General Magnaplate Corp.

CASE STUDY

Tomorrow's Materials Solutions... Today.

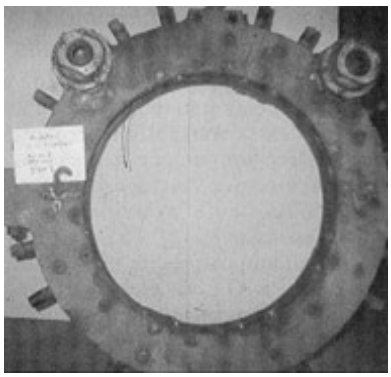
"Space-Age" Surface Enhancement Coatings Fight Environmental Attacks On Oil & Gas Equipment

By Edmund V. Aversenti, Jr., General Magnaplate Corp.

Design engineers, operating engineers, and equipment maintenance specialists in the oil and gas industry are increasingly turning to high-tech surface enhancement coatings that allow oil and gas operating equipment and their component parts to withstand the rigors of the environments to which they are exposed. Unprotected or inadequately protected metal components used in oil and gas exploration, completion and production operations can quickly become pitted, brittle, degraded and worn. This can lead to failure of expensive, critical equipment and serious interruptions of production and/or product flow. Offshore drilling rigs and the equipment they house, for example, are not just exposed to salt water, they are often immersed in it.

Space-Age Solutions

The harsh environments and corrosive product streams in the oil and gas business present extremes not unlike what metals undergo in space missions. General Magnaplate Corporation originally developed its coatings for the space industry; they are employed on every U.S. aerospace vehicle. These "space-age" coatings have come down to earth to help metal parts survive in the harsh conditions of the oil/gas business - one among the many critical metal performance challenges the coatings have met.



One particular surface enhancement process toting up successes in the oil/gas industry is General Magnaplate's NEDOX®. This coating process dramatically increases surface hardness; resists corrosion, chemicals, and acids; prevents abrasive wear and galling; and is permanently dry-lubricated to yield a very low COF of friction. Metals successfully treated with Magnaplate's NEDOX enhancement technology include steel, stainless steel, copper, brass, bronze, and even titanium and aluminum.
NEDOX coatings have been instrumental in solving the following problems in oil and gas processing and exploration.

Tomorrow's Materials Solutions... Today.

Clamshell Cutters for North Sea

When it was discovered that the Ekofisk Oil Field drilling platforms had lowered 3.7 meters closer to the North Sea surface than when installed, engineers arrived at a challenging solution to raise the five 40,820-ton platforms with minimal loss of production time. They would jack up the platforms in one lift, using a computer-controlled hydraulic lifting system. The combined load would bend slightly under the world record for the heaviest lift.

The basic sequence of operations was to: install the jacks; rig flanged riser extension sections in place next to the legs; cut the legs; weld flanges to the legs; make the lift; install/weld on the riser extension pieces.

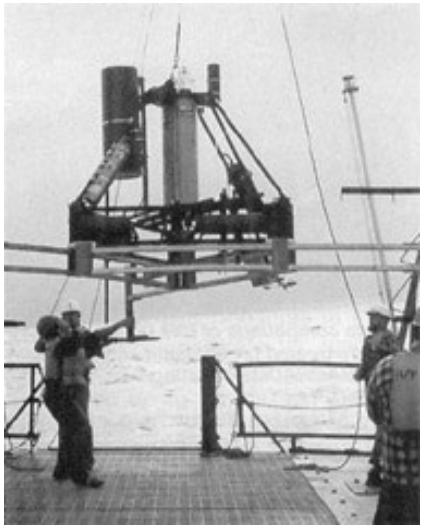
For the cutting, torch cutting was ruled out as too risky and costly. Instead the engineers cold-cut the legs. Keys to that operation were steel split-frame "clamshell" pipe lathes designed to sever in-line piping and simultaneously bevel the pipe for welding. Sixteen clamshell lathes, ranging from 6" through 42" pipe sizes, had to be coated to protect them against salt water corrosion. At the same time, the coating had to protect the aluminum gear drives and function on gib-ways and plain bearing surfaces without breaking down and/or galling. Tests showed that conventional coatings would not do the job. Instead, two multi-step space-age coatings were applied - NEDOX on the steel lathes and MAGNAPLATE HCR® on the aluminum gear drives.
The NEDOX nickel alloy coating on the steel components of the clamshells created a new surface with unique levels of salt spray resistance, surface hardness, abrasion resistance, as well as chemical resistance. The MAGNAPLATE HCR coating to the aluminum parts incorporates colloidal bi-metallics in its formulation to achieve over 10,000 hours of salt spray chamber exposure on 6061-T6 aluminum, with a protective coating as thin as only 0.001". It protects against wear, abrasion, friction, sticking and galling.

When new plans required the contractor to use untreated clamshells as well as treated ones, an opportunity arose for in-field comparative tests. The treated clamshells surpassed all expectations. The lathes needed only grease replacement and a thorough wipe-down. The untreated lathes had to be fully disassembled and bead blasted to remove the corrosion, and then had to be reassembled.

Undersea Ball Valves

Ball valves on an underwater safety valve for drilling offshore stop the flow, "bubble tight," with no seepage - even at the ocean floor. The valve can withstand repeated openings and closings with minimal damage or wear at the seal surfaces. Additionally, the valve can be tested regularly without scoring the critical sealing surfaces of its resilient seal, metal seat or ball.

To achieve this performance, the valves needed to be coated for corrosion resistance. During testing, conventional coatings commonly failed from galling when rotating the ball at metal-to-metal pressures exceeding 30,000 psi. With pressure reduced to near zero before rotation, conventional coatings developed flaws, which increased friction and encouraged corrosion. But a NEDOX surface enhancement coating evidenced no galling, seizing, or corrosion during the test period.



The way it works: The valve, installed in the tubing string, opens for flow-in steps, equalizing the pressure. Pressure applied to the hydraulic control line moves a balance sleeve downward until the unloading ports open, equalizing pressure across the valve. The mechanism is designed so large pressure drops are never unloaded across the ball or seal.

The piston moves the ball down and away from the resilient seal before the ball rotates, protecting the seal from damage. After the ball starts moving downward, it contacts rotation control pins, and cams open. The valve is held in the open position by pressure, monitored by the surface control console, until there is an accidental or deliberate pressure drop.

Valve manufacturers continue to send steel ball valves of every type to General Magnaplate for its multi-step coating processes. After an initial cleaning of the ball valves, the ball surface is electroplated with porous, hard cobalt-nickel alloy, then infused with a proprietary engineering polymer and treated to assure complete integration of the polymeric material into the micropores of the surface. Coating thickness can be controlled to meet specifications for lubricity and/or wear resistance.

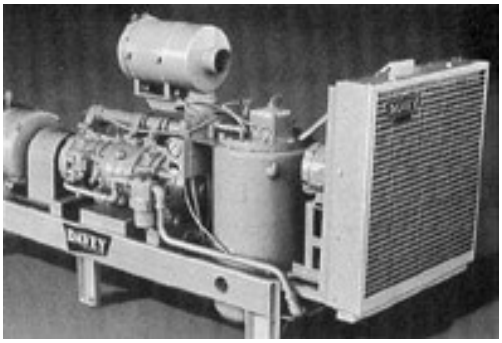
Downhole Tools

An engineering firm that designs downhole tools has had a coating of NEDOX applied for a number of years. One of the downhole tools is a pressure sensor that runs on a slick line and features a self-contained downhole computer. Because the housing is coated with NEDOX, the tool can be made of 4140 steel rather than stainless. This saves time and money, first by being able to substitute a lower cost base metal, and second by avoiding the need to machine the stainless. Performance is excellent. Although the tool is continually subjected to pressures up to 15,000 psi and temperatures of 302°F (150°C), the tool can stay downhole for up to 30 days.

Air Moving Equipment

Air moving equipment used in oil and gas exploration is particularly susceptible to damage from corrosive gases, which can significantly shorten the useful life of vanes, blades, turbines, and similar equipment. NEDOX and other Magnaplate coatings have solved many corrosion problems on air moving parts, including critical parts on turbo compressors, compressor heads, impellers, blades and vanes. The surface enhancement coatings provide a harder-than-steel, corrosion resistant, permanently dry-lubricated surface. Because these coatings are extremely smooth and uniform and have a very low coefficient of friction, they permit greater operating efficiency

through improved performance, even if there is no danger of deterioration from hostile environments.



Conclusion

As these examples illustrate, oil and gas industry metal parts can be effectively treated to resist the damaging effects of corrosion and corrosive product streams. Application of “space-age” surface enhancement coatings to such parts creates sealed surfaces with hardness and density that match or surpass parts fabricated from more expensive, corrosion-resistant metals such as stainless steel.