

Kelvin Hales Associates Ltd.

Consulting Control Engineers



Since 1993 Kelvin Hales Associates Ltd. -Consulting Control Engineers (KHACE) has been helping engineers in a wide range of companies and industries to improve their process and control system designs. Oil companies such as BP and Statoil, major engineering contractors such as Bechtel and M.W.Kellogg, chemicals manufacturers such as BP Chemicals and Tioxide and water treatment supply companies such as Thames Water, and others, have all benefited from studies carried out by KHACE Engineers.

In addition, KHACE model libraries and software for thermophysical properties and dynamic simulation have been supplied to clients, universities and engineering companies around the world.

Below is a summary of some of the most significant areas of process and control-system design in which we have been active, typically involving the provision of results from test-case studies carried out on dynamic simulation models.

PROCESS MODELLING AND DYNAMIC SIMULATION

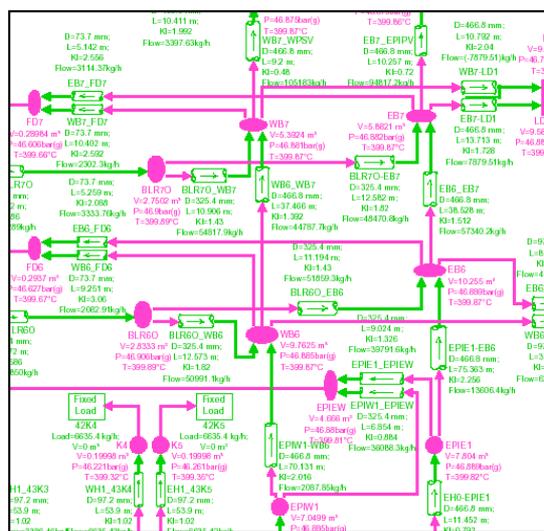
We carry out process and control system modeling and dynamic simulation in support of both plant and control-system design and improvement. Working together with client's own engineers or liaising directly with actual, proposed or potential system and equipment suppliers, we obtain the necessary model parameters for a rigorous simulation of plant and control-system performance. Our reports on test-case studies carried out on completed or evolving models are typically used to confirm expected plant operation, or to identify gaps in plant design specification or performance.

Frequently it is the builders of a dynamic simulation who the first, sometimes the only, people to gain an overview of the complete project design requirements, and to experience how the completed system is likely to perform against those requirements.

This is especially the case where different parties are contracted individually, with each concentrating on their own contractual requirements within the overall project, perhaps with no central authority responsible for making systems work as a whole. In these circumstances simulation studies carried out by experienced process and control-system engineers have played a valuable role in highlighting potential problems at the earliest possible stage in a project.

GAS INDUSTRY

For a major contractor we developed the models, engineered the simulations and carried out the start-up and shutdown test-case studies for propane and mixed-refrigerant cycles of a large LNG plant in Nigeria. For the principal UK national gas distribution network operator, we modelled and simulated a gas



Extract from an Steam Header Model

compression station for a pipeline supplying a new Scottish & Southern Energy power station in the West Country. Modelling and simulation of compressors requires good representation of compressor controls, and our experience has ranged from modelling generic anti-surge and pressure/flow controls in simulation studies to a very detailed reproduction of Compressor Controls Corporation (CCC) controls for incorporation into a training simulator for the Conoco-Chevron Britannia platform.

WATER INDUSTRY

For Thames Water KHACE has carried out process and control-system modeling and dynamic simulation for new and existing potable water treatment plants. Simulation benefits have included verification of tank capacities to accommodate transient upsets; quantification of the magnitude of hydraulic transients within treatment filters for comparison with maximum design specifications, and verification of pump and valve characteristics for normal and adverse operations.

In one study our simulation showed that a stepping strategy for incremental control-valve movement, introduced to minimize transient changes in water flow through filters, was actually provoking more severe transient changes than was the case with single-stroking. In another study, excitation of the plant model with recordings of actual downstream pressure disturbances measurements led to design modifications that reduced their impact on the filter flows and de-gassing process.

OIL INDUSTRY

We have modelled and simulated vessels and their controls for novel approaches to slug-catching, and applied dynamic analysis and frequency-response methods to analysing the multi-input multi-output

performance of dynamic simulation models of plant for north-sea platforms receiving slugging flows from multiple incoming lines. We also built and delivered a simple slug-flow demonstrator for presentation during a client's oil-company technical centre open-day. For Bechtel, we modelled and simulated the gas injection compression process for the ADNOC Sahil project.

STEAM SYSTEMS

The modelling and simulation of site-wide steam systems, and of modifications to these systems, is of great significance to the process and energy industries. The complex dynamic responses of steam generators, such as boilers and HRSGs, and the fact that speed-governed steam turbine consumers introduce positive feedback into system responses to pressure disturbances, make for some interesting modelling and control problems. KHACE has worked with major contractors, such as M.W.Kellogg, and gas-processing and refining companies, such as Statoil, to model and simulate site-wide steam systems. Our largest project to date, comprising two 120t/h HRSGs, seven 120t/h boilers and more than 100 separate pipe segment models, was for the composite simulation of steam-generation from a new GTG/HRSG power station and adjacent refinery HP steam system in the Jubail Industrial City, Saudi Arabia.

In addition to simulation studies, KHACE has provided its steam-system model libraries under license, with user training; e.g. on-site at Statoil's Karsto terminal in Norway.

The KHACE steam-system model libraries are now also available as the SIMSTEAM commercial software package for the Simulink simulation environment, and licensed to a major European energy company. Many universities and some nuclear power and energy companies have also licensed KHACE's WATSTEAM properties package.

PETROCHEMICALS

For BP Chemicals we compared the performance in dynamic simulation of three manufacturers of large air compressors to support bid evaluation in a replacement application for a petrochemical plant. As well as modelling of the compressors, their controls

and the delivery lines, the simulation also incorporated the client's model of the downstream reactor and off-gas processing – to provide a realistic load model for the air delivery. This project features in Matlab News and Notes, 2002.

CHEMICALS

For BP we modelled a reaction process with re-circulating reactant loop, and delivered the model for dynamic analysis studies by a third party.

For Tioxide in South Africa, we modelled the gas treatment from a calciner and were able to identify that proposed process modifications to would impact significantly on performance and were therefore unadvisable.

GENERAL

Our rigorous numerical method for the design of averaging level controls to achieve specified dynamic performance, developed originally for BP's Advanced Control handbook, and applied in our simulations and in customer's processes, has resulted in significant improvements to flow and plant stability in a variety of plant applications.

We also develop and supply software for facilitating the use of rigorous thermophysical properties, which is in use in companies and universities around the world.

CONCLUSION

In some cases the major value of the simulation study may not come, as originally anticipated, from the results of pre-specified test-case studies; but rather from the unanticipated results of the modelling and simulation commissioning exercise itself. We have no doubt that in this project a great deal of money was saved by highlighting necessary changes in both refinery and power-station steam-system design and control during the construction phase and well before the commissioning.

Formal tests using pre-specified test-case scenarios usually lead to some unexpected results, and the requirement to carry out some additional tests. In this project the supplementary simulation results suggested a satisfactory and inexpensive solution to the potential load-shedding problem.

FURTHER INFORMATION

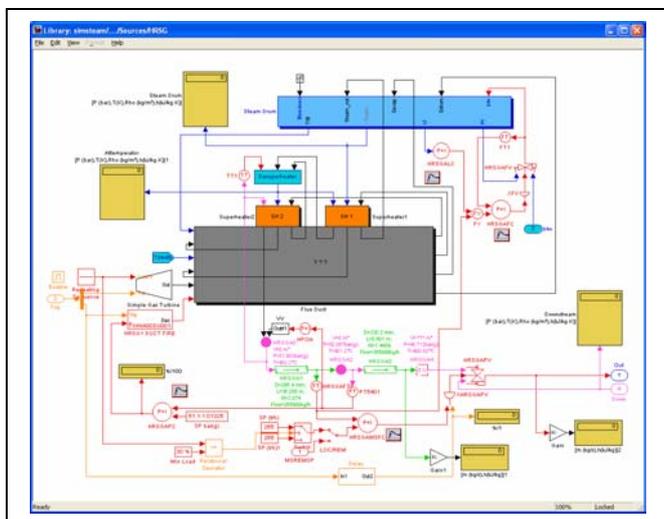
Additional information is available on-line at:

<http://www.khace.com/services/simulation>

and at:

<http://www.khace.com/products>

Or please contact us at the address below.



Typical overview of an HRSG Model

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