# Praxair Inc.

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# Introduction

Praxair Inc. was, for more than a century, a cornerstone of American industrial innovation and global progress. From pioneering breakthroughs in air separation and industrial gas supply to shaping the very landscape of modern manufacturing and healthcare, Praxair's story is one of vision, resilience, and transformation. This book, "Praxair Inc.: The Story of An American Company," traces the journey of a company that not only witnessed but also engineered many of the technological and commercial revolutions of the twentieth and twenty-first centuries.

To understand Praxair is to trace the evolution of the industrial gases industry itself—a sector that, while often working quietly behind the scenes, is indispensable to countless aspects of everyday life. Praxair's roots reach back to the late nineteenth century, when Karl von Linde’s innovations first made the liquefaction and separation of air practical on an industrial scale. These foundational advances set the stage for the creation of Linde Air Products Company in America and ignited decades of technological leaps and commercial growth.

The company’s history is closely intertwined with some of the most significant industrial and economic developments of the modern era, from its early consolidation under the Union Carbide conglomerate to its mid-century achievements in cryogenic and non-cryogenic technologies, on-site gas supply, and global distribution systems. The narrative of Praxair runs parallel to the rise of American industry and globalization, embodying both the opportunities and challenges faced by corporate leaders adapting to an ever-changing economic order.

Following its 1992 spin-off as an independent entity, Praxair rapidly established itself as a leader not just in product innovation but in operational excellence, financial discipline, and international expansion. Its blend of customer focus, technological drive, and continuous improvement earned it a reputation for quality and reliability across a diverse array of markets—from food and beverage to aerospace and energy.

But Praxair’s legacy extends further than products and profits. The company developed a strong culture of social responsibility, prioritizing environmental stewardship, community engagement, and sustainability. Its people, from pioneering engineers to executive leaders, forged a culture that valued safety, diversity, integrity, and shared achievement. Praxair’s merger with Linde AG, culminating in the formation of the world’s largest industrial gas company, closed a chapter while ensuring the continuation of its influence and values under the Linde plc banner.

In telling the story of Praxair, this book explores the challenges and triumphs, the

innovations and human stories behind a truly American company. It aims not only to record history, but to draw lessons for tomorrow’s leaders in industry, technology, and corporate citizenship.

# CHAPTER ONE: The Dawn of Industrial Gases

The story of Praxair, and indeed the entire industrial gas industry, truly begins with a German professor of mechanical engineering named Karl von Linde. Born in 1842, Linde was a man driven by scientific curiosity and an eye for practical application. His early work wasn't even in gases, but in refrigeration, a field he revolutionized with his reliable and efficient compressed-ammonia refrigerator in 1876. This invention was a game-changer for industries like brewing and food preservation, displacing the age-old practice of using ice and establishing Linde's reputation as a formidable innovator.

Having successfully commoditized cold, Linde turned his attention to an even more ambitious pursuit: the air itself. By the early 1890s, his research shifted towards low-temperature refrigeration and the liquefaction of gases, specifically air. The challenge was immense. Air, a seemingly simple and abundant mixture of gases, had resisted attempts at large-scale separation for centuries. Scientists knew its components, primarily nitrogen and oxygen, but extracting them in pure, usable forms was a monumental task.

Linde's breakthrough came in 1895 when he successfully liquefied air. His method involved a continuous cycle of compressing air, cooling it, and then allowing it to expand rapidly. This expansion caused a significant drop in temperature, a phenomenon known as the Joule-Thomson effect. By using a counter-current heat exchange technique, the cold air produced by expansion pre-chilled the incoming ambient air, gradually lowering the overall temperature of the apparatus to the point of liquefaction. It was an elegant solution, a testament to his understanding of thermodynamics and his relentless pursuit of a practical outcome.

While Linde was making strides in Germany, others were independently exploring similar avenues. William Hampson in the United Kingdom and Charles Tripler in the United States were also developing processes for air liquefaction around the same time. However, it was Linde's approach that proved to be the most commercially viable and scalable. His patents, filed in 1895 (though not approved in the U.S. until 1903), laid the groundwork for industrial-scale air separation.

With air successfully liquefied, the next hurdle was to separate its components. Linde's further research in 1901 led to the development of fractional distillation techniques for liquid air. This process capitalizes on the different boiling points of oxygen and nitrogen. By carefully controlling temperatures within a distillation column, nitrogen, with its lower boiling point, would vaporize first, leaving behind liquid oxygen. This allowed for the production of high-purity oxygen and nitrogen.

The industrial application of this cryogenic air separation technology began to take shape in the early 20th century. In 1902, Linde pioneered the world's first air separation unit to produce oxygen using a single-column rectification system. This marked a turning point, transforming oxygen from a laboratory curiosity into a commercially viable product. The following year, in 1903, Linde's first oxygen generator began operations, producing about 10 cubic meters of oxygen per hour.

The market for this "new" commodity quickly emerged. One of the most significant early applications for oxygen was the oxyacetylene torch, invented in France in 1904. This revolutionary tool transformed metal cutting and welding, becoming indispensable in the construction of ships, skyscrapers, and other iron and steel structures. The demand for oxygen soared, further fueling the nascent industrial gas industry.

Recognizing the immense potential, Carl von Linde sought to expand his reach beyond Germany. He set his sights on the United States, a vast, untapped market where industrial-scale oxygen extraction had yet to be established. In 1907, he traveled to the U.S. and, in collaboration with Cecil Lightfoot, established the Linde Air Products Company in Cleveland, Ohio. Their first plant was in Buffalo, New York, a facility later dubbed "the birthplace of the oxygen industry in the United States." This marked a pivotal moment, bringing Linde's groundbreaking technology to American soil and laying the direct foundation for what would eventually become Praxair.

The early days of Linde Air Products in America saw rapid expansion and success. The Buffalo plant, from 1907 to 1909, was the sole commercial source of oxygen in the country. The company quickly added a second floor to its original factory in 1909 and continued to expand through 1948, reflecting the growing demand for industrial gases. The focus remained on producing pressurized oxygen for use in industrial welding and developing innovative methods for transporting liquid oxygen.

The burgeoning industrial gas industry was still in its infancy, but the groundwork had been firmly laid. Carl von Linde's vision and perseverance had unlocked the potential of air itself, transforming it into a valuable resource that would underpin countless industrial processes for decades to come. His pioneering work in cryogenic air separation set the stage for a new era of technological advancement and global commerce, an era that Praxair would eventually inherit and continue to shape.

The importance of Linde's double-column rectifier, developed around 1910, cannot be overstated. This innovation allowed for the simultaneous production of both pure oxygen and pure nitrogen from the same apparatus without requiring additional energy, significantly improving efficiency and making the large-scale production of these essential gases even more economically viable. This technological leap solidified the foundation of cryogenic air separation as the primary method for producing high-

purity industrial gases, a method that continues to be refined and utilized today.

As the world approached a new decade, the industrial landscape was ripe for transformation. The ability to produce oxygen and nitrogen in commercial quantities opened doors to new industrial processes and vastly improved existing ones. The initial applications, like the oxyacetylene torch, were just the beginning. The story of industrial gases, and therefore Praxair, was just gaining momentum, preparing for a period of immense growth and diversification that would forever alter the course of modern industry.

The foundation laid by Linde's pioneering work was not merely theoretical; it was intensely practical, driven by a desire to bring scientific discovery into everyday industrial use. His initial refrigeration patents were successful because they solved a real-world problem, and his later work with air separation followed the same trajectory. This practical application of science and engineering would become a recurring theme in the history of the companies that descended from his original vision.

Indeed, Linde's dedication to commercializing these processes was as important as the scientific breakthroughs themselves. The intricate design of his air liquefaction apparatus, though complex, was engineered for effectiveness and eventual mass production. It was this dual focus on scientific rigor and commercial practicality that distinguished Linde and ensured his inventions would have a lasting impact on industry.

It's worth noting that while oxygen was the primary focus in the early days due to its immediate industrial uses, the process of air separation also yielded nitrogen. While not as immediately in demand for welding, nitrogen would find its own crucial applications in various industries, from food packaging to chemical manufacturing, illustrating the versatility of Linde's core invention.

The establishment of the Linde Air Products Company in the United States was a strategic move, anticipating the vast industrial expansion America was about to experience. It positioned the company at the forefront of a burgeoning market, ready to supply the lifeblood of many emerging manufacturing processes. The commitment to building a local presence demonstrated foresight and a determination to be a key player in the American industrial scene.

The early success of the Buffalo plant proved the concept. With only one commercial source of oxygen, the demand was clearly there, and the ability to meet that demand efficiently and consistently was paramount. This initial period of market dominance allowed Linde Air Products to establish a strong foothold and build the infrastructure necessary for future growth.

The innovations continued beyond the initial liquefaction and separation. The development of methods for transporting these newly commoditized gases, first in cylinders and later in liquid form, was crucial for wider distribution and greater accessibility for industrial customers. This logistics challenge was as important as the production itself, enabling the gases to reach every corner of the industrial world.

The rapid advancements in air separation technology spurred by Linde's work laid the groundwork for a cleaner, more efficient industrial future. The ability to precisely control and separate atmospheric gases enabled processes that were previously impossible or highly inefficient. This fundamental shift would echo through the decades, paving the way for further innovations in various sectors that relied on these essential building blocks.

Ultimately, the story of Praxair is inextricably linked to this initial spark of ingenuity. Without Karl von Linde's relentless pursuit of practical cryogenic solutions, the industrial gas industry as we know it would simply not exist. His work was not just about making gases; it was about unlocking a fundamental resource that would empower countless other industries and shape the modern world.

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