MOL Group is one of Central Europe’s leading international oil and gas companies, with operations in Hungary, Slovakia, Croatia and Italy. The company’s core activities cover exploration and production of crude oil, natural gas and gas products; refining, storage and distribution of crude oil products; natural gas transmission; and production of olefins and polyolefins. The Algyő gas distillation plant near Szeged in southern Hungary has the capacity to process up to 12 million m$^3$/d of gas from the nearby Algyő field, one of the largest oil and gas fields in Hungary.

In 2008, as part of an ongoing energy saving initiative, MOL upgraded its ageing distributed control system at the Algyő plant by installing Emerson’s DeltaV™ digital automation system. The new system covered the gas fractionation section, distillation columns and associated equipment. This part of the project produced immediate process performance improvements including a reduction in energy consumption through better process control.

Column sense: a case study

Andrew Riley, Emerson Process Management, USA, describes how the MOL Group achieved significant energy savings by optimising its gas distillation columns with an advanced process control system.
One of the reasons this system was selected for the upgrade was the availability of an advanced process control (APC) package for distillation columns. The second part of the project was to exploit these APC capabilities to optimise the performance of the gas distillation columns and further reduce energy consumption. MOL estimated that it could save £734 000/y in natural gas usage and its aim was to increase operational stability and reduce operator workload, whilst maintaining on specification product.

**Optimising process performance**

The Algyõ plant has two trains of distillation columns, with each train having three columns. Gas is supplied to both trains via a low temperature extraction unit and an oil absorption process. The process energy is supplied by hot oil, which is heated using four furnaces and the waste heat from the low temperature extraction units. The distillation products are propane, propane butane mix, iso butane, normal butane, iso pentane and normal pentane. These are drawn off as top/base products from different columns in each train.

The quantity and quality specification for each of the product streams changes with demand, and the feed of fractionation fluctuates considerably. For the final column in each train, the operation uses high reflux ratios to achieve good quality. As the field is relatively old, the fractionation unit operates at only 50% of its maximum capacity, yielding 450 tpd of liquefied hydrocarbon products.

Product quality is obviously very important and to maintain high quality levels, operators tended to overheat and over reflux the columns. Instead of delivering a product purity of 95%, which is acceptable to its customers, the actual product purity was normally 97 – 99%. However, this higher purity level came at a cost, as it required more energy in the production process.

Better control of the process was needed, but experience had shown that distillation columns are highly interactive, multivariable processes that exhibit long delays and lag times. These are difficult conditions for typical closed loop proportional integral derivative (PID) controllers to work satisfactorily.

**Advanced process control**

Emerson’s SmartProcess™ distillation optimiser uses a number of predefined calculations that speed up the configuration of the advanced control by using embedded knowledge from previous applications. This advanced control enables the control system to make automatic adjustments to key flows on the column, allowing product to be reliably and safely produced with 95% purity. This means that MOL can meet its customers’ requirements and, at the same time, optimise its energy usage.

In addition, the APC enables the operating pressure of the columns to be varied and reduced to optimise the process. This is desirable in distillation processes because products separate more easily and require less energy at low pressures. However, as the pressure in the column was reduced, this resulted in the overhead cooler running close to capacity. By changing the column pressure slowly, the operators could ensure that the overhead fans were running close to their capacity. At
night, when the air temperature is lower and the cooler has more capacity, the column can be run at a lower pressure than during the day. On average, it was possible to make very large reductions in operating pressure. This was assisted by the fact that the columns were operating at feed rates significantly below their design capacity.

In general, the changes necessary to control product qualities are small and can take many hours to have an effect. The upgraded software, with advanced control algorithms and detailed memory of what has happened on the column in the past few hours, can accurately predict what the effects of these changes will be. This means that the optimum 95% specification product at the column can be more easily maintained.

The enhanced predictive capability of the system enables improved control stability, disturbance rejection and optimisation of column pressure, and reflux ratio on each column, thus minimising the reboiler heat duty and hence the overall energy requirement of the process.

Implementation
Using the knowledge and experience of the plant operators, the implementation team developed the APC schemes to take account of the individual characteristics of each column. This allowed some tuning of the system and provided the operators with the opportunity to become familiar with the new system. These operators can now make process adjustments to take account of changes in feed composition or product specifications.

As the project moved into commissioning and the operators’ knowledge of the characteristics of each column grew, the overall performance could be optimised.

Results
Benefits were gained from the APC as soon as it was commissioned on the first column. For example, a change to the average product quality from 97% to 95% resulted in a significant reduction in energy usage for that column.

The advanced software has now been applied to five of the six gas distillation columns. As a result of closer control and improved plant optimisation, there has been a 40% reduction in hot oil consumption, saving fuel gas and reducing CO₂ emissions. This reduction represents a saving of €1.2 million/y, providing a payback period of two months on the investment.

Operational stability has improved, as the multivariable model predictive control (MPC) technology constantly monitors where each unit is in its normal operational envelope. If the unit starts to move outside that envelope, the system automatically corrects the error. As a result, there tends to be fewer process deviations than when the unit was operated traditionally.

Operator workload has also been reduced since operators no longer have to make the small adjustments necessary to keep the column operating at the product quality limits. They can now spend more time monitoring the unit, and they have less to worry about during the high stress times of dealing with any process upsets. Relying on automatic, rather than manual, adjustments also helps ensure consistent operation across all shifts.

Overall, MOL is pleased with the outcome of the project. All of the objectives have been met and savings of €1.2 million have been realised so far. Based on these successes, a similar system will be deployed on the sixth column when the prerequisite online analyser is commissioned.