Achieving High-Quality, Dry, Contamination-Free Compressed Air For EV Battery Manufacturing

INGERSOLL RAND WHITE PAPER
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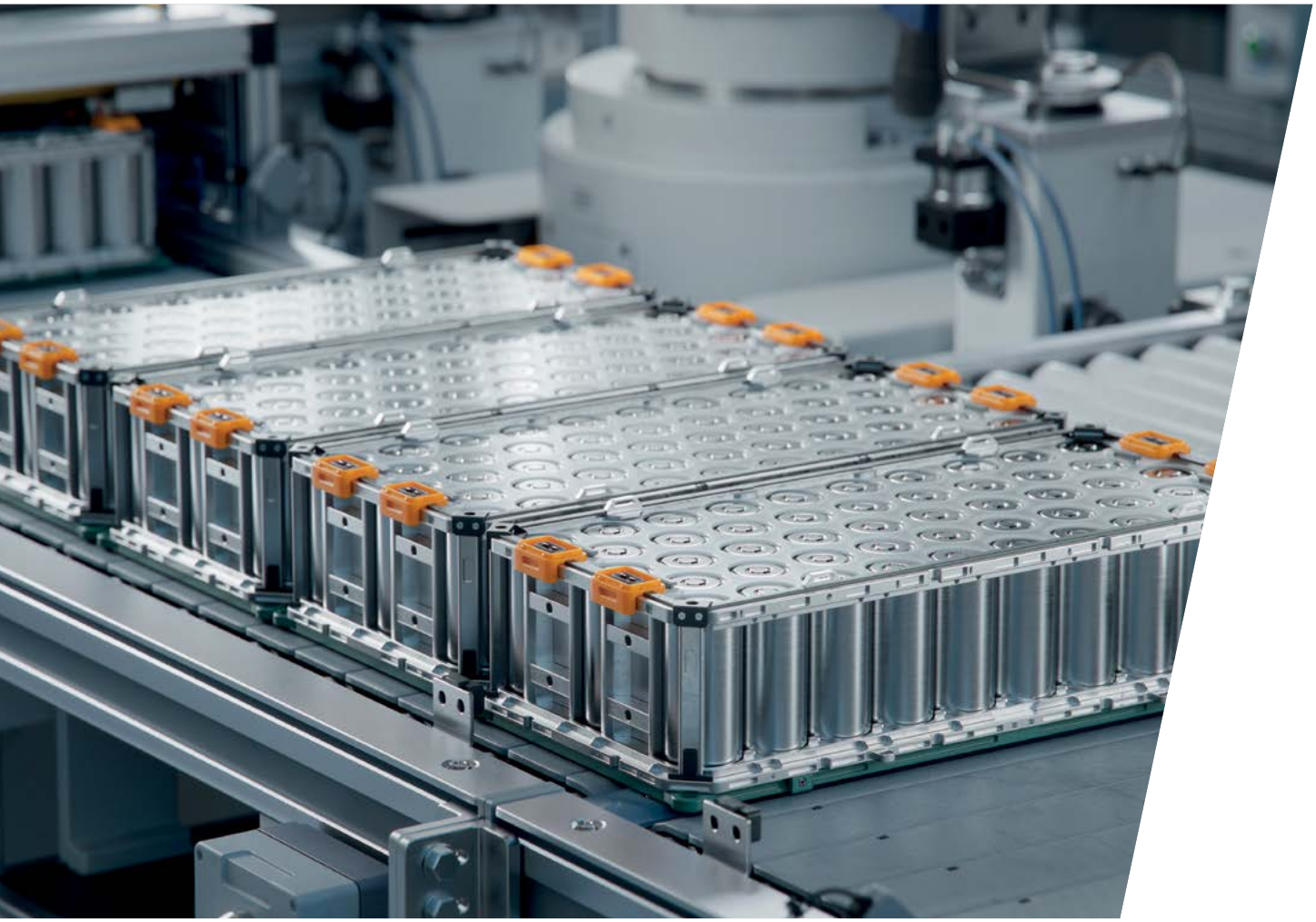


Introduction

As some of the largest emitters of greenhouse gases, the global transportation and automotive sectors are actively developing alternatives to petrol and diesel, with the demand for electric vehicles increasing every year. With some of the most prominent names in the automotive industry already shooting ahead, the electrical revolution is driven by growing environmental concerns and uncertainties. The end goal is a greener, more sustainable future for generations to come.

A part of this electrical revolution is the manufacturing of EV batteries, particularly lithium-ion solutions, which are favoured by car manufacturers such as Nissan, Tesla, and Jaguar. With the demand for EV batteries constantly growing, battery manufacturers continue to vie for pole position, making a competitive edge vital to win the race. This is where we come in! To aid your gigafactory or other EV battery manufacturing facility, we can help you come out on top by focusing on one invaluable commodity of your operations: compressed air.

In This White Paper, You Will Learn:

- The uses of compressed air in gigafactories for EV battery manufacturing
- How to achieve high-quality, dry, contamination-free compressed air in your gigafactory for EV battery manufacturing
- How to select the right air compressor and the solutions we have available to you
- How to find service and maintenance programs that optimise the total cost of ownership

Compressed Air In Gigafactories And For EV Battery Manufacturing

As you're likely aware, the fundamental principle behind EV battery manufacturing involves producing a positively charged cathode and a negatively charged anode, separated by an electrolyte. Cathodes are usually manufactured from lithium and a mixture of other metals, including nickel, cobalt, and manganese, whereas the anode is typically made of graphite. Together, these form an individual battery cell, which can then be enclosed in a typical steel or aluminium casing that holds it together and protects the cell. Compressed air is a vital commodity for a significant portion of this manufacturing process and for the global EV battery supply chain as a whole.

Global EV Battery Manufacturing Supply Chain

For reference, here is a brief overview of the global EV battery supply chain:

Upstream:

This is the process of mining the raw materials, such as lithium, nickel, etc., that go into manufacturing the batteries.

Midstream:

This refers to the processing, refinement and purification of the raw materials to enable the production of cathode and anode battery materials. These are then sold on to gigafactories and other facilities that produce the battery cells.

Downstream:

Next is the battery manufacturers or gigafactories, who turn these materials into the final product in order to situate them in electric vehicles.

End Of Life:

When the batteries no longer serve their purpose, they can be recycled or reused.

Reused or Recycled:

The Life of electric vehicle batteries doesn't end there; by recycling and reusing them, they help to contribute to a more sustainable future.

Applications That Rely On Compressed Air In Gigafactories And For EV Battery Manufacturing

Electrode, Anode And Cathode Production:

Compressed air is used in the production and coating of electrodes, anodes, and cathodes, which are essential components of electric vehicle battery cells. A steady flow of clean, dry air is vital to ensure even and precise application of the active materials onto the current collectors and components. Therefore, air treatment equipment is often recommended in conjunction with an oil-free rotary or centrifugal compressor. This is because, left untreated, the moisture produced by the air compression process can contaminate your compressed air, resulting in substandard electrodes, anodes and cathodes.

Cell Assembly:

Throughout the battery cell assembly process, compressed air is utilised for various tasks, including sealing the battery cells and precisely positioning electrical components.

Welding Processes:

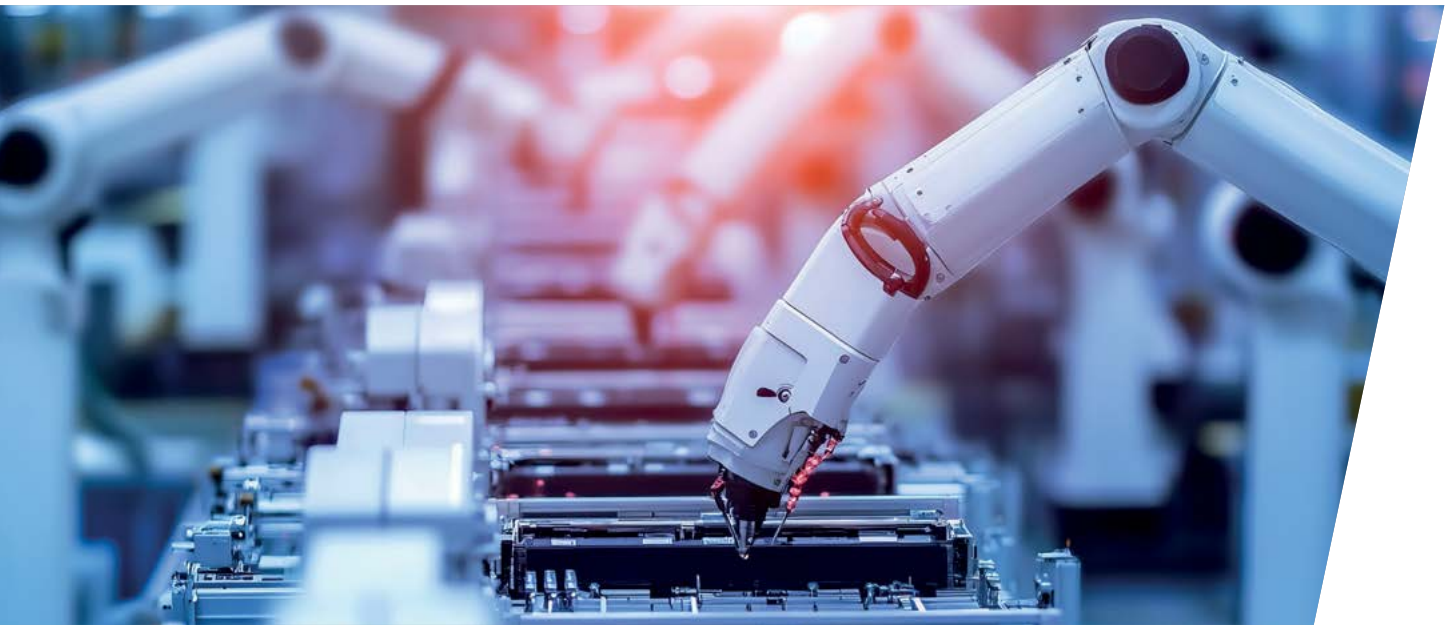
Compressed air is also used to weld battery components together. To ensure product safety, it's essential that your compressed air is dry and free from contamination. Substandard air can prevent components from securely welding and weaken the integrity of the battery cells.

Cooling and Drying:

Compressed air cools and dries down the electric vehicle batteries during production, ensuring an efficient and safe manufacturing process.

Cell Finishing:

To create and maintain a clean and controlled environment, compressed air is used throughout cell finishing processes to prevent contaminants and moisture from affecting the EV battery's performance. To ensure a clean and controlled environment, all compressed air should be treated. An efficient air treatment system, including dryers, filtration, and condensate management, is vital to ensure optimal air quality. Dryers will help to remove any moisture from your compressed air, whereas condensate management units will help eliminate condensate from your air stream. Two natural by-products of compressing air, moisture and condensate, left untreated, will prevent the creation of a clean and controlled environment, making their removal essential.



Quality Control:

Due to the nature and purpose of EV batteries, they must be thoroughly quality checked to ensure customer and vehicle safety. Compressed air is used in processes such as leak testing, which helps identify weaknesses or defects in the batteries before they are distributed to car manufacturers. This helps to ensure the safety and reliability of the final product.

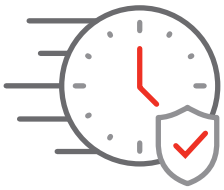
Powering Gigafactory Equipment:

Around your gigafactory, compressed air also plays a variety of other roles, including operating machinery, powering pneumatic tools and controlling ventilation systems. Clean, contamination-free air is equally as vital here as it is for your manufacturing processes. This is because the presence of moisture, condensate or other contaminants can cause the rusting and corrosion of your equipment. This can lead to safety concerns and unexpected breakdowns, which will increase your maintenance or replacement costs.

Removing The Pain Points

How To Achieve High-Quality, Dry, Contamination-Free Compressed Air For EV Battery Manufacturing.

As mentioned, a reliable stream of high-quality, dry, contamination-free compressed air is vital for EV battery manufacturing. At Ingersoll Rand, however, we understand that this level of air quality comes at a price! This is why we've stripped it back, returning to basics in order to help you achieve high-quality air in your gigafactory without seeing a significant increase in costs. But how can we help you do this?



1. ENSURING SECURITY AND SYSTEM OPTIMISATION

There are a variety of ways you can ensure the safety and efficiency of your compressed air system. Here are two we recommend:

Air Audits And Leak Detection:

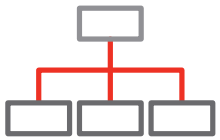
Did you know that a leak of only 5mm diameter could cost you up to 22,000€ a year? Not only do leaks and inefficiencies have detrimental impacts on operations and air quality, but they also contribute to environmental degradation by exacerbating climate change and global warming. With all the progress the EV and EV battery industries are making in the fight against climate change, it seems counterproductive to have a compressed air system that actually does more harm than good. Do you know how efficient your existing system is? Do you know how you can detect and prevent air leaks? Is your system designed to operate efficiently and sustainably? Ingersoll Rand offers thorough air audit and leak detection services to analyse your current compressed air network. Through actionable insights and full transparency into the inner workings of your system, changes and adjustments can be made to optimise your compressed air setup and, consequently, your EV battery manufacturing processes.

Oil Sampling:

As mentioned, oil-free, clean air plays a vital role in electric vehicle battery manufacturing. To ensure optimal air quality, particularly if any of your machinery is oil-lubricated, oil sampling can be carried out at your gigafactory. This assessment analyses any external or internal contamination that can or may already be impacting your compressed air system. Oil sampling provides an overview of the current condition of your compressor's components, while also assessing the inner workings of your system and its ambient conditions. This helps identify anything that may be impacting or compromising the quality of your compressed air. If you are opting for an oil-flooded compressor, which is often not recommended for this industry, frequent lubricant changes are vital to ensure optimal air quality.

2. IMPLEMENTING THE CORRECT EQUIPMENT

Using the wrong compressed air equipment in your gigafactory is a disaster waiting to happen. To prevent customer and employee risk, and ensure you meet demand and deadlines while also ensuring optimal quality, safe, and reliable EV batteries, the right equipment is essential. We provide more information about this in the 'Sizing Up Your Needs' section of this White Paper, where we discuss how to select the appropriate compressed air equipment for your specific application and offer a closer look at our available portfolio. Adapting your equipment to market change, particularly in a constantly evolving industry like the electric vehicle sector, is also essential, but can be costly. This is why we'd recommend Ingersoll Rand's energy-efficient, tried-and-tested designs, as they're more likely to keep up with industry shifts.



3. AN EFFECTIVE DOWNSTREAM SYSTEM

As we've mentioned, compressed air used for EV battery manufacturing should be three things: high-quality, dry, and contamination-free. Often, if not always, it should also adhere to ISO certification and be of Class 0 quality. This ensures customer and employee safety. To achieve this standard of compressed air, an effective downstream system is indispensable to treat the air. This consists of three vital components:

Dryers:

As mentioned, one of the most essential characteristics of the compressed air you use in your gigafactory is its dryness. Moisture can wreak havoc on the quality of your batteries, the integrity of your production processes and the safety of your equipment. This is because not only does it lead to substandard products, but it can also cause any pneumatic or other production equipment to rust and corrode. This can lead to employee and operator safety risks, as well as increased maintenance or replacement costs. Dry air, therefore, is vital for both employee and customer safety.

There are various compressed air dryers available on the market, including desiccant dryers, which provide ultra-dry, high-quality air at a lower dew point. These are ideal for a range of EV battery manufacturing applications. Alternatively, there are also refrigerant dryers which are better suited to more general applications. If you want to save some money and operate more sustainably, you can opt for a heat-of-compression (HOC) dryer and utilise wasted compression heat. There are also other energy-saving dryers on the marketair leaks? Is your system designed to operate efficiently and sustainably? Ingersoll Rand offers thorough air audit and leak detection services to analyse your current compressed air network. Through actionable insights and full transparency into the inner workings of your system, changes and adjustments can be made to optimise your compressed air setup and, consequently, your EV battery manufacturing processes.

Filtration System:

Another essential component of any reliable and effective air treatment system is a high-quality filtration system. This is important to remove contaminants and impurities, such as oil, moisture, dust, and other particulates, from your compressed air. As mentioned, air should be clean, dry and contamination-free, usually of an ISO-certified Class 0 quality. Therefore, by implementing an effective filtration system, you can achieve optimal air quality, thereby protecting the quality and integrity of your processes and final products.

Condensate Management and Treatment:

Condensate is actually a natural by-product of compressing air, but its composition of oil and water means that it is typically considered hazardous industrial waste. Therefore, its safe removal and management are essential. The most effective way to deal with condensate in your gigafactory is to implement a condensate management unit that contains condensate or zero-loss drains. These drains are able to transfer the condensate into an oil-water separator, which, as its name suggests, separates the oil from the water. Condensate and zero-loss drains typically have timers, which remove condensate from your oil-water separator and out of your compressed air system. This can then be disposed of in a manner that adheres to strict industry and environmental regulations. Your operations will also benefit, as the removal of condensate is crucial for the high-quality, dry compressed air required by your EV battery manufacturing processes.

4. SYSTEM MONITORING AND MANAGEMENT

Constantly trying to keep up with monitoring and managing your compressed air setup can often feel like a chore, especially when we know that your main focus is on your EV battery manufacturing processes. However, effective monitoring and management do translate to optimised efficiency and assured air quality, which is why it is so important to consider. Compressor controllers are one solution here, allowing you to optimise the cost and energy efficiency of your compressed air network. This is because they will enable you to adjust pressure and flow rates to prevent inefficiency and wasted energy. Different processes in your gigafactory will undoubtedly require pressure at varying levels, but the more pressure you need, the more energy you consume, and the higher your costs will increase. This is where compressor controllers come in, ensuring you use only what you need, when you need it.

At Ingersoll Rand, we also offer our 24/7 remote monitoring solution - the Helix™ Connected Platform – that provides optimal visibility into your system. This allows you to monitor your efficiency and air quality, and address any issues before they lead to downtime. You can take this even further with Ecoplant, an advanced control platform that integrates with your compressed air network to maximise efficiency and reduce downtime. These solutions are discussed more in the 'Service and Maintenance' part of this White Paper

5. HEAT RECOVERY SYSTEMS

Not necessarily vital to ensure air quality, but a good way that you can cut costs in your gigafactory is through heat recovery. Heat is a natural by-product of compressing air, and is an often wasted commodity, being released back into the atmosphere where it contributes towards global warming. But did you know that up to 90% of this wasted heat can actually be recovered and redistributed? Implementing a reliable heat recovery system, or as mentioned above, a HOC dryer, allows you to repurpose heat and utilise it in other areas of your gigafactory or manufacturing processes. This will help keep your costs and your carbon footprint down.

6. WARRANTIES, OEM PARTS AND MAINTENANCE

Understanding the warranties, OEM parts and accessories, and maintenance plans available to you is crucial to protecting your compressed air investment and preventing unnecessary costs. Maintaining your system will also help ensure optimal air quality and efficient manufacturing processes, as a well-maintained system is crucial for maintaining quality standards and product integrity. In the 'Service and Maintenance' section of this White Paper, you can discover more about our suite of CARE™ maintenance plans. We discuss all of our available options in depth with our partners, placing particular emphasis on discovering as much as possible about their applications and compressed air needs. This puts us in a strong position to deliver the best possible solutions for their industry. Whether you need a warranty, remote monitoring, OEM parts and accessories, scheduled predictive maintenance, or total asset management, Ingersoll Rand has all the tools and experience to provide you with the services you need.

Sizing Up Your Needs - Ingersoll Rand's Portfolio Of Gigafactory And EV Battery Industry Solutions

Choosing The Right System For Your Gigafactory

Choosing the correct compressed air system for your gigafactory and EV battery manufacturing is vital to ensure the integrity, quality and safety of your batteries. There is little room for error, and manufacturers must be diligent about their air quality to ensure reliable final products. Every decision you make when purchasing your next compressed air system must protect the consumer and the vehicle manufacturers who rely on your EV batteries. High-quality compressed air systems will also help ensure operational efficiency in your gigafactory by eliminating product recalls, spoilage, and unscheduled and unbudgeted liability and downtime.

Before purchasing an air compressor or air treatment system, several key considerations are essential, as asking the right questions is crucial to ensure you choose the right system for your gigafactory. Our compressed air experts have compiled a list of essential considerations to help you get started…

Risk Mitigation

- Does compressed air come into contact with your product?

Compressor Technology

- How much airflow is required for your manufacturing applications?
- How many hours will the compressor operate each day?
- Will the flow demand fluctuate?
- Are there any space constraints in your gigafactory?
- What are the pressure requirements?
- Is noise a concern in your manufacturing facility?

Air Quality

- How clean or dry does your air need to be?
- Which filters or dryers will you need?

Systems Approach

- Are you planning on expanding your manufacturing operation in the future?
- Will generating nitrogen in-house for lithium-ion battery production save you money?
- Do you need external help with parts and maintenance?

By beginning with these questions, you should have a good idea of which compressor is right for you. If you have any concerns, uncertainties or queries, Ingersoll Rand is always willing to help guide you in the right direction!

Our Compressed Air Portfolio

We offer an extensive portfolio of compressed air solutions for the EV battery manufacturing industry. Here's a brief overview…

Oil-Free Rotary Screw Air Compressors:

Our high-performance E and ES-Series oil-free rotary screw solutions offer optimal reliability and flexibility. With their ISO 8573-1 certification and impressive energy-saving capabilities, they ensure optimal air quality, reliable, oil-free performance, and efficiency. Available in a variety of sizes to suit your specific needs, these expert rotary screw solutions excel in any environment, thanks to their robust design, which can be easily integrated into any area of your EV battery production line.

Centrifugal Compressors:

Ideal for achieving the air quality and efficiency demanded by your processes, Ingersoll Rand's Centac® compressors operate at the highest level of efficiency at full load, partial load, and no-load, offering ultimate flexibility. With unmatched efficiency and their ISO-certified design, these machines help you optimise your air quality and the cost and energy efficiency of your EV battery manufacturing processes.

Air Treatment:

As mentioned in the 'Removing the Pain Points' section of this White Paper, air treatment is vital to ensure the production of high-quality, dry, contamination-free air for your manufacturing processes. Ingersoll Rand offers the entire air treatment package! From dryers to filtration systems and condensate management units, we have everything you need to ensure optimal air quality. For more information on which air treatment equipment would best suit your gigafactory or other EV battery manufacturing facility, please speak to a member of our team, who will happily streamline your options to ensure the perfect fit.

Service And Maintenance Programs

There are many applications during the EV battery manufacturing process in which you will require high-quality compressed air in your gigafactory. You now understand how to achieve high-quality, dry, contamination-free air for EV battery manufacturing applications. Now it's time to look at how to service and maintain your equipment to avoid unplanned, unbudgeted downtime and production interruptions.

Package CARE™

PackageCARE™: We Protect You

- The greatest value for asset management
- Transfer operational risk for up to 10 years
- Includes all scheduled maintenance
- Predictive and analytical tools prevent production interruptions

Planned CARE™

PlannedCARE™: We Help You

- Predictive, on-time planned maintenance
- Preventative diagnostics to catch potential problems
- Up to five-year coverage on major airend components in new rotary compressors

Lower cost of ownership, quality results, increased uptime, and efficient energy use all add up to peace of mind.

Performance Services

Our performance services include electronic, air leak, and system assessments. Whether you need to manage costs, increase reliability, or plan for future growth, our portfolio of assessment tools provides you with detailed diagnostics that give you the proper insights to help lower the total cost of ownership.

System Automation

System assessments often identify waste caused by a lack of adequate controls. Our suite of system automation solutions lowers energy costs and stability pressure.

HELIX™

24/7 Remote Monitoring With The Helix™ Connected Platform

Developed to maximise uptime and peace of mind, the Helix™ Connected Platform from Ingersoll Rand gives you real-time monitoring that provides visibility into machine functionality and equips you to operate at maximum efficiency. Your team will have direct access anytime to Helix™ insights and diagnostic reporting that can help prevent lost productivity from unforeseen breakdowns. Maintenance scheduling is simplified thanks to proactive service reminders and automated communications that help to preserve machine health.

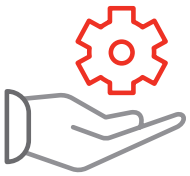
Powered by ECOPLANT

Proactive Control With Ecoplant

Ecoplant is a remote, cloud-based IIoT solution for compressed air management. Combining intuitive predictive maintenance with SAAS proactive analytics and controls, it can automatically analyse and respond to your exact production needs. Its development using IIoT cloud-based technology enables it to optimise your system using dynamic AI, stabilise pressure leaks, maintain ISO quality standards, minimise production outages and detect and isolate leaks. This intuition means most, if not all, outages are prevented before they become costly downtime.

Reliability For Life

- Generate air in any environment. We offer solutions that operate indoors and outdoors in compact spaces and extreme temperatures.
- Enjoy increased oversight with controls you can access remotely. Regulate your air use with compressor controls that monitor critical operating parameters and adapt the system to prevent downtime.
- Designed for easy serviceability and maintenance, our compressors minimise the total cost of ownership.
- An extensive catalogue of OEM genuine consumable and replacement parts is available to you to make service and maintenance easy and cost-effective. Genuine OEM parts guarantee a perfect fit and function to the highest quality standards.



Protect Your Investment With Ongoing Preventative Maintenance

When it comes to compressed air for EV battery manufacturing, original equipment manufacturer (OEM) parts are an operator's best choice to maintain maximum reliability and performance. Non-standard parts can expose equipment to unnecessary wear and tear, leading to downtime and higher operating costs.

If you want to protect your investment and the performance and longevity of your equipment, make sure to invest in quality parts to keep it running. Ingersoll Rand has a complete offering of maintenance and OEM-quality compressor parts, including lubricants, maintenance kits, replacement parts, filtration and condensation management, complemented by the expertise to keep your gigafactory or other EV battery manufacturing facility up and running.

CARE SERVICES PROGRAM

Find A Partner You Can Trust…

Ingersoll Rand is your trusted partner for the long haul. We take a systems approach, providing expert services that go beyond providing just a compressor. Our services include skilled project management, installation for start-up, system expansion or decommissioning, as well as flexible maintenance programs that meet your specific requirements. We work with you to enhance your operation's compressed air equipment, running consultations, as well as maintaining your system to ensure that it runs at peak performance. Our main goal is to offer you the highest efficiency and quality while supporting your business with the very best equipment, accessories and service repair at the lowest possible cost.

Global Service And Support Network

Renowned for its market-leading reliability, quality, and untroubled performance, Ingersoll Rand brings over 160 years of innovative solutions to the compressed air market. In addition to a comprehensive portfolio of best-in-class air compressors, Ingersoll Rand offers various maintenance programs as well as air compressor repairs that use OEM genuine components.

Depending on the needs of your gigafactory or other EV battery manufacturing plant, Ingersoll Rand offers a range of service packages, from a comprehensive service program that takes the operational risk away from the customer. We also offer a simple package that includes delivering the right part to you at the right time. Choosing the right package that provides the best, most efficient support to keep your business up and running requires careful consideration. To save our customers' time, our engineers will perform a deep analysis to help determine which maintenance plan is the best for your specific industry and application needs.

There's a lot riding on the quality of your air. Let Ingersoll Rand help you get it right!

Ingersoll Rand's Wide Portfolio Of Air Compressors

Ingersoll Rand provides a wide range of high-quality, low-maintenance commercial and industrial air compressors to fit every application. Our engineers can provide you with a bespoke solution and the support you need to keep your gigafactory or other EV battery manufacturing facility working at maximum efficiency.

About Ingersoll Rand Inc.

Ingersoll Rand Inc. (NYSE:IR), driven by an entrepreneurial spirit and ownership mindset, is dedicated to helping make life better for our employees, customers and communities. Customers lean on us for our technology-driven excellence in mission-critical flow creation and industrial solutions across 40+ respected brands where our products and services excel in the most complex and harsh conditions. Our employees develop customers for life through their daily commitment to expertise, productivity and efficiency. For more information, visit irco.com

ingersollrand.com

Member of Pneurop

Ingersoll Rand compressors are not designed, intended or approved for breathing air applications. Ingersoll Rand does not approve specialised equipment for breathing air applications and assumes no responsibility or liability for compressors used for breathing air service.

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