INGERSOLL RAND WHITE PAPER

How General Manufacturers Create High-Quality Compressed Air

Ingersoll Rand®

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Introduction

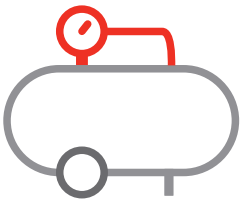
The choice can be a bit overwhelming: how do you find a high-quality, reliable compressed air solution that is available when you need it? Your manufacturing operation demands it, but you also have other pressing things to worry about, such as issues with the supply chain, the economy, the labor shortage, and more. And now, as well as everything else on your mind, you have to consider how to design, deliver, and install an air system that is customized to your plant. Or, you may already have a compressed air system in place. But how do you know if it's operating efficiently? Has it been designed specifically for your plant application? Does it offer cost-effective airflow matched to your needs?

As if that isn't enough, you hear more and more about smart connected equipment enabled by advancements in IIoT (Industrial Internet of Things) technology and how it can deliver, but you don't know how or if it can help you, if it will make your operations more effective, or if it can provide cost and time efficiencies.

There are many decisions to be made when it comes to compressed air solutions and the complete lifecycle support programs that could potentially make you more productive. That's where we come in; Ingersoll Rand is here to help!

In This White Paper, You Will Learn:

- The types of compressed air solutions available
- How to lower operating expenses and boost productivity
- How to find service and maintenance programs that optimize the total cost of ownership
- How to create high-quality compressed air for your facility



Available Compressed Air Applications

Compressed air is an integral part of most manufacturing processes, but it can be inefficient and expensive if not managed properly. One challenge is that compressed air is often considered a free commodity, so many plant operators don't spend a lot of time thinking about how to manage it. But, by the time air is compressed, cooled, dried, transported, regulated, and then finally used, it is anything but free.

By the very nature of physics and thermodynamics, compressing air is inherently inefficient. For example, the motor that drives the air compressor heats the air, which then needs to be cooled. This requires a fan and an air-or water-cooled heat exchanger. Both of these pieces of equipment consume even more energy! Then, once the air is compressed, it has to be delivered at a certain pressure, but as the air is transported, losses occur, and inefficiencies arise along the way.

That's why it's essential to consider a compressed air solution that takes out the guesswork and provides efficiencies, both in terms of time and cost.

There are seven typical applications compressed air is used for in general manufacturing:

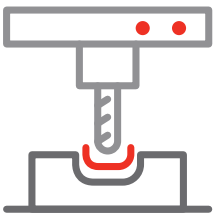
- Power pneumatic equipment and tools
- Cooling metalwork and steel
- Paint and powder coating
- Conveyance
- Mixing
- Sparging
- Aeration

Here is what you need to know about each of them.

Power Pneumatic Equipment and Tools

Powering pneumatic equipment and tools is the most common application for an air compressor solution. Several different types of tools and equipment rely on compressed air to operate, such as impact tools, air hammers, grease guns, and speed saws. No matter which pneumatic tool you use, moisture will always be the enemy. Therefore, when you use dry, compressed air with a very low particulate count to power your point-of-use equipment and tools, it helps to maintain their performance and longevity.

But how do you get dry air? The secret is an effective downstream system! For powering pneumatic equipment and tools, a desiccant dryer is the ideal choice, as it uses absorbent material to remove any moisture from your equipment. Alongside this, we'd recommend an efficient air filtration system, which will also act to remove moisture from your compressed air. This will allow you to maximize the quality of your compressed air whilst also eliminating costly moisture damage!



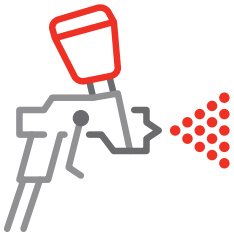
Cooling Metalwork and Tools

In metal fabrication, a reliable air compressor system is the central power source—it's what keeps production moving quickly and efficiently.

Metal and fabrication both consume a lot of compressed air, whether it is from clamping/unclamping spindles, running pneumatic tools and lasers to activate shear and puncher machines, or powering punch hole drills, cutback saws, and more.

Compressed air is a quick and easy way to cool machined metals or steel. Very dry air may be required based on the material used for the part and whether it is susceptible to rust or corrosion. Alternatively, if the metal will be painted or powder coated after cooling, it's vital for the air to have minimal particulates and a low oil content.

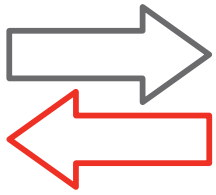
For this particular application, we'd recommend a refrigerant dryer, as this will act to cool your compressed air by forming dew drops that can then be removed and discharged. To ensure the presence of minimal particulates, it's vital to implement an effective filtration solution into your system, which will filter impurities, such as oil, dust and moisture, out of your compressed air, ensuring its quality and viability for your operations.



Paint and Powder Coating

When you're painting or powder coating, contaminants can travel through your powder coating gun and onto the part. These contaminants, when heated, will cause issues in the final finish, typically referred to as "fisheyes."

A compressed air solution that meets the ISO rating for this application will prevent this from happening and keep moisture and other contaminants away from your parts. To ensure your compressed air system does meet this standard, reliable downstream equipment is essential! As you're working with paint and spray guns, we'd recommend implementing a desiccant dryer into your system, which will help to prevent moisture from contaminating your paint! Alternatively, you could opt for a refrigerated dryer, which will also act to remove moisture, preventing damage to your tools and the finish of your paint or powder coating. There are other solutions available too to help maximize your air quality, including filtration and condensate management systems, all available to remove oil and moisture from your air, helping it to meet the required ISO standard!



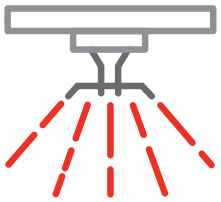
Conveyance

Conveyance means that bulk goods can be moved by air through the pipelines. This happens when the flowing conveying air transmits a propulsion force on the bulk material, which then moves it through the conveying line. Consistent air power keeps this process moving when moving products and conveying bulk material. If air touches the product in the process, it's important that it's relatively clean and contains minimal oil. This can be achieved by implementing a high-quality filtration system, which will act efficiently to remove oil, moisture and any other contaminants, helping to maximize the quality and usability of your compressed air.

A compressed air solution is used because conveying requires a pressure difference between the beginning and the end of the pipeline. Due to this required pressure difference, it's vital to ensure your equipment has the correct power and flow rates to avoid unexpected equipment breakdowns! The best way to check this is with a thorough air audit, that will allow for a complete assessment of your existing equipment. This way, you can gauge where your system is at and discover how to enhance your equipment to better suit your conveyance operations.

Mixing

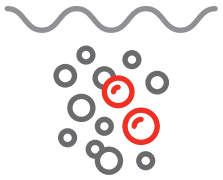
It's essential to promote fast and efficient tank mixing, which can be done with quick bursts of compressed air that are released at timed intervals at the tank bottom. The air is released through a series of pipes that are connected to disks attached to the tank bottom. The compressed air is also used to maintain over-pressurization in the tanks to ensure product integrity and sterility.



Sparging

Sparging, or gas flushing, is a method of degassing. It creates a gas that is bubbled through a liquid to remove other dissolved gas and/or dissolved volatile liquid. When sparging, it's essential to have high-quality air to effectively remove contaminants from the liquids. Your compressed air must meet ISO 8573.1 specifications to ensure low levels of solid particulates whilst also adhering to moisture level requirements to prevent other issues. Moisture level is especially important to consider depending on the components of the mixture you're using.

You may be wondering the easiest way to ensure it adheres to all of these standards. It really is all down to having an effective filtration system in place! This will ensure that any solid particulates, oil, moisture and other contaminants are removed from your compressed air. This way, you can maximize the quality of your air and guarantee that it meets ISO standards and moisture level requirements!



Aeration

Aeration is the process of injecting air into water, typically wastewater, to maintain water quality and reduce algae growth. When compressed air is aerated into wastewater, it helps to remove harmful particles, such as suspended solids, biodegradable organics, pathogenic bacteria, and nutrients. To help aid this process, we'd recommend using filters to effectively remove contaminants, ensuring high-quality results.

A reliable, high-quality compressed air system is essential for aeration, as it needs to be able to handle the wide range of pressures and flow outputs required to effectively mix chemicals of varying viscosities. Therefore, an air audit is the perfect way to assess your existing system and analyze whether enhancements or improvements need to be made to better suit your operational needs.

Removing the Pain Points

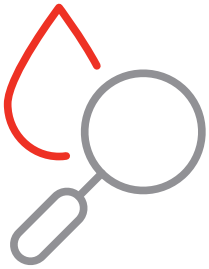
Creating An Efficient Compressed Air Installation That Seriously Improves Your Bottom Line

Achieving clean, dry air that is moisture and oil-free, that meets ISO specifications or that can cope with pressure differences without damaging your equipment doesn't have to be difficult! These challenges can all be overcome simply and effectively by installing the correct systems for your individual plant whilst also considering proper ongoing management that maximizes your productivity and efficiency.

1. AIR AUDITS

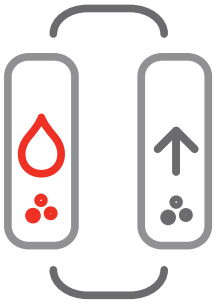
Did you know that a leak of only 2mm diameter in a 10 bar network can cost you nearly $32,000 a year? Therefore, the first thing we'd recommend is a complete air audit that

analyzes your existing compressed air system, checking for inefficiencies, leaks and areas of improvement. After a thorough assessment, the next steps can be considered, whether that means designing a new system or enhancing and improving your current system to maximize its efficiency and reduce energy consumption. We'd recommend air audits, particularly for applications such as conveyance and aeration, where considering the specifications, sizing and performance of your equipment is critical to efficiency!



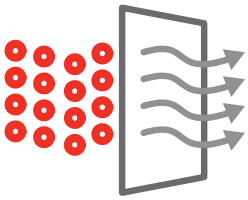
2. OIL SAMPLING

Oil sampling is another assessment service available which provides you with detailed reports regarding both external and internal contamination that may impact your compressed air system. By assessing both the inner workings of your compressor as well as its ambient conditions, you can gain insight into factors that may affect the oil or lubricant in your system, as well as the condition of its components. Identifying potential issues or abnormalities before they become an issue allows you to plan and schedule maintenance and reduce your downtime, thus maximizing the efficiency of your system. This is vital for applications such as paint and powder coating, conveyance and mixing, where sterility and the presence of minimal or no oil is essential to ensure high-quality results.



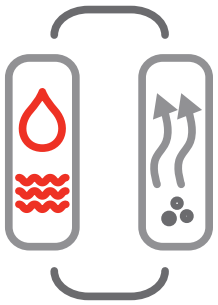
3. DRYERS

The primary purpose of an air dryer is to eliminate the moisture from your compressed air to ensure you are using only dry, clean air for your processes and operations. This is important for most if not all, applications within the general manufacturing industry due to stringent quality standards, but it's also important to prevent damage caused to your equipment by excess moisture, such as rust and corrosion, which can impact the longevity of your machinery. There are a variety of dryers on the market, including desiccant which are ideal for applications which require ultra-dry, high-quality air and a lower pressure dew point, and refrigerant dryers which are better suited for general applications, to remove moisture from your compressed air. For utilizing wasted heat that is a natural by-product of the compression process, there are also heat of compression dryers which regenerate the desiccant throughout the drying process. Arguably, this makes them the most energy-efficient type of dryer on the market. However, different dryers will work better for different applications, so it's vitally important to ensure the correct specification is used for your operations!



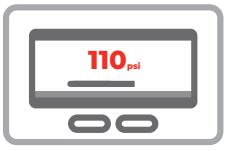
4. FILTRATION

Having an effective filtration system in place is essential to get rid of impurities and contaminants such as oil, dust and moisture. This is particularly important for applications such as powering pneumatic tools and equipment, cooling metalwork and tools, paint and powder coating, sparging and aeration, where achieving ISO standard compressed air is essential.



5. CONDENSATE TREATMENT & MANAGEMENT

Condensate treatment and management is an essential part of operating a compressed air system, as all compressors will produce a water condensate that can cause costly equipment damage. Usually, the best way to deal with condensate is by implementing a condensate management unit, which contains drains. The drains transport the condensate into an oil water separator, which will separate out the oil from the water. The condensate or zero-loss drains, often equipped with set timers, will then transfer it from the oil water separator out of your compressed air system. An oil water separator is of fundamental importance during condensate management, as it ensures the condensate is being disposed of in a way that adheres to strict industry regulations. This process is critical for a variety of general manufacturing processes, particularly paint and powder coating, where condensate in your compressed air can massively impact the finish of your paint.



6. MANAGEMENT SYSTEMS (CONTROLLERS)

Compressor controllers are an easy way to monitor and manage your system, allowing you to adjust flow rates and pressure to prevent inefficiency and wasted energy. This way, you can ensure your compressed air system is operating at maximum efficiency! It's important to remember that the higher the pressure your applications require, the higher the energy consumption and, therefore, the higher your costs! For this reason, controllers may be particularly useful for general manufacturing applications such as conveyance or mixing, which both depend heavily on pressure.

7. HEAT RECOVERY SYSTEMS

Did you know that 90% of the wasted heat generated by your compressed air system can actually be recovered and used? By implementing an efficient, high-performance heat recovery system, you can potentially save 1000s of dollars a year whilst also reducing your carbon footprint! This way, your costs and environmental impact will decrease, and you'll be able to get more out of your system. The heat collected by a recovery system can be used for a variety of applications, such as heating the plant and generating and preheating hot process water.

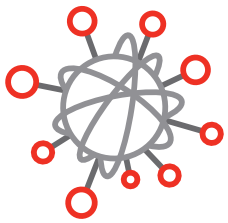
8. WARRANTIES, OEM PARTS & MAINTENANCE

Understanding the warranties, OEM parts and accessories and maintenance programs available to you and your compressed air equipment is of the utmost importance. For example, at Ingersoll Rand, we offer a suite of CARE maintenance plans, which you can discover more about later on in this Whitepaper. When communicating with our customers, we analyze their particular needs and compare them to our available packages to ensure they are receiving the exact service they need! Whether this may be a warranty, total asset management, scheduled maintenance, remote monitoring or OEM parts and accessories, correctly managing your compressed air system is vital to maximizing its efficiency and performance and protecting your investment.

Lower Operating Expenses and Boost Productivity

Now you understand the pain points and how to eradicate them from your compressed air installation, you can shift your focus to how to lower operating expenses and boost productivity — by understanding how to use a compressed air solution to yield operational gains.

External factors affect the way you use a compressed air solution in your plant. Aspects such as energy, carbon footprint, and downtime risks all play a key part.



So does the way your business operates. Of course, all of these things must be considered when investing in a compressed air solution, but so must the ability to use that investment to yield operational improvements.

The new Smart Connected Compressors, enabled by advancements in IIoT (Industrial Internet of Things) technology, allow you to do this in many aspects of your business. The data collected from the equipment provides deep insights into the behavior and performance of your compressed air solution, allowing you to analyze any adjustments or enhancements required to drive and yield the highest operational improvements. As you dig further into those insights, additional improvements will become apparent.

Smart Connected Compressors can help you get the most out of your compressed air solution to lower operating expenses and boost productivity. They can do this by:

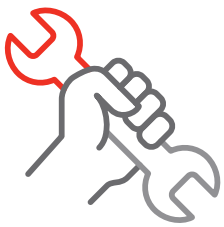
- Using real-time data to create a maintenance routine and schedule.
- Ensuring engineers and technicians can be optimized according to the machine schedules.
- Transitioning your equipment's response time from reactive to proactive and preventative if downtime occurs.
- Providing you with high-value data that can change the way you operate.

With predictive maintenance, you can accelerate your understanding of machine usage and sensor data. This is because:

- You may not have enough data—or good-quality sensors. Adequate data is one of the key drivers, and sensors have become more intelligent and less expensive.
- Engineering schedules can move forward based on the probability of failure.

With augmented reality, connected services and products are overlaid with virtual services. This means that:

- Typical use cases involve products being disassembled virtually for the service engineer
- Augmented reality allows technicians to break down compressors without referencing paper-based systems



Service and Maintenance Programs

There are many applications you will require high-quality compressed air for in your plant. You also now understand how to lower operating expenses and boost productivity by utilizing and employing the additional data and insights gathered by smart connected compressors and how to create an efficient system that improves your bottom line. Now it's time to look at how to service and maintain your equipment to avoid unplanned, unbudgeted downtime and production interruptions.

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

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

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

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 maximize 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.

Create High-Quality Compressed Air in Your Facility

Taking everything you have learned in this white paper and implementing it into your operations may feel a bit overwhelming. As your compressed air solutions partner, we can take the burden off of you, collaborating to design, deliver, and install an air system that is a perfect match for your operations.

We first work with you to identify the air quality required for your application, including the air's ISO specification, which considers the optimum moisture level and particulate and oil content. Then, we design an air system that delivers the air quality, quantity, and power needed for your manufacturing process. We can also oversee the installation and recommend service and maintenance programs that optimize the productivity and efficiency of your system.

With various configuration options available, such as fixed or variable speed drives, single or two-stage airends, or Total Air System packages, our team collaborates with you to design an integrated, complete system that maximizes efficiency and airflow.

We can also help you understand service options and preventative maintenance programs that optimize your total cost of ownership and extend your compressor equipment's lifecycle.

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 minimize the total cost of ownership.
- An extensive catalogue of genuine OEM consumable and replacement parts and accessories are available to you to make service and maintenance easy and cost-effective. OEM parts and accessories are important as they guarantee a perfect fit and function to the highest quality standards.

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

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

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

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