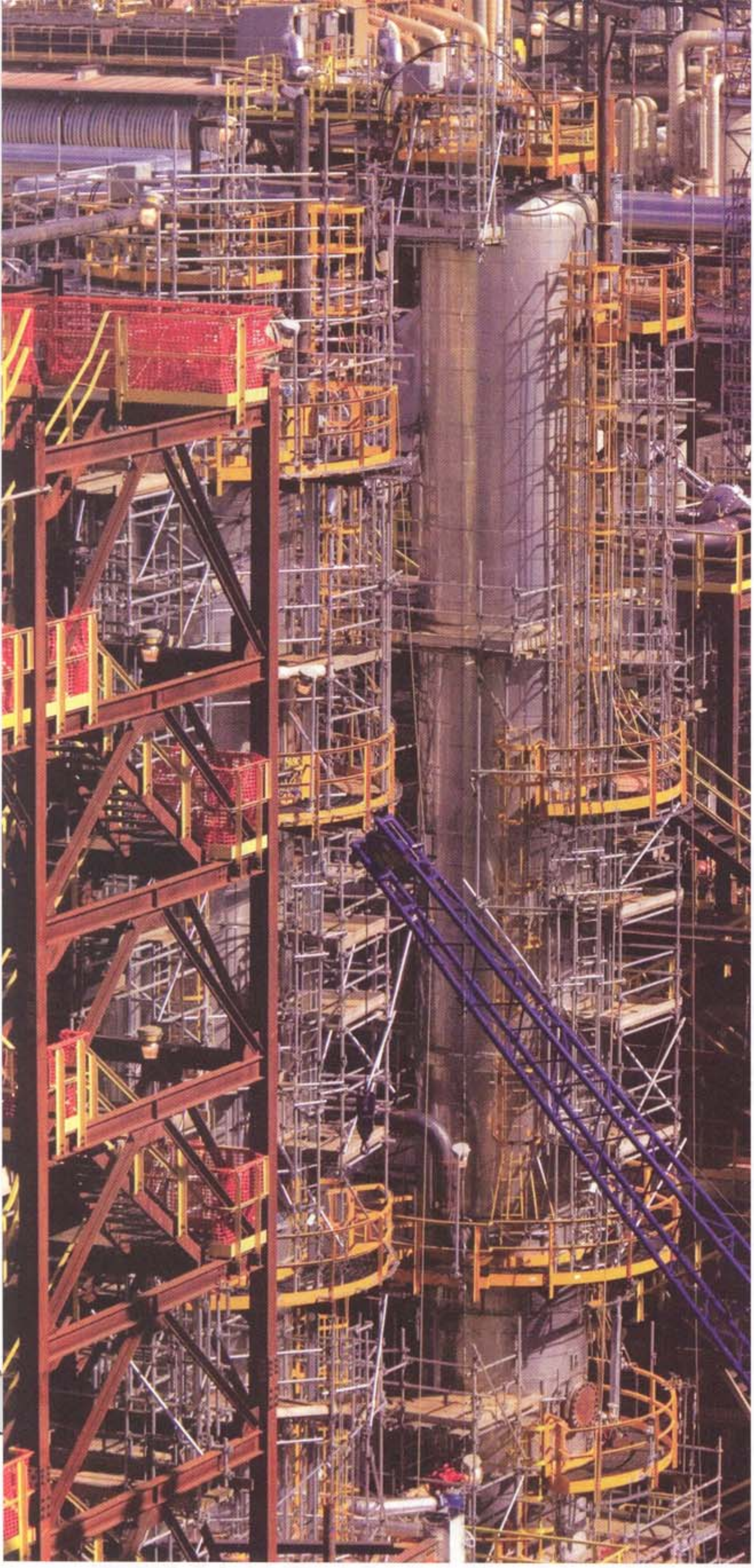

Fig. 1 — The cylindrical tower of a typical coker.

Mechanized Weld Buildup Repairs Coker

Few Americans realize that their neighbor to the north, Canada, currently supplies 17% of the total U.S. crude oil demand. While much of this crude comes from conventional wells, a large contribution comes from the vast oil sands located in the province of Alberta. There, however, the oil is found in a semisolid tar-like form mixed with sand, variously called oil sands, tar sands, and bitumen. According to U.S. Dept. of Energy estimates, Alberta's oil sands contain between 1.7 and 2.5 trillion barrels of reserves, of which 300 billion barrels are recoverable with today's technology. Stretching across 54,000 square miles, these reserves are largely untapped because of the expense and complications of removing the oil from the sands. The deposits are mined in massive open pits. It takes about two tons of sand to extract one barrel of oil. Special facilities/refineries must first chemically process the bitumen to yield an oil grade known as synthetic light crude, which is then conventionally refined to various petroleum products.

Mining the Tar Sands

Several companies are now active or in the developmental stages of mining the tar sands. The largest producer so far, Syncrude Canada Ltd., came on stream in 1978. It is jointly owned by several of the largest North American oil companies. It operates a large facility 25 miles north of Fort McMurray equipped with the special capabilities required to process the oil sands. Another company with both mining and processing facilities is Suncor, which came on stream in 1967. Shell operates a mine, but does no processing on site, instead transporting the bitumen in a diluted form by pipeline to its upgrader and refinery at Scotford, Alberta.

Syncrude pioneered a technique called hydrotransport to move the tar sands from mine to extraction plant. The oil sand is mixed with water to form a slurry that can be economically transported via pipeline. After oil extraction, the sand is returned and the land reclaimed to its original condition.

Growth prospects for oil derived from the tar sands were hampered by the low price of oil in the 1980s and 1990s, and the assumption that prices would remain low in the future. Recent technological breakthroughs have brought down costs, while oil prices have risen. Syncrude's $7.8 billion UE-1 expansion project was completed in early 2006, which boosted production by 44% to 360,000 barrels a day.

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The use of mechanized pipe welding equipment allowed control of the welding process away from the heat of the preheated surface and fast job completion

BY JOHN PAGE AND JOHN EMMERSON

Vessel Wall Corrosion Dictates Buildup Repair

Turning bitumen into synthetic crude involves a process called "coking," which removes some of the carbon. A fluid coker can stand up to 23 stories high — Fig. 1. Maintenance involves shutdown of the giant unit. A recently completed shutdown project for one of the industry majors involved repairing a 50-ft-diameter burner vessel (adjacent to the coker) that had lost 0.5 in. of wall thickness due to corrosion over the years. The preheat requirement of 300°F made for an extremely hot working environment for manual welders. A local contractor was awarded the maintenance contract. The contractor turned to Edmonton-based John W. Page Welding Consulting Ltd., which assisted as a subcontractor to provide mechanized welding equipment and technician services. John Page has 30 years of experience in orbital pipe and mechanized welding projects, and has accumulated a fleet of orbital gas tungsten arc welding (GTAW) and flux cored arc welding (FCAW) systems. Page recommended that the contractor use several Magnatech Pipeliner systems for the weld buildup. Conventionally used for orbital FCAW of pipe from 6 to 60 in. in diameter, the weld heads can also be used on larger diameters using Flx-Track. These flexible, 7½-ft-long tracks can be magnetically mounted on a large-diameter vessel wall and be joined together for longer continuous runs.

The union welders were trained in equipment operation prior to the job start — Fig. 2. The Alberta Boiler Safety Association (ABSA) mandated that the welders qualify the weld procedure as a butt joint weld, because the weld buildup required was not a corrosion-resisting alloy cladding, but rather was replacing the carbon steel base metal, similar to doing fill and cap passes on a butt joint weld.

Access to the areas requiring weld buildup required cutting 9-ft-wide windows (17 of them) in a surrounding stainless steel "skirt" — Fig. 3. Equipment installation was simple and straightforward. The welding power sources, controllers, and coolers are modular, and were lowered through a manhole in the grid floor to a scaffold in the middle of the 50-ft-diameter vessel. From there, the 50-ft-long extension cables allowed the wire feeders, control pendants, and weld heads to fan out and reach every area around the circumference. The welders reached in and slapped the 7½-ft tracks on the wall with magnets. They then installed the weld head on the track in seconds using a unique push-button pneumatic clamping system.

Cladding was done at 18 in./min travel speed. As the pendant has motorized steering, with a dial counter from 0 to 1000, the welder lays the first pass on at a dial setting of 1000, which is the maximum distance away from the weld head and track. At the end of that pass, a toggle switch reverses the travel direction, and the welder decreases the steering dial counter by an increment, such as 50 per

Fig. 2 — Shown are the welders being trained at the Edmonton Boilermakers training center, prior to the buildup project.

Fig. 3 — Nine-ft-wide windows were cut out of the inner skirt to allow access to the corroded steel shell.

Fig. 4 — An optional gun axial slide bracket, combined with wide stroke steering, minimized the need for repositioning tracks.

pass, to create a "step-over" increment for perfectly uniform and stacked passes. Once the step-over increments have counted down to zero, a second layer is applied in the same fashion. To continue higher up the wall, the extended mechanical gun slide bracket is quickly repositioned allowing the motorized steering to start counting down from 1000 again. Using the mechanized and motorized adjustments, the track had to be only repositioned once to complete the job — Fig. 4. "As the flexible tracks conform to the curved wall, and are quickly mounted using magnets, it requires only minutes to move the track, check it for level, and continue welding," Page said.

An all-position formulation of an 0.045-in.-diameter Air Liquide wire (–E71T-12MJ) was used. This wire met the new, more stringent requirements for 4 mL of hydrogen per 100 grams of weld metal and had excellent low-temperature impact properties (125 ft/lb at –50°F). All welding fume and dust were well evacuated by the Smogbusters company, professionals at air quality in confined spaces, which also used some of its air-movement systems to bring in fresh cool air, greatly welcomed by the welders due to the high preheat temperature used for the walls.

Shortening the Shutdown Duration

The decision to hire the services of a specialized consultant can drastically reduce project mobilization time. Hiring a specialist (with additional technical staff if required) can greatly reduce the training learning curve and provide speedy solution of problems that appear once the job gets underway at the work site. "Very often the contractor jobsite personnel and the craftspeople on a project are new to mechanized welding," explained John Emmerson, president of Magnatech. "If a problem appears, it's sometimes difficult to determine the root cause: equipment, consumables, welding technique. If the problem is not quickly resolved, it can quickly lead to frustration on the part of the welders and equally for the contractor's staff, under deadline pressures. I can't count the number of times we've been told that an equipment malfunction was causing porosity in the weld. Porosity can result from a defective regulator or gas line connection aspirating air, bad gas, hydrocarbon contamination of the weld joint, welding technique, moisture in the flux core wire due to improper storage, etc. This often leads to a retreat to the 'safety' of manual welding, forgoing the original goal of getting the job done faster with a substantially lower repair rate."

Page brought up the point that "many contractors or fabricators have doubts about flux cored wires due to porosity problems they've seen, but almost no one doing semiautomatic welding with flux cored wires realizes how the guns are rated. For example, that oh-so-popular 300-A gun is designed for 100% CO_2 gas, which helps keep the gun parts cool, but most distributors and wire manufacturers recommend the much hotter 75% argon/25% CO_2 shielding gas for the modern wires. If you read the fine print in the gun manufacturer's manual, the gun rating is actually cut in half for mixed gas, and you need a heavier-duty gun, at least in the front end parts. Using a typical gas-cooled gun with mixed gas will often lead to porosity after a few minutes of welding, as the front end parts overheat. The light-duty contact tips seize on the wire, and the thin-walled brass nozzle expands and sucks in air. But that's what you get with light-duty components." Use of a liquid-cooled gun, with heavy-duty tips, and high-quality, heavy-walled copper nozzles for continuous weld buildup jobs eliminates porosity defects.

Automated FCAW equipment is typically six times as fast as manual SMA welding for these larger jobs. It is also much faster than hand-held, semiautomatic welding with similar wires, due to the high duty cycle of mechanization, and there is a dramatic improvement in uniformity of the weld, according to Page.

By allowing the welder to remotely control the welding process away from the intense heat of the preheated surface, the job was done in record time, while improving safety — Fig. 5. "Manual welders working inside the vessel with the bottom preheated to 300°F (177°C) can only work 15 minutes before retreating outside for one hour to cool off," Page said.◆

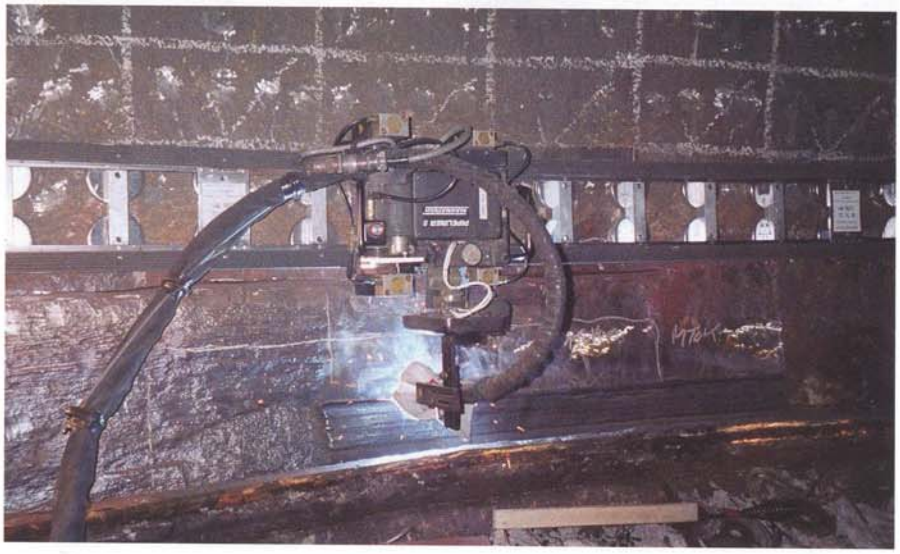

Fig. 5 — The orbital welding equipment is shown on the workpiece, which was preheated to 300°F.