3Dvision

Vornel Walker, COADE, USA, describes the design stages and CAD software used by Gas Liquids Engineering Ltd of Canada when developing a gas processing plant in the United States.

Gas Liquids Engineering Ltd. (GLE), based in Alberta, Canada, was established in 1987 with a focus on the design of natural gas purification and liquids recovery systems for the petrochemical industry.

During its 20 years of existence GLE has undertaken over 3000 projects for over 500 clients in countries all over the world. It is a full service project engineering and management company developing such processes as gas sweetening, acid gas injection, amine regeneration, process dehydration, refrigeration and LPG recovery. Over half of the facilities designed by GLE are developed from the ground up, with the company offering services anywhere from conceptual engineering and physical design all the way up to facility testing, plant optimisation and operations training.

Challenges and experience

Being based in an energy rich yet environmentally sensitive area of Canada has helped GLE gain experience in natural gas processing, the purification of sour natural gas and the extraction of natural gas liquids (NGLs). Currently over one third of the gas in producing Canadian gas fields has excess levels of hydrogen sulfide (H_2S), all of which has to be removed. Carbon dioxide (CO_2) is another component of much of the natural gas that is being brought to the surface that has to be greatly reduced, especially with the global focus on reduction of greenhouse gases.

In recent years there has been an ever greater call for experience in the area of natural gas processing, gas sweetening, and the production of NGLs. For example, in the Middle East, where there had traditionally been a focus on oil production, natural gas had been seen as a byproduct of the process of oil extraction and had typically been flared off. This byproduct is now seen as a viable revenue stream of its own. It is now being used for local energy generation and compressed into liquified natural gas (LNG) for subsequent transport and export.

Colorado Piceance Basin

Back in North America, Enterprise Products Partners L.P. of Houston, Texas, USA (Enterprise) approached Propak Systems Ltd in Calgary, Alberta, Canada (Propak), an engineering, fabrication and construction company, to manage the design and construction of phase two of its Meeker gas processing facility. Soon after the project was awarded to Propak they subcontracted the design portion of the project out to GLE.

Located above the gas rich 'tight sands' of the 6000 square mile Colorado Piceance Basin, the Meeker production complex is the largest gas processing plant currently under construction in the United States and sits atop one of the largest undeveloped gas reserves in the lower 48 with estimated reserves of over 20 trillion ft^3. By comparison, the better known Powder River Basin in Wyoming has estimated recoverable reserves of up to 39 trillion ft^3.

Exploration drilling and gas extraction from the tight sands of the Piceance basin offers unique production challenges and, although still very viable, comes in at a higher cost than the gas of the coal bed methane (CBM) fields of nearby Powder River Basin.

The Meeker project has been divided into two parts of equal size and capacity. Meeker phase I (Meeker I) is now completed and currently in production with Meeker phase II (Meeker II) currently in the design/construction phase and due to be online in the third quarter of 2008.

According to data from facility owner Enterprise, Meeker II will double the Meeker production complex's gas processing capacity to 1.5 billion ft^3/d and 70 000 bpd of natural gas liquids (NGL) such as pentane, ethane, propane, isobutane, butane and condensate.

The Colorado Piceance Basin represents one of the most prolific and fastest growing energy producing areas in the USA. The completion of the Meeker processing complex aims to provide the region with valuable midstream energy production, and the recent 50 000 bpd expansion of the mid American pipeline that services the Piceance Basin means that the Meeker facility will be able to find a ready market for its NGL production.

Figure 1. Project review model of Meeker Phase II facility showing the main piperack. In the foreground is the the NGL product amine contactor and behind it are the regeneration gas, dehydration and compression areas. On the right hand side of the main rack is the cryogenic and inlet areas.

GLE project

When Enterprise first awarded Propak the contract for Meeker II, Propak's brief was to take the 1000 ft four level main pipe rack from Meeker I and modify it for use in

Meeker II and to update the existing Meeker I designs that were previously done in 2D. The idea was that these Meeker I designs were to be utilised as much as possible for Meeker II as this new phase was seen as virtually a copy of the phase currently in production. The budget called for 8000 man hours.

As the design subcontractors for the project, GLE first set to work on the 1000 ft pipe rack. Even though there was no mention of doing the work in 3D, it was obvious to the company that the layout for this vital main artery of Meeker II, with its hundreds of interconnections, could be done more accurately and efficiently in 3D, even if the eventual deliverables were in 2D. So, GLE set to using COADE's CADWorx Plant Professional for the task. During the modelling, they discovered certain important inconsistencies in the as-built 2D drawings with which they were provided. If these had found their way into production, they would have caused scheduling delays and ultimately cost the client more money.

3D client review identifies savings

When it was time to review the work in progress, GLE presented Enterprise with a fully interactive 3D model with which they could review the design to date. During the review, GLE was able to show Enterprise areas where they thought design, process and construction savings could be made. From experiencing the design model review process, it was now obvious to Enterprise that this type of review should become an integral part of the design process. However, the question was how could this be achieved when the vast majority of the design layout was in 2D electronic and paper form?

In seeing the value and potential of the 3D model, Enterprise and Propak made the bold and seemingly unprecedented decision to let GLE model the whole project in 3D and also redesign portions, if deemed necessary. This increase in scope for GLE gave them 85% of the project which added 140 pieces of equipment, 13 skidded units, 2 million lbs of steel, 2000 fabrication piping isometrics to their work load, and resulted in a fivefold increase in GLE's budgeted hours. By making this decision, both Enterprise and Propak demonstrated a commitment to technology that would provide them the best possible design at the lowest possible price, plus give them the ability to review, identify, and resolve any scheduling difficulties as early as possible in the design process.

Working in 3D

Using 3D was not new to GLE. In fact, they had performed a lot of in-house development in producing their own tools for 3D plant design. At a time when most equated 3D with extra expense and extra time, the company could see the enormous savings an accurate 3D plant model could bring into the process of producing plant deliverables.

Their first look at this technology goes back to 2002 when many of the complex tools being offered were being discounted due to the high costs of implementation and administration, plus heavy training needs and the lack of qualified users. As the company was an AutoCAD house, they also looked at some of the AutoCAD based tools on the market at the time but felt that none of them met their current needs, nor would they meet their long term strategic goals for growth. Also, to add to the challenge of using the tools on the market at the time, the models from these AutoCAD based systems for a typical petrochemical plant were enormous, which made them a challenge with which to work.

Settling on a solution

In 2004 things changed. Autodesk had made some changes to AutoCAD 2004 that drastically reduced the sizes of 3D models that were produced on that platform. As an example, the current Meeker 2 model is about 2.5 GB. If produced with AutoCAD versions prior to AutoCAD 2004, that figure would increase to at least 7.5 GB. This change suggested that, because of the smaller footprint that these models now processed, AutoCAD based solutions were now worth another look.

During the two years prior to 2004, GLE had continued to evaluate the available plant design solutions on the market. One of the vendors they were considering was COADE Inc., based in Houston, Texas. One thing they saw as attractive about COADE's offering was that it was a complete suite of engineering and design solutions that were developed to seamlessly pass information between one another.

Figure 2. Gas dehydrator plant designed by Gas Liquids Engineering for Industrie Meccaniche Scardellato, Treviso, Italy. The plant was fabricated in Italy, in modular form, and transported to Romania for installation.

GLE was already using COADE's CAESAR II package for pipe stress analysis, so they were familiar with the quality of tools that COADE offered. On the design side, they looked at COADE's AutoCAD based CADWorx Plant Professional, which meant that they could work using the familiar graphics platform and produce deliverables in the company's preferred file format.

After a long evaluation, GLE eventually settled on CADWorx Plant Professional for the physical plant design. This package suited their work practices and was also a complete solution with piping, equipment, steel, ducting, and cable tray capabilities that matched the company's preferred way of working. The package also includes automatic generation of fabrication isometrics, project wide bills of material, 'on the fly' clash detection, model review capabilities, and bidirectional links to CAESAR II for pipe stress analysis.

Further benefits of project collaboration

Although Meeker II was not the first project on which GLE had used this integrated solution, the company's experience with the system gave them the ability to easily identify the cost savings and efficiencies that could be gained by using CADWorx Plant Professional and CAESAR II on a project of this size.

The capabilities and flexibility of these two packages working together gave GLE's multi discipline designers the flexibility to work in the most efficient manner possible by providing total design coordination for their areas. For instance, a single person could model the piping systems and also design support steel and locate individual pipe supports. Once done, they automatically produce bills of material and generate fabrication isometrics.

These same designers, using the bidirectional interface between CADWorx Plant Professional and CAESAR II, could send piping configurations, complete with all of their supports, directly to the stress engineers for analysis. GLE estimated that this saved the stress engineers 40% of their time in performing analysis by having this information fed directly from the designers.

According to Bruce Parsons, the vice president of Drafting Services and Information Technology at Gas Liquids Engineering, the challenges of such a large project as Meeker II included interdepartmental and inter company coordination, plus interfacing with fabricators, customers, and other engineering firms working on the project. By the time Meeker II was awarded, GLE had already established work practices that would leverage the benefits of using CADWorx Plant Professional, which eventually made efficient internal and external coordination virtually seamless.

As the project took hold GLE became the coordination hub for the weekly design and progress reviews of the model between its designers and engineers and the project's other stakeholders. These ongoing model reviews made everything on the project flow much smoother and faster, thus allowing changes to be made with little or no impact on the schedule.

Conclusion

GLE estimates that if it had followed the contract verbatim and delivered only what was originally stated, they may have gained a few more design hours over those originally allotted but such an approach would have had an adverse effect on the performance of the design and, ultimately, on the project schedule. GLE has been able to deliver a design that allows Enterprise to quickly make adjustments in the design to improve efficiency, reduce costs, and shave weeks off of the schedule.

For example, it was determined that if certain parts of the plant were mirrored it would save on time, money, and materials; with the CAD system this was tested and eventually approved. This could never have been done with any certainty using traditional 2D systems. In a separate case, another part of the plant was rotated for the same reasons and with the same positive outcome. Again, in yet another instance, it was determined that piles could be used to underpin some of the foundations, saving thousands of tons of concrete.

As noted before, when GLE was first brought in for the design phase of Meeker II, they realised that they could save their clients money by using efficient design and engineering practices. GLE has a saying, 'the model is golden,' and even though this refers to the model as the standard against which all project decisions should be made, it also helps to explain the effect a quality designed model has on the client's bottom line.