Sample time adjustment, Manipulated variable start row, Manipulated variable end row

- **Multi-Control Analysis Relative Gain Array**
  - Controller pairing analysis
  - Interaction analysis
  - Open existing models
  - Run through data
  - Stability index plots
  - Predicted versus actual plots

- **APC CONTROL METHODS**
  - Multivariable Dynamic Matrix
  - Quadratic Matrix
  - Biggest Log-Modulus Tuning
  - Adaptive Control
  - VB Model Control
  - Neural Network Control
  - Polynomial Model Control

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