Going to the Limit

Large-scale production of chemicals depends a great deal on process technology. In a market where price and supplier reliability count, all production and supply processes have to be extremely efficient. APC is the first step.

"We need to move from APC to RTOpt if we want to completely exhaust all possibilities with MBC." Process engineers love to talk in acronyms. This enables them to speak as precisely as possible, while saving time in the process. Jim Conner, Director of Operations and Technology for the Acetyls business line, is constantly traveling the Celanese globe to focus on improving the manufacturing processes and their profitability. For him, everything revolves around increasing efficiency. APC, RTOpt, and MBC stand for the sophisticated tools currently being used to control and optimize chemical production processes. "Model Based Control (MBC) is all about squeezing more out of what you have already invested in – taking good process technologies and then doing things even better," says Conner.

Jim Conner is responsible for the production of vinyl acetate monomer and other products in the Acetyls value chain at Celanese sites around the world. These advanced process control (APC) projects are very important to Celanese's strategy to steadily drive down the cost of production. These projects generate significant savings in energy and raw materials while simultaneously increasing the yield, that is, the capacity. However, achieving the goal represents a unique challenge in conveying and applying technical know-how.

Deviations are not tolerated

Celanese VAM plants are guided by process control systems. In the control station of each plant, process parameters are queried and the production process is electronically monitored and optimized. Advanced Process Control has elevated this control process to a new level. John Ruiz, VAM plant operator in Clear Lake, describes the difference: "To operate optimally in the past, we had to count on everybody remembering all the set points that tie in in order to make the moves. In APC, we gathered all the expertise from the unit and came up with a foundation for APC, so that the operators do not have to remember every little point themselves. It's all in APC now." John Ruiz and his shift colleagues sit like vigilant air traffic controllers in a semi-darkened room, their eyes glued to a large flat screen, which displays a diagram of the entire VAM production process. If you touch individual process points on the screen, the diagram displays a higher degree of detail. APC is based on multi-variable, predicative logic, which means that around 400 process parameters are monitored. By constantly comparing them with a mathematical model, APC recognizes deviations from the optimum parameter setting in advance and can avoid problems by taking counter measures. APC is thus similar to the Six Sigma approach, which focuses on using statistical methods to tolerate processes with a standard deviation of 0.000003 or less.

Since Jim Conner hates variability, he is completely sold on APC. "APC is the path of lower variability, thus eliminating issues of operator vigilance and drift." For example, the oxygen content in the reaction phase of ethylene and acetic acid, the two most important raw materials for VAM production, is subject to variability. During the distillation process, the water which inevitably forms in the reaction loop must be separated using the least amount of energy possible. In both cases, optimization means trying to prevent variability or keeping it at an absolute minimum in order to bring the relevant process variables as close to the maximum economic value as possible.

Taking it to a specific point, but not beyond

In VAM production, certain parameters deemed essential to safety are not allowed to be exceeded. In traditional process control, safety concerns required that higher limits be set on constraints to accommodate the variability that

1. In spite of electronic process control at the VAM plant in Clear Lake, Texas, the shift team has to know the actual plant by heart, both inside and out.

2. Plant operator Kevin Simmons (front) and John Ruiz (middle) report to Jim Conner (back) on their experiences with APC.

2

occurs in the reaction loop. That meant that it was impossible to optimize the use of energy and raw materials. With APC's precision and process manipulation, Celanese engineers and plant operators can successfully approach optimal reaction points without compromising plant safety.

Getting more with less

Efficient use of energy and raw materials to achieve cost savings is only one of APC's advantages. "The big returns will come from additional capacity," says Jim Conner emphatically. Based on experience in the industry so far, the benefit from extra capacity normally runs at a 3-5 multiple of the benefits from cost reduction alone. But to achieve this, it is necessary to move from an APC system to a real-time optimizer system, or RTO. RTO incorporates the experiences from APC into a thermodynamic model, which uses greater computational power to simultaneously solve both mass and energy balances, that is, the variable costs for raw materials, energy and waste. The leading software company for process technology in the chemical industry, Aspen Technology of Cambridge, Massachusetts, is supporting Celanese in introducing APC and RTO. RTO will generate a significant amount of additional cost savings in VAM. Celanese is in the process of implementing MBC to control all the plants in its Acetyls chain and to train its staff in this system.◂

Celanese is a global leader in vinyl acetate monomer

Vinyl acetate monomer (VAM), which is produced from ethylene and acetic acid using a fixed bed catalyst, is an important link in Celanese's strong Acetyls chain. With the help of its trademark VAntage™ technology, Celanese recently made significant increases in production efficiency at its six production sites in Bay City, Clear Lake, Frankfurt, Singapore, Tarragona and Cangrejera. Celanese produces around 1.2 million metric tons of VAM a year and has a global market share of around 25 %. Nearly half of all VAM produced is a feedstock for emulsions, which, in turn, are used to manufacture paints, adhesives and coatings. Celanese is the largest producer of polyvinyl emulsions in Europe. Another 30 % of VAM is processed into polyvinyl alcohol (PVOH), a chemical employed in a broad range of applications in the construction, film, polymer, paper and textile industries, etc. Celanese is the second largest PVOH producer worldwide.