

BY BRENT HAIGHT

What role does gas compression play for your business and end markets?

Gas compression is pivotal across a spectrum of industries, serving as the backbone for a multitude of critical processes in sectors such as hydrogen, oil and gas, chemicals, and food production, to name a few. Compression is indispensable for creating and sustaining the high pressures necessary for a wide range of operations. Without gas compression technologies, many essential processes in these industries wouldn't be feasible.

One of the paramount aspects of gas compression also lies in its ability to transport gases across vast distances, seamlessly linking demand with supply. This capability is particularly crucial for ensuring the smooth functioning of global supply chains and meeting the needs of diverse markets.

For Chart Industries (Chart), with a longstanding focus on cryogenic applications and processes, gas compression assumes an even more pivotal role. It's not just about achieving high pressures but also about liquifying gases essential for industries like natural gas, nitrogen, carbon dioxide, and notably, hydrogen. As hydrogen continues to emerge as a key contributor to the energy transition, the significance of gas compression as an enabler for this expanding industry cannot be overstated.

This strategic vision led us to acquire Howden in 2023, a global provider of compression technologies and equipment. Howden's rich history includes diaphragm compressors and screw compressors, along with monumental achievements like building the world's largest hydrogen compression solution.

At Chart, we take immense pride in our compression business, which has been instrumental in supporting and enabling groundbreaking projects globally. These include the world's first green steel project in Sweden, the world's largest hydrogen refueling station in China, the world's first e-fuels



CHART INDUSTRIES

A CONVERSATION WITH SALAH MAHDY,
HYDROGEN MARKET DIRECTOR

plant in Chile, Europe's largest green hydrogen project — Shell Holland Hydrogen I — and numerous other initiatives that are driving innovation and sustainability across industries.

Additionally, the role of hydrogen compression is paramount for Chart in facilitating the development of the very large-scale liquid hydrogen liquefiers, capable of producing 100 tons or more per day. These hydrogen liquefaction facilities are crucial for the hydrogen market, as they enable the efficient transportation of hydrogen from production hubs to the markets where it will be consumed. This capability is essential for scaling up hydrogen infrastructure and meeting the growing demand for clean energy solutions worldwide.

In your opinion, what are the biggest challenges facing the gas compression industry today? What is Chart doing to meet these challenges?

The gas compression industry is navigating several challenges in today's dynamic market environment. One of the primary challenges is the increasing demand for energy and the transition toward cleaner and more sustainable energy sources. This shift requires innovative solutions in gas compression technology, to support the development and adoption of alternative fuels such as biogas, renewable natural gas, and hydrogen.

Another challenge is the need for enhanced efficiency and reliability in compression systems, especially as industries strive to optimize operations and reduce their environmental impact. This involves advancements in compressor design, materials, and digital technologies to improve performance, reduce energy consumption, and minimize maintenance downtime.

Furthermore, there is an expected surge in demand for gas compression, particularly for hydrogen compressors, as they play a pivotal role in the energy transition. Meeting this heightened demand poses a significant challenge, as the world must produce enough compressors to support the transition to net-zero emissions. This challenge underscores the critical need for scalable and efficient compressor solutions to facilitate the global shift toward sustainable energy practices.

Market strength varies by location. In your opinion, which geographic locations (globally) hold the most promise for the gas compression industry? Why?

The geographic locations that hold the most promise for the gas compression industry can vary based on several factors, including market demand, energy transition initiatives, infrastructure development, and regulatory environment. The gas compression industry sees promising opportunities across several geographic locations globally, driven by distinct factors that contribute to market strength and growth potential. Among these regions, the following stand out for their promising prospects:

North America: The United States and Canada are experiencing substantial growth in the energy sector, started by shale gas production and now with renewable energy investments. The region's focus on energy independence, coupled with advancements in hydrogen infrastructure, makes it a promising market for gas compression technologies.

Europe: Europe is at the forefront of the energy transition, with ambitious targets for reducing greenhouse gas emissions and promoting renewable energy.

This region sees growing demand for gas compression solutions, particularly in hydrogen infrastructure development and offshore wind energy, where compression is vital for gas handling and storage.

Asia-Pacific: Countries like China, Japan, South Korea, and Australia are investing heavily in clean energy technologies, including hydrogen and liquefied natural gas (LNG) infrastructure. The rapid industrialization and urbanization in Asia-Pacific drive demand for gas compression systems in various sectors, from power generation to industrial processes and mobility.

Middle East and Africa: The Middle East's position as a major player in the oil and gas industry, coupled with Africa's emerging energy markets, presents opportunities for gas compression technologies. Investments in gas processing, LNG export terminals, and renewable energy projects, including the big hydrogen liquefiers for energy export, drive the demand for compression solutions in these regions.

These geographic locations offer diverse opportunities for the gas compression industry, with factors such as robust energy demand, market trends favoring clean energy solutions, and a growing focus on hydrogen as a sustainable energy vector driving growth and innovation in the sector.

What market indicators do you follow/track to forecast the short- and long-term health of the gas compression industry?

Chart closely monitors a range of market indicators to assess the short- and long-term health of the gas compression industry. These indicators include energy demand and consumption trends, infrastructure investments, hydrogen economy developments, the regulatory environment, technological advancements, and of course, market dynamics and competition.

By leveraging these market indicators and staying attuned to industry trends and developments, we can effectively forecast the short- and long-term health of the gas compression industry, identify growth opportunities, and drive innovation to meet market demand.

Discuss any trends you've identified throughout the gas compression value stream and any impact you foresee these trends having on the gas compression market.

Today's gas compression industry is shaped by several key trends. A significant one is the increasing adoption of renewable energy sources such as wind, solar, and biofuels. This shift fuels demand for gas compression technologies to support renewable energy projects, including biogas processing, hydrogen production, and compressed natural gas (CNG) storage for backup power.

The rise of the hydrogen economy is significantly impacting the gas compression market. The growing emphasis on green hydrogen production, storage, and utilization necessitates advanced compression technologies for hydrogen refuelling stations, industrial applications, and energy storage solutions.

Modular design is another important trend shaping the gas compression industry in certain applications which allows for greater flexibility, scalability, and customization in gas compression systems. With this design principle, manufacturers can offer more versatile solutions that can be easily adapted or expanded based on specific customer requirements.

Furthermore, digitalization and the integration of Internet of Things (IoT) technologies are transforming the gas compression value stream. Advanced data analytics, predictive maintenance, remote monitoring, and automation enhance the efficiency, reliability, and performance of compression systems, reducing downtime and operational costs.

These trends collectively drive innovation and competitiveness within the gas compression industry, reshaping the market to address evolving customer needs while contributing to a more sustainable energy landscape.

What opportunities does Chart see in hydrogen gas compression, renewable natural gas, liquefied natural gas, and/or compressed natural gas? What solutions is Chart developing to meet the needs of these growing industries?

Chart's Nexus of Clean encapsulates the global growth potential of increased clean energy adoption across various sectors. Each sector, although progressing at different rates, presents unique opportunities and challenges that require tailored solutions.

In the realm of hydrogen gas compression, we are witnessing a notable surge in demand. Hydrogen is gaining momentum as a clean energy carrier, and efficient compression systems are essential for its widespread adoption. Chart is developing advanced hydrogen compression solutions tailored for diverse applications, from refuelling stations to industrial processes. Our focus is on scalability,



Containerized Diaphragm Compressor

energy efficiency, and safety, aligning with the evolving needs of the hydrogen industry. This covers a wide range of our compression products such as the piston, diaphragm, and screw compressors.

Moreover, we are currently developing completely new compression products that are not yet in our portfolio. These innovative solutions are set to be launched later this year, and we've already received significant interest from our customers and partners.

The renewable natural gas (RNG) and LNG sectors offer promising growth opportunities. Environmental regulations and the push for carbon-neutral energy solutions are driving demand for optimized compression systems. Our expertise lies in developing solutions that prioritize emissions reductions, operational reliability, and cost-effectiveness, ensuring seamless handling and transportation of RNG and LNG from production sites to end users.

How have customer needs and expectations changed in the past five to 10 years and how has Chart addressed them?

In recent years, the gas compression industry has witnessed notable shifts in customer needs and expectations, driven by various factors such as technological advancements, regulatory changes, and sustainability requirements.

One significant change has been the increased focus on sustainability. Customers now prioritize solutions that reduce carbon footprint, minimize emissions, and promote cleaner energy sources. In response, Chart has been focusing on further advancing our compression technologies specifically tailored for clean energy applications, including piston, diaphragm and screw compressors.

Additionally, customers expect advanced technology integration in compression systems. This includes features such as IoT capabilities, real-time data analytics, remote monitoring, and predictive maintenance functionalities. Chart has embraced digitalization and IoT technologies to deliver smart compression solutions that optimize operational efficiency, enhance reliability, and provide actionable insights for

proactive maintenance. Our digitization platform, Howden Uptime, has been helping our customers all over the world in optimizing their operations and significantly cutting their downtime. Howden Uptime is a key part of our compression offering that ensures our customers benefit from cutting-edge solutions that meet their evolving operational needs.

Flexibility and scalability have also become paramount for customers. They require compression systems that can adapt to changing demand levels, industry trends, and operational scenarios. Chart has responded by offering modular designs and customizable options for a number of our compression solutions and market applications. This modular approach allows for seamless scalability, easy customization, and efficient integration into diverse applications, meeting the varied needs of our customers across different industries.

What's next for the gas compression industry?

The gas compression industry is poised for a transformative journey marked by innovation, sustainability, and global impact. As the world shifts toward cleaner energy sources and decarbonization, gas compression's critical role becomes even more apparent. We envision a future where advanced compression solutions enable the expansion of the hydrogen economy, driving the transition toward a zero-carbon energy landscape.

Digitalization and IoT integration will drive efficiency gains in gas compression systems. Smart solutions with real-time analytics and predictive maintenance ensuring optimized performance and reliability full-time will become a standard and integrated offering. This digital transformation revolutionizes compression operations and paves the way for an intelligent energy infrastructure.

Furthermore, sustainability will continue to drive the industry toward low-emissions technologies that minimize environmental impact and improve energy efficiency. Chart is committed to leading this charge with innovative compression solutions, shaping a sustainable energy future for generations to come. 