Modernise to optimise

Roger Erfurdt, Deer Park Refining Services Company, Shell Oil Products US, details a technology platform for the future that uses digital plant architecture with diagnostics from FOUNDATION fieldbus devices.

Planning for the modernisation of process controls at the Shell Deer Park Refinery began more than five years before the first new system went into operation in 2003. It had become obvious that the old instrumentation, some dating to the 1950s, needed to be replaced. Much of the refinery was operated from the control rooms using panel mounted pneumatic or single loop electronic controllers.

The planning team began considering the use of the newest plant automation technologies in order to sustain highest safety, improve refinery operations efficiency, provide greater reliability and deliver more consistent yields. The plans called for a five year, US$ 125 million + control modernisation in the refinery's catalytic cracker (including a gas fractionisation plant), selective hydrocracker and other process units. The project was well on its way to completion by the beginning of 2005, with the whole cat cracker under the control of a newly installed system.

Key objectives of this control modernisation programme were to increase the utilisation (availability) of these essential production systems and take advantage of the diagnostic capabilities provided by the latest advances in digital instrumentation, namely the FOUNDATION™ Fieldbus technology, in order to minimise production losses resulting from unexpected equipment failures.

Predictive technology: the route to improvement

Operations and control systems personnel had worked hard to optimise the existing control system and had achieved remarkable results. However, it was decided that further improvements would be possible only with new controls utilising more feedback from the field about the health of the process and the instrumentation and equipment running it.

Such feedback is based largely on the ability of microprocessor based, fieldbus enabled instruments and valves to evaluate and report on process status, as well as their own operating condition and that of associated equipment. The predictive health information can be used to identify potentially damaging situations so that corrective action can be taken before a major failure occurs. This causes a slowdown and lost production. Extensive work with Shell Global Solutions US examined the development of necessary guidelines and defaults for diagnostic alerts. Reacting to predictive data from the new instrumentation can also help reduce variability and keep operations steady, avoiding ups and downs. Furthermore, networks of instruments utilising the fieldbus communications protocol are less expensive to wire than conventional input/output devices and easier to commission and start up.

Diagnostics from these smart field instruments are delivered by the digital plant network to those running and maintaining the operations units. Control room operators, for example, are expected to recognise developing problems before they cause an upset. Without this kind of

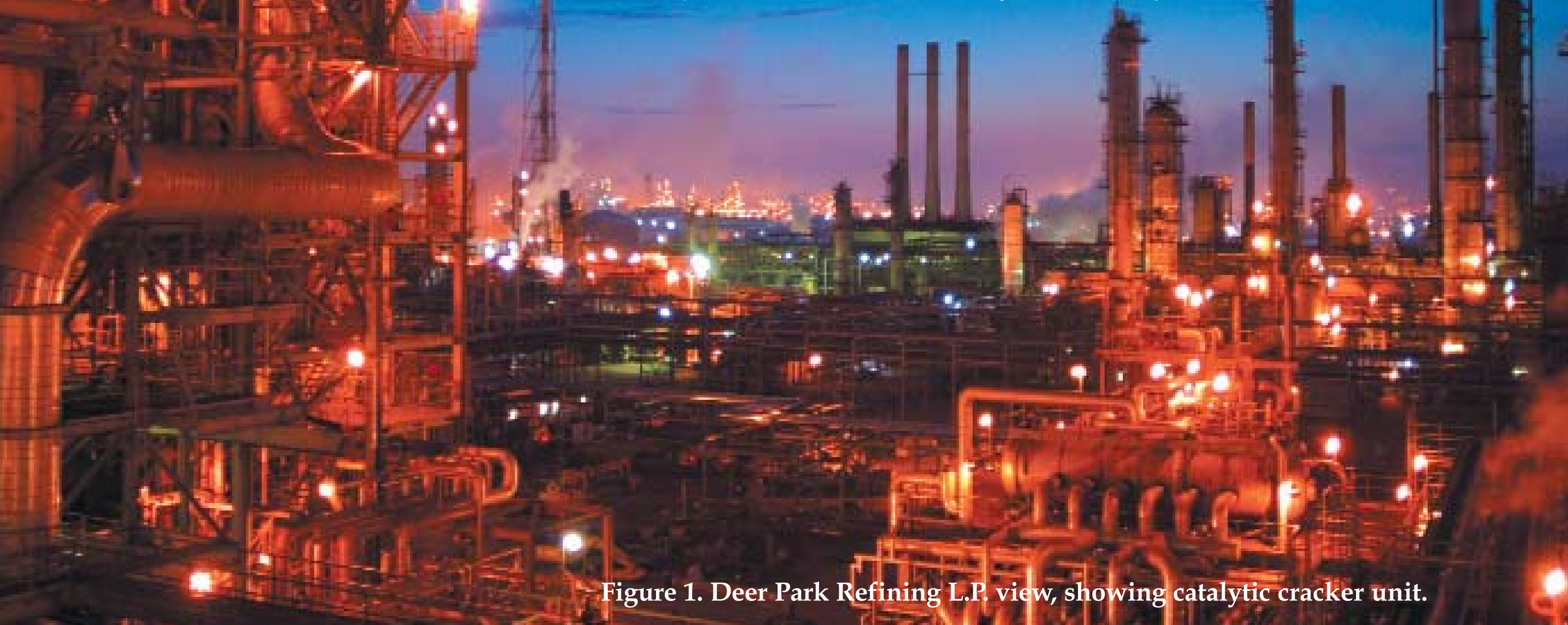

Figure 1. Deer Park Refining L.P. view, showing catalytic cracker unit.

Figure 2. At times, it is hard to tell the difference between Shell and Emerson personnel.

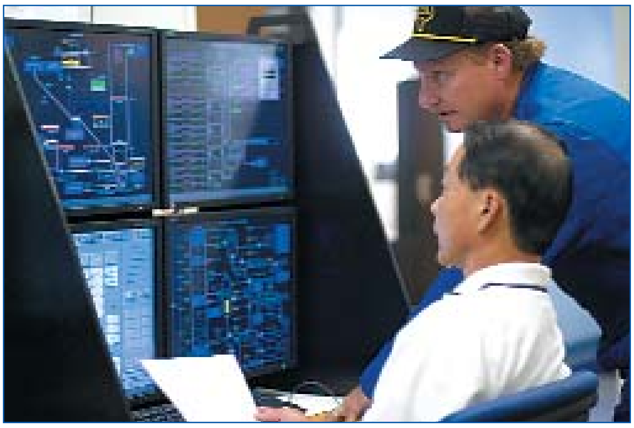

Figure. 3. Shell operations representatives designed the screen graphics.

Figure 4. Hot cutovers of transmitters required only the repositioning of process measurement tubing from old to new.

information tied in with inputs from the Triconex protective instrument system, an operator could conceivably watch an upset condition develop without understanding what has caused it. In the event of a system upset, output is slowed at best. In the worst case, production is lost. Upsets can also have an adverse effect on the long term health of production equipment, limiting the time between maintenance shutdowns. Currently, most refinery units are shut down approximately every four years for major maintenance or overhaul. Predictive maintenance information from the instrument modernisation programme will assist in permitting extensions of this period.

The right technology decision

Accepting FOUNDATION fieldbus as the control technology of the future involved recognising the advanced diagnostics capability of instruments meeting the fieldbus requirements, and the ability of new software to manage large volumes of field based data to optimise production assets. Achieving goals required collaboration with a supplier that had resources of a main automation contractor (MAC), as well as working with Shell Global Solutions US. The decision was based on the need for expertise to implement the newest technology, and the ability to provide effective training and ongoing support services. This is the primary basis behind the Deer Park Refining Services Company's selection of Emerson and its PlantWeb® digital plant architecture with DeltaV™ digital automation system for these projects. The digital plant architecture embodies the FOUNDATION fieldbus technology. Early demonstrations and training, coupled with field trials and project discussions, convinced the refinery that Emerson was the best, and essentially the only, viable alternative. Emerson's approach to fieldbus was substantially ahead of competing manufacturers.

Pilot operation verifies selected technology

Having reviewed technologies with Shell Global Solutions US to assure this was the direction for the future ,and with a vision clearly in mind, a decision was made to install a pilot operation in the North effluent treater, where the digital plant architecture could be evaluated without jeopardising any part of the refining process. A fast track project was initiated in October 2000, involving 105 fieldbus instruments controlled by the DeltaV system. When this system went into operation the following April, it gave refinery personnel their first opportunity to work with, and begin to fully understand, the fieldbus technology. The Deer Park Refining Services Company tried every possible configuration to see if it could create problems and then determine how they might be handled. Cable lengths of up to 2300 ft were tested, as were control in the field devices, and in the controllers and a mix of digital and analog transmitters. A great deal of the knowledge gained in the pilot plant was later put into practice in the refining units. The company was encouraged by the intuitive nature and significant advantages of the technology, as it was very easy to learn, engineer and use.

At the same time, planning for the modernisation programme continued, and the requisite economic projections were developed and presented. The final decision to employ Emerson as the MAC and install PlantWeb and the DeltaV system, which was supported by top management at the Deer Park Refinery, was made by the Vice President of refinery operations for Shell US.

Implementing fieldbus

In February 2002, it was announced that Shell had committed US$ 32 million to initiate the control modernisation programme, with US$ 12 million designated for installation of the fieldbus technology in the catalytic cracker unit. Engineering was already under way, and almost two years later the base level control system was complete.

The control system in the cat cracker and gas fractionisation plant includes approximately 1100 fieldbus devices, split 2/3:1/3 respectively. These instruments are networked according to the PlantWeb architecture, controlled by DeltaV, and managed by the AMS™ Suite: Intelligent Device Manager software. The AMS device manager receives diagnostic information from the control network and makes it available for maintenance purposes.

The open architecture accepts any manufacturer's fieldbus compliant devices, including the Rosemount® pressure, flow and temperature transmitters, and FIELDVUE®

digital valve positioners, which were used. Process information is delivered to and from the controllers via the fieldbus communications protocol. Other systems are integrated with this technology by means of the OPC protocol, including the Triconex protective instrument/surge control system and vibration monitoring of 10 critically important electric motors and steam turbines/expander turbines.

The use of OPC to facilitate high speed, two way communications between the Triconex system and the control room is unique; it has never been done before, and it was only accomplished here after considerable effort. The OPC connection enables operators to view far more data from the Triconex protective system than in previous systems, on the same monitors as are used for process control. The operators are also able to communicate with the Triconex system in case some action must be taken. In this way, they have direct control over several large turbines and compressors.

Such bi-directional communication between a control system and Triconex, using OPC, has never previously been implemented, and solving the problems encountered in doing so required the cooperation of all involved. It was important to resolve the issues regarding the application of OPC communications in order to achieve the high reliability required to match the triple modular redundancy (TMR) of the Triconex system. With TMR, part of the protective system can fail, and operation can continue until repairs are made.

MAC and Shell personnel roles

The MAC on these projects provided a wide range of services, including project management; development of engineering specifications for all field devices; configuration of the DeltaV system; coordination of construction activities with refinery engineering and operations personnel; assistance in solving various challenges on the project; and safety management and coordination for the Emerson construction team. During the six week turnaround period at the cat cracker in 2002, the MAC was deeply involved in the installation and startup of the first elements of PlantWeb and the DeltaV system.

Shell and MAC personnel have dual management responsibility on each project. The Deer Park Refinery managers and MAC managers are officed within 50 ft of one another and within walking distance of both project sites. This allows constant communication and cross communication between projects. In this way, learning from the initial project was communicated to the next project on an almost daily basis.

Emerson's SureService[SM] personnel helped solve the OPC interface challenge. They set up a lab at their home facility for verifying interoperability of the safety shutdown system, and identifying any issues that could affect system performance or operation. This effort supported testing, diagnosis, and engineering resolution of complex integration issues.

Operations personnel were key to handling basic design and work processes during the detailed design phase of the project. Shell operations representatives designed the screen graphics for the DeltaV monitors, determining what information was needed to operate the units and planning the graphic representations that would be required once the units were cutover to the new control system. They also played a major role in the factory acceptance testing of the system by putting the system through a rigorous test prior to installation.

Hot cutovers

Hot cutovers from field instruments serving the old control system to new fieldbus devices represent another area where the company worked very closely with Emerson.

Figure 5. Red tape over old control panel gauges reminds operators as each loop is shifted onto the new quad console.

Figure 6. Emerson's ValveLink software gives full valve and positioner information during hot cutover.

Some parts of the new system were initiated during the cat cracker shutdown in 2002, but all 1100 of the new field instruments could not be put into service in that limited time, so a programme of hot cutovers was started. This allowed operations personnel to take control of a few loops at a time. The operations representative played a key role by scheduling which device would be cut over and when.

Hot cutovers have been pefrormed many times in the past with conventional DCS systems, but new work processes had to be implemented with FOUNDATION fieldbus instrumentation and a network of instruments. Hot cutovers of transmitters are fairly simple, often requiring only repositioning of the process measurement tubing from an old instrument to a new one. The corresponding gauge on the

Figure 7. Predictive diagnostics within FOUNDATION fieldbus instruments help improve maintenance efficiency.

old control panel is then covered with a big piece of red tape to remind the operators that this loop has been shifted to DeltaV control. In this way, operators instantly know which loops are no longer controlled by the old system.

Cutting over control valves can be a little trickier, as new FIELDVUE digital valve controllers need to be mounted on existing valves. The crew only has approximately 15 - 30 minutes to install the digital valve controllers when the control room tells them the valve will not be moving. To ensure that the new instruments could be installed quickly during a hot cutover, steps were taken to prepare. The new FIELDVUE instruments were put in position on approximately 20 of the most critical valves in the cat cracker. They were precalibrated during the October 2000 cat cracker shutdown, and then replaced with the old analog positioners before startup. Thus, the company was ready to react quickly during hot cutover when operations signaled that hot cutover could proceed for each valve.

On control valves that could not have a new digital valve controller installed, hot cutover was made possible by the FIELDVUE instrument's unique pressure control mode. This enabled a fieldbus connection to the DeltaV system, and sending a pressure signal to the existing actuator or pneumatic positioner bellows. Once pressures balanced, control was transferred to the digital valve controller. The FIELDVUE instrument had accomplished both positioner and transducer functions required during cutover.

This hot cutover process was aided by the ValveLink® software loaded into a field hardened laptop, which enabled the cutover crew to know exactly what was happening within the valve during the hot cutover. They remove the old positioner, mount the new FIELDVUE digital valve controller, make necessary adjustments, stroke the valve and calibrate it with the laptop attached directly to the digital valve controller.

Predictive maintenance

The AMS Device Manager software can be used by maintenance personnel for a variety of purposes, including commissioning and startup of new field devices; aiding in instrument calibration; troubleshooting of suspected operating problems; warning of unsuspected conditions that could cause trouble; and documenting all maintenance activities related to field instrumentation. Information obtained by this software can be used for predictive maintenance to replace unnecessary preventive maintenance practices. Instead, maintenance personnel make repairs as and when necessary, based on diagnostics provided by the new instrumentation.

The maintenance of approximately 80 000 pieces of equipment related to instrumentation and control in the refinery is a monumental task. Old preventive maintenance programmes, which require each piece to be checked periodically, are simply too labour intensive. Reactive maintenance, i.e. waiting for something to malfunction or fail before taking remedial action, can result in lost production and be even more costly. New concepts of reliability centred maintenance call for ensuring all equipment that is essential to production is well maintained, while devices of lesser importance can be allowed to run to failure if they don't impact productivity, safety or environmental performance.

In the past, if operators suspected a problem in the process, a maintenance person would pick up a tool belt and rush into the field, even though very little could be done there. Now, that person can determine the condition of a field transmitter with a few simple keystrokes.

A status alert will be raised by an intelligent field device and sent to the process system and AMS device manager at the first sign of an impending malfunction. Maintenance personnel use these warnings to predict when that equipment will need to be serviced or replaced in order to prevent a malfunction: the genesis of the predictive maintenance programme, and it relies on critically important field based information that had never been available before.

Shell studies in the Far East and Europe indicate that nothing is wrong in half of the cases where job tickets are written on instrumentation. Other studies have shown that two thirds of trips to the field by instrument technicians result in 'nothing found wrong' reports. Avoiding such fruitless trips will give maintenance personnel more time to spend on actual maintenance tasks that could result in substantial savings by preventing the development of severe problems.

Conclusion

The modernisation programme is on track to support and sustain 100% refinery performance at the Deer Park Refinery, reflected in the linear operations model used to manage and benchmark results. As part of this, the key requirement is operating the catalytic cracker at 100% of planned uptime (or greater) with no surprises and no unscheduled stoppages is being met. The cat cracker, which currently processes approximately 70 000 bpd of feedstock, is expected to show an increase in utilisation of at least 1%.

It is too early to give quantifiable information on the long term results of these projects. The gas plant was only recently cut over to the new control system, and the cat cracker was fully cut over in February 2004. However, based on early experience in the cat cracker, personnel believe that they will achieve the 1% increase in utilisation projected for that unit.

The unit is already becoming something of a showcase, with visitors from as far as Russia and Kuwait coming to view the technology in operation.

The availability of sound diagnostics from the field will enable operators to have a better sense of what is going on within their processes, making it easier for them to avoid upset conditions or at least minimise the effects of upsets. If the loss of three or four days of production in a year can be prevented, this control modernisation programme will have achieved its objective. ■