Transformational process offers nickel-plated cylinders at scale

Meeting accelerating growth in demand for specialty gases in the US

By **Stephen B. Harrison,** Managing Director, **sbh4 consulting**

With the planned investment in new wafer fabs in the Midwest and Southwestern US, it is likely that there will be an increase in the demand for electronic specialty gas cylinders to support the expanded market. Many of the cylinders used for specialty gases have been nickel-plated to preserve the purity of the gases, but currently the availability of nickel-plated cylinders is limited.

A Texas company, Houston Plating & Coatings has developed a scalable process which it calls Ni-side™, that can supply the industrial gases industry with an ample supply of nickel-plated cylinders to fill this increased demand. Electroless nickel-plating has been applied extensively in the oil and gas sector to ensure that certain components of transmission pipelines do not suffer from corrosion during decades of use.

Like gas cylinders, pipelines operate at pressure, undergo pressure cycles, and are exposed to all types of weather conditions from snow and sun to driving rain.

The appeal of nickel-plated steel cylinders is that they are significantly cheaper than stainless steel cylinders of equivalent size but can have similar properties. However, nickel-plating of specialty gas cylinders has, in the past, been difficult to execute at scale. This has limited the production rate which has, in turn, limited the potential breadth of applications and depth of penetration for nickel-plated cylinders.

Ni-side™ Cylinder Plating is a transformational electroless nickel-plating process for cylinders that leverages tried and tested technology, which has been proven in the most demanding energy sector applications. It allows Houston Plating to offer unprecedented levels of scalability, cost-effectiveness, and consistently high quality for specialty gases cylinders.

The Ni-side™ technology relies on immersion of the components to be plated in baths filled with chemical solutions. Conversely, the chemicals can also be filled into a vessel, such as a cylinder. The finish is a very smooth layer of high-phosphorus nickel that mirrors the contours of the plated part, and the thickness can be tightly controlled through the plating process to ensure an optimal balance of cost and materials properties.

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Rising metals prices risks are pulling for plating as a cost-competitive alternative

Most specialty gas cylinders have traditionally been made of carbon steel alloys or aluminum alloys. The more expensive aluminum alloy cylinders are favored for corrosive gases, such as some types of electronic special gases.

For inert gases, strong, low-cost carbon steel cylinders are fit for purpose and represent the most economical solution. In exceptional cases, stainless steel has been used, but due to its extremely high cost, it is reserved for the most aggressive chemicals where materials compatibility calls for the ultimate solution.

Nickel is also an extremely inert metal and has been used to plate the internal surface of carbon steel cylinders. Nickel-plating of gas flow and pressure control equipment components such as valves and pressure regulators for use with specialty gases is also common.

Nickel-plated carbon steel cylinders can also be more cost effective than an aluminum cylinder. The price of aluminum spiked on February 24 and was $3,394 per ton. On March 4, within two weeks of the commencement of the war in Ukraine, the aluminum price had shot up 13% to $3,849 per ton. Surging commodity costs will put pressure on traditional technologies and drive gas cylinder innovation.

Nickel prices have also risen since the invasion of Ukraine, with the notable suspension of nickel trading at the London Metals Exchange on March 8, as the price hit $100,000 per ton. However, the amount of nickel used to plate a carbon steel cylinder is very small compared to the amount used in a stainless steel cylinder, and the nickel price has only a small bearing on the overall costs of creating nickel-plated carbon steel cylinders.

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Leveraging lessons from nickel-plating in the US energy sector

William H. Howard, Jr is Chief Executive Officer (CEO) at Houston Plating & Coatings, LLC. His company has been supporting the US energy sector with advanced materials coating processes at scale for over three decades. He says that "the time is right for us to offer our nickel-plating services to a broader range of industries."

Whilst geopolitical uncertainties are likely to see a massive expansion in US energy supply for national and international demand, Howard is convinced that his team is ready to support additional sectors.

"With some of the largest plating tanks in the country, we will undoubtedly have the capacity to extend our offering to industrial gas cylinder plating, provide the fastest turnaround, and become a trusted resource in the specialty gases cylinder supply chain," says Howard. "Operating at scale with consistently high quality is what we do best. We have been an approved supplier to the world's largest oil and gas companies for years and our nickel-plating process has been written into customer specifications for use across the US. Major multinational energy companies have come to trust us through years of partnerships and lessons we have learned will be transferrable to new applications in other safety conscious and quality-critical sectors."

Regarding the technology-fit to the electronic specialty gases sector, Howard is equally convinced of the value his company can bring. "We have been running trials to nickel-plate carbon steel cylinders for a number of gas distributors and a cylinder OEM," he says. "Independent laboratory testing has proven that our process is ready to support the high expectations of the industrial gases and semiconductor sectors."

Houston Plating has also allowed selected electronic specialty gases cylinder experts within the industrial gases sector to examine some early batches of their nickel-plated cylinders. "Feedback from prospective users of our cylinders has been outstanding and has spurred us on to commercialize our technology and product offering," adds Howard.

Enabling cost-effective growth in US semiconductor manufacturing

Leading chip manufacturers such as Intel, Samsung, and Taiwan Semiconductor Manufacturing Co (TSMC) are planning new wafer fabs in the American Midwest, South, and Southwest.

TSMC and Intel are expected to build new plants in Arizona. Samsung ▸


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is planning a semiconductor facility in Texas and Intel will also seek to build new wafer fabs in Ohio and New Mexico. All three high-tech semiconductor giants are scaling up production to curtail the global semiconductor shortage which has led to slowdowns in downstream sectors such as automotive production in recent years.

Investment in the construction of these five new fabs is likely to be close to $70bn. Once operational, they will need a steady supply of electronic specialty gases. Some high purity gases such as nitrogen can be produced onsite, while other electronic materials are supplied in cylinders through international supply chains. As these production facilities start up, more cylinders and specialty gases filling plants will be required to ensure a reliable supply of electronic specialty gases. The investment in these filling plants and cylinders to support the chipmakers will be made by major industrial gases companies.

Profit margins in the supply of electronic specialty cylinder gases must be tightly controlled and the costs of investment in new cylinders can be significant. So, the option of investing in additional cost-effective nickel-plated cylinders as an alternative to stainless steel or aluminum will be attractive for many specialty gases suppliers.

Qualification of products in the electronic specialty gases sector is a key requirement to comply with the tight quality control processes that the wafer fabs operate to. So, switching from one supplier to another or from one type of cylinder to another during the operation of a fab is costly and time intensive. Howard appreciates the challenges and says, "As chip production cells are commissioned in the newly built facilities, they can use the most appropriate cylinder technology from day one to meet the increased demand and avoid the costs of change in years to come. So, we believe that the timing for the introduction of our new nickel-plated cylinder technology to the US market is ideal."

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Other applications for nickel plating

As the industrial gas industry becomes aware of the increased availability and cost benefits of nickel plating, there are likely to be several other applications for that technology. For instance, ethylene oxide is used to sterilize medical equipment and medical consumables such as Covid-19 test kits and surgical masks. This is a 'high-tech' application with high growth potential.

One of the challenges of distributing ethylene oxide in cylinders and drum tanks is that it reacts with moisture to polymerize. The polymerization causes cloudy ethylene oxide of poor quality. It is also a chain reaction that can have catastrophic implications.

Cleaning carbon steel cylinders and drum tanks is problematic because moisture 'hides' in rusty areas of the cylinders, meaning that avoiding moisture in the ethylene oxide is almost impossible. The solution that has been implemented in many cases is to use very expensive stainless steel drum tanks which avoid the rust and thereby avoid the water and maintain the quality and safety of the ethylene oxide.

"Houston Plating can provide nickel-plating services for large drum tanks in addition to cylinders," adds Howard. This will enable low-cost carbon-steel drum tanks to offer the high-performance levels of stainless steel, but at significantly lower cost. "Bear in mind that our background is working at scale in the oil and gas processing sector. Industrial gas cylinders and drum tanks are small in comparison to some of the components we handle." gw