





# **Robust Quality Estimator**

The Complete Toolbox for Robust and High Sustained Accuracy Inferred Measurements

RQE is Shell Global Solution's powerful, yet user friendly, software package for off-line design and on-line implementation of Inferred Measurements for control, monitoring and information purposes.

#### Inferred measurement applications

An inferred measurement is a calculated variable, based on selected simple measurements (temperature, pressure, flow,...), used to predict the current value of a critical product property or complex process variable, when it cannot be measured on-line, or when it is measured on-line but infrequently, with significant delay or not reliably. In a typical application, RQE provides a calculated process value for closed loop control purposes. RQE is particularly suited for applications in combination with Shell Global Solution's SMOC (Shell Multivariable Optimising Control) technology.

Example of applications include product quality estimation for multi-draw fractionators (ASTM distillation temperature, flash point, cloud point,...), for light ends distillation columns (composition, RVP,...) and reaction products (reformate Octane, hydro-treater product %N2,...). RQE is a generic package and can also be applied to other types of continuous processes.

RQE is used essentially in two different configurations :

- in combination with on-line analyser : the inferred measurement provides a fast responding continuous value of the property of interest, whereas the analyser measurement often has a large time delay and/or is discontinuous. In addition, the inferred measurement provides a back-up value when the analyser fails or is being calibrated.
- with laboratory update mechanism : the inferred measurement value is periodically updated on the basis of results from the laboratory. The inferred measurement can be seen as a replacement to an on-line analyser, when it is not justified economically or when it is not technically feasible.

### **RQE Off-line package**

The RQE Off-line package is a fully Microsoft Windows 95/NT based graphical package for fast track design and maintenance of inferred measurements.

It includes the following functions.

- Data analysis and manipulation : This function allows the user to import, display and perform statistical analysis of data sets of process variables to be used for modelling purposes.
- Inferred measurement modelling : The modelling phase consists in selecting the calculation inputs, selecting the model type, estimating the model parameters and validating the resulting model. Various options are available : linear models (including PLS, PCA) and Neural Network types. The user does not need to have detailed technical knowledge on modelling. The modelling, including inputs and delay selection, can be done fully automated in a few, but reliable, steps.
- Inferred measurement update design : This part of the package allows the user to test and tune several different options available for updating the prediction model from on-line analyser or laboratory measurements. The available options include SPC rules (Statistical Process Control), Kalman filtering and a simple bias update mechanism.

A special type of Neural Network models (RBF networks) has been chosen for use in RQE. RBF networks, unlike standard Neural Networks, allow the application of a method to automatically select the network structure, and can be combined with the Kalman filtering prediction model update option.

The Kalman filter update option provides superior performance in terms of measurement noise filtering. It also allows the full model to adapt to changing process conditions such as varying gains due to non-linear or time varying processes (e.g. catalyst deactivation or equipment fouling). Compared to conventional bias update mechanisms, Kalman filtering provides a smoother prediction, has proven to give significant additional accuracy, improves the reliability of the on-line inferred measurement, and reduces maintenance requirements.

The off-line RQE package generates a model file, including all parameters required for the on-line implementation of the inferred measurement.

#### **RQE On-line package**

RQE is one of the modules in Shell Global Solutions' COAST (COntrol Applications STandards) library of on-line advanced control tools. RQE includes the full range of flexible and configurable tools required for the robust and reliable on-line implementation of inferred measurements.

The main features include :

- extensive on-line analyser signal checking, including out-of-range handling, frozen value detection and spike rejection,
- operator lab interface with entry consequence preview,
- inputs processing (dynamic compensation, non-linear transformation, combination of variables, filtering),
- prediction calculation and output processing (clamping, asymmetrical filtering),
- full model updating using Kalman filtering (either on basis of on-line analyser or on basis of laboratory results),
- handling of non-linear qualities either via non-linear Neural Network type model, or via built-in configurable characteriser functions,
- input checking of reference laboratory result prior to model prediction update,
- SPC techniques, including score card, CUSUM, and spike rejection,
- · optional steady state detection,
- robust handling of uncertain and varying delay of the quality reference measurement,
- operator graphical interface and engineer graphical interface,
- messaging and alarming.

For the model update, RQE includes a unique feature to robustly compensate for varying or uncertain time delays associated with measuring the property of interest. This mechanism has proven to significantly increase the accuracy and robustness of the RQE prediction.

RQE on-line will be rolled out on major DCS platforms (Foxboro, Honeywell, Yokogawa), and also on a number of real-time control process computer systems (Pross2, Infoplus and Setcon).

## SHELL GLOBAL SOLUTIONS' ADVANTAGE

More than 500 inferred measurements are in operation at Shell Global Solutions' advised sites, in refining, chemicals and gas processing applications. With this wide basis of applications, Shell Global Solutions has the practical experience to help its clients select, design, and implement successful inferred property calculations for control, monitoring and information.

The vast field experience and extensive R&D which has been combined in the RQE toolbox is your guarantee of a robust and highly reliable inferred measurement portfolio.



#### Japan

Yokogawa Electric Corporation System Integration Solution Group 2-9-32 Nakacho, Musashino-shi, Tokyo, 180-8750 Japan Tel:(81)-422-52-6437 FAX: (81)-422-52-0557

Singapore Yokogawa Engineering Asia Pte. Ltd. South Asian Headquarters, APC Centre 5 Bedok South Road Singapore 469270 Tel: (65)2419933 FAX: (65)2419919 United States Yokogawa Control of America Advanced Automation Division 401 S.Dewey, Suite 401, P.O Box 848, Bartlesville, OK 74005 Tel: (918)-337-0918 FAX: (918)-337-0968

Europe Yokogawa Europe B.V. European Headquarters Vanadiumweg 11, 3812 PX Amersfoort The Netherlands TEL: (31)-33-464-1611 FAX: (31)-33-464-1610

Subject to change without notice. All rights reserved. Copyright © 1999, Yokogawa Electric Corporation.