

- the virtual model of the control object ensures selection of the most optimal process without interfering with the actual process by varying the control algorithms and their settings.

The APC comprises the tuning station of the control loops and special software for efficient and advanced process control installed on the tuning station and controllers of the existing DCS.

The APC meets the challenge of efficient and optimal control. Efficient control takes into account the specific features of the process such as the control object. Advanced control is optimal control ensuring the best results under the set conditions.

NIIK has developed a three-phase procedure to implement the APC:

In the first phase, the tuning station (dynamic optimisation station) is adjusted to the DCS conditions and put into operation. Consequently, each control loop has the following:

- automated control of the operation efficiency;
- operator's interface with the online tasks;
- software for automated selection of the settings required for the control loop adjustment.

Software tools help the operator to commission all the control loops.

The second phase comprises the development and realisation of the algorithms and software package "Efficient Process Control".

The third phase comprises development and realisation of the algorithm and software "Optimal Process Control" with stabilisation of the synthesis section to achieve optimal conditions.

Each phase corresponds to a certain mode of the DCS:

- Reference conditions of the DCS (based on the simple control loops);
- Mode No. 1 (after the first phase): reference conditions + tuning station;
- Mode No. 2 (after the second phase): Mode No. 1 + Efficient Process Control;
- Mode No. 3 (after the third phase): Mode No. 2 + Optimal Process Control – entire APC.

Therefore the tuning station, "Efficient Process Control" package and "Optimal Process Control" package can be supplied to the customer as independent products,

but should meet the following conditions:

- the tuning station is supplied if the plant has an up-to-date DCS;
- the "Efficient Process Control" package is supplied after the tuning station installation;
- the "Optimal Process Control" package is supplied after implementation of the tuning station and the "Efficient Process Control" package.

Although the tuning station requires minor adjustment for each particular case it can be applied universally for different processes.

NIIK has successfully implemented the tuning station for the DCS at Eurochem's urea plant. The guarantee performances have been achieved. In the guarantee performance test report the customer noted the improved economics and operational efficiency due to the tuning station implementation.

Currently NIIK specialists are collecting data on economic performances to estimate the tuning station efficiency, calculating the cost reduction per product unit.

Work continues on the next APC phase, a software package "Efficient Process Control" for Eurochem's urea plant.

Preliminary figures indicate savings of 1-2 \$/t of urea due to implementation of the APC, depending on the particular urea plant. The savings are derived from steam savings savings in fixed costs when the output of the synthesis distillation section is increased.

According to NIIK estimates, the payback period for the APC is one year maximum.

### Other NIIK developments

For improved operator training, NIIK offers an operator training simulator for urea plants. The process simulator trains operators and process engineers by improving their knowledge and skills in safe operation. State-of-the art tools are used in the process simulator such as audio and video, 3D graphics to aid memory of information, and regulation documentation (emergency localisation plan, safety instructions etc.). The realistic imitation of the existing DCS helps an operator to remember and practice the sequence of actions during start-up and shutdown of the equipment in a particular section of the plant or the entire urea plant. To date, NIIK has successfully implemented four process simulators. ■

## NIIK APC for urea plants

NIIK recognises the importance of advanced process control in improving plant efficiency, especially the efficiency of the DCS. By equipping the distributed control system (DCS) with additional APC functions economic savings can be made compared to conventional control systems.

The APC is aimed at improved process control, better dynamic accuracy, enhanced safety, fewer forced outages, improved stability, as well as reduced energy consumption and production costs.

The increased demand for highly efficient process control systems applies not only to urea plants but also to ammonia, methanol and other chemical plants.

NIIK has developed its own concept of Advanced Process Control (APC). Several articles have been devoted to the concept and published in Russian and foreign scientific magazines. High performance software has been developed based on the NIIK concept. Key features of the software are:

- an intuitive interface helps DCS operators (not APC experts) to monitor the control loops on line;
- the virtual model of the control object and continuous monitoring of its performance help to detect control failures in advance;