modec
moteurs & solutions pneumatiques

AIR MOTOR GUIDE

EDITO

Thank you for downloading this Air Motor Guide.
We hope that the information and tips provided will help you see the unique advantages of this technology and make you want to learn more about it.
Air motors have many advantages and unique features that respond simply and reliably to specific industrial needs.
Much less common than electric motors, they are an effective alternative in many high-stress applications, particularly in the chemical, petrochemical and automotive industries.
Our technical team is at your disposal for the study, design and realization of pneumatic solutions to meet your specific needs.

Welcome to a world of innovation, expertise and agility.
Welcome to the modec universe!

The modec team

TABLE OF CONTENTS

1 | A BIT OF HISTORY

Compressed air is a form of energy which has many advantages: safe, clean, easy to create, store and transport.

Compressed air is produced from the ambient air that has been compressed by a compressor at a higher pressure than atmospheric pressure. During the mechanical compression process, the

pressure is usually increased to a pressure value between 6 and 12 bars for the most industrial applications.

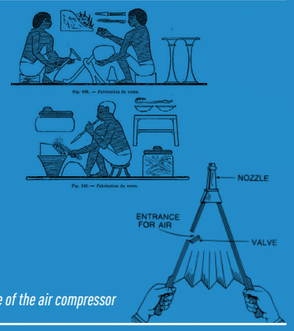
This form of energy is widely used in most of the world's industries whole, in various ways (jackhammers, jackhammers, etc.). to the cleaning blowers), but it is mainly used for the small industrial tooling (screwdrivers, riveting machines and other), as well as for lifting and transporting, sorting...

Compressed air was used as an energy source long before electricity, oil or gas were known.

1500 BEFORE J-C

The first man-made air device was a simple blowing tube (a blowpipe), which Egyptian metallurgists used to produce the precious metals found in ancient tombs.

The introduction of foot-operated bellows provided air for metalworking. The device, consisting of a flexible bag, greatly facilitates the production of compressed air. Today, bellows are still used in certain applications, such as breathing apparatus used in the hospitals



The bellows: The prototype of the air compressor

1650

In 1650, the German physicist Otto Von Guericke designed a vacuum pump that could suck gas through tiny chambers, leaving some compartments without air.

1860

The first major construction using compressed air technology was the Fréjus railway tunnel. The Italian and French teams used pneumatic drills on the project.

1888

In 1888, the Austrian engineer Viktor Popp inaugurated Europe's first compressor station with a power of 1,500 kW. Located in Paris, the plant produced 18,000 kW.

The development of blast furnaces led to the need for a more powerful form of compressed air.

XX th CENTURY TO DATE

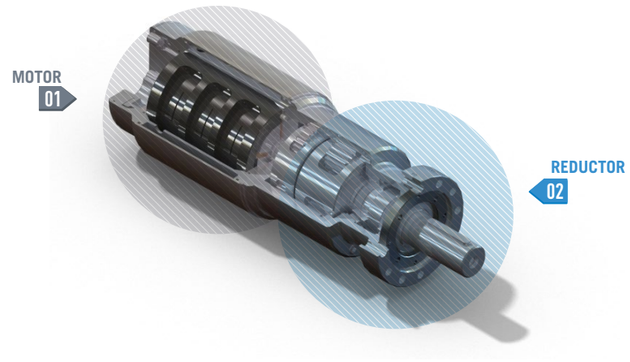
Modern air compressors
Today, compressed air is used in many industries: automotive, aeronautics, military and war artillery, furniture, household appliances, electronics, food products... It is often described as the fourth source of energy.
Even if its role is not as important as that of electricity, gas or gasoline, air remains a fundamental element of the modern industrial world. Compressed air is a form of energy that is currently used in many ways and some equipment is specifically designed in pneumatic mode.

Whether they are necessary for eating, resting, entertaining, moving, communicating, etc., air compressors are part of everything, from the moulding of parts to the assembly of products.

2 | AN AIR MOTOR, HOW DOES IT WORK ?

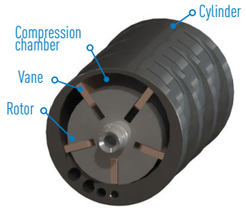
An air motor, or compressed air motor, is a motor that gets its mechanical power from gas expansion, usually compressed air.
This energy carrier is safe, clean, reliable and easy to use, store and transport.

Modec air motors consist of a pneumatic vane motor and a system of planetary gear reduction.

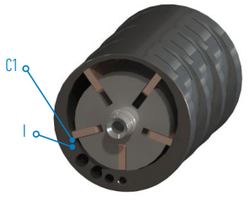


01 PNEUMATIC VANE MOTOR

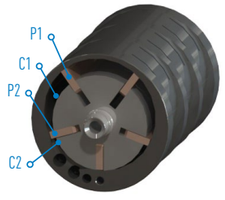
It consists of a cylinder called stator containing an eccentric rotor and closed by two flanges at both extremities.
The space created between the stator and the rotor is crescent-shaped. The rotor has notches in
which pallets can move freely.
As the rotor rotates, the centrifugal force drives the vanes outward from the rotor against the inner face of the stator, dividing the space into compression chambers of different volumes.



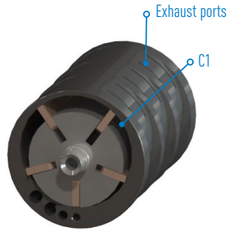
Pressurized air (4 to 6 bar) is injected into the air motor through the injection point (I). It enters the first compression chamber (C1), which is then pressurized. This pressure applies a force on all sides of the chamber. This force is proportional to the surface to which it is applied.



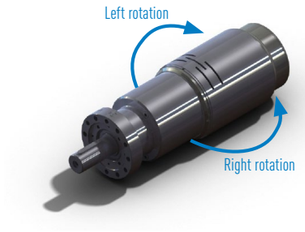
Since the two sides of the chamber have different dimensions, the force applied to each of them is thus different generating a rotational movement on the rotor. The volume of the chamber (C1) increases and the air inside expands. The chamber (C2) is then pressurized and the same phenomenon starts again, maintaining a constant rotation.



This rotational movement then brings the chamber (C1) into the exhaust position, releasing the air outside the motor.



By changing the injection point, the rotor rotates in the opposite direction. Thus, it is possible to change from a clockwise rotation to a counterclockwise rotation by simply changing the injection point on the motor. The direction of rotation of the motor output shaft is defined by looking at it from the rear (air inlet side).

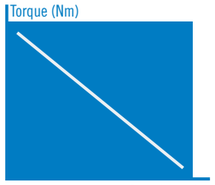


02 PLANETARY REDUCTION

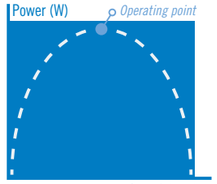
At a pressure of 6 bar, the rotor rotates at a speed of approximately 10 to 20,000 revolutions per minute (rpm) depending on the motor. Planetary gears are used to adapt the movement to the desired application. These gears reduce speed and increase output torque.

With different types of pinions and/or several gear stages, a multitude of combinations are possible resulting in a wide range of speed and torque.

HOW DOES IT WORK ?

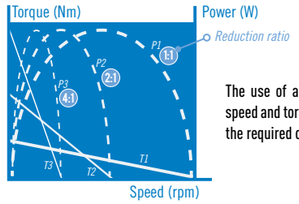


The power of the air motor depends primarily on the pressure and flow rate of the air (or any other inert gas) supplied. For a given supply, there is an inverse relationship between speed and torque.

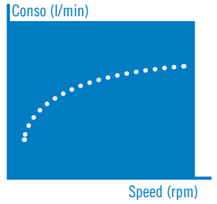


Air motor power (in Watts) is equal to the speed (in revolutions per minute) multiplied by the torque (in Newton meters) divided by a constant (9.55).

The maximum power is reached at a speed approximately equal to half the no-load speed (speed without load on the motor).
This combination is called the «optimum operating point».

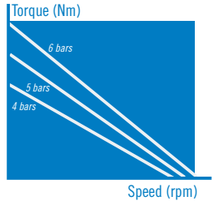


The use of a planetary gear allows to modify the speed and torque for a given power, in order to obtain the required characteristics.

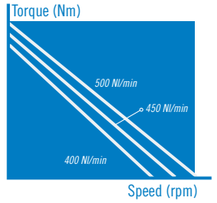


The air consumption depends on the speed of the motor.

CONTROL OF AN AIR MOTOR



Controlling an air motor consists of managing its direction of rotation, its torque and speed.
This can be done by controlling the air pressure and flow rate using a pressure and flow regulator. For a reversible motor, changing the direction of rotation is simply done by changing the air supply from one inlet to the other through a 5/3 valve. Be sure to use a pneumatic valve capable of delivering and exhausting sufficient air flow for optimal motor operation.



For a given motor and gear ratio, the speed and/or torque can be changed by simply changing the air supply.
The supply pressure of the motor impacts essentially the maximum torque of the motor (fig.5)

The motor supply flow rate impacts essentially the maximum speed of the motor

All data (maximum power, no-load speed, speed at Pmax, starting torque, torque at Pmax, stall torque, air consumption at Pmax) are indicated for each of our motors on its product sheet.

3 | AN AIR MOTOR, WHAT'S IS IT USED FOR ?

Because they use an easy-to-use energy source, air motors are a flexible and efficient alternative to electric and hydraulic energy. Air motors are perfectly suited for a wide range of industrial applications.

They have unique characteristics for specific applications and environments.

Here are 10 technical characteristics to convince you of the efficiency of air motors:

1 EASY IMPLEMENTATION

Compressed air motors do not require a sophisticated control system. **It is easy to control torque or speed by limiting supply pressure or exhaust flow.**
While the installation of a hydraulic motor requires the installation of a drip tray in case of leakage, air motors do not have this constraint. Compressed air networks are generally available on industrial sites, and no additional installation is required.

2 NO FIRE RISK

Some applications require a large number of on-off cycles, sometimes at high frequencies. This type of operation limits the use of electric motors that have current peaks at start-up and tend to «heat up» when they stall.
Hydraulic motors have the same weakness; overheating of the hydraulic system is a major risk of malfunction and fire.
Air motors can start as often as necessary, and can also stall indefinitely without overheating or risk of damage.

3 OPERATIONAL FLEXIBILITY

Air motors have the particularity of being able to operate over the entire torque curve, from no-load speed to controlled stop, without being damaged.
Unlike an electric motor, an air motor adapts its speed according to the required torque. The motor evolves according to a specific power curve. The maximum power is reached at about 50% of the no-load speed.

4 RELIABLE AND DURABLE

Air motors are extremely durable, **they are continuously cooled by the expansion of air, which prevents them from overheating, even at very high speeds**. This protects the mechanics of the air motor from high temperatures, which improves the durability of its parts.

5 COMPACT DESIGN

Compressed air motors are 4 to 5 times smaller and lighter than electric motors for a given power.
This is why air motors are used in many portable applications and in those where space is limited.

6 EASY MOTOR RECYCLING

Compressed air motors are strong, durable and easy to maintain. Designed with recyclable materials (aluminum, steel, etc.), it is very easy to recycle them at the end of their life. **They do not contain any materials that pollute or require special precautions.**

7 OPERATION UNDER EXTREME CONDITIONS

Pneumatic motors are resistant to dust, humid air, high temperatures, magnetic fields, radiation and do not generate any risk of explosion. They can operate from -30 °C to +150 °C. They can be used in most environments.

8 CAN BE USED IN BOTH DIRECTIONS OF ROTATION

Air motors can be used in both directions of rotation. **Often reversible, they can be easily controlled by remote control or by means of a handle mounted on the device.** Rotation changes can be made easily without going through a stop phase, thus optimising cycle time.

9 SAFE OPERATION IN FLAMMABLE AND/OR EXPLOSIVE ENVIRONMENTS

Compressed air motors do not produce heat or sparks, making them suitable for use in explosive environments. This avoids the use of a power supply in ATEX zones. **Motors can easily be ATEX certified at no significant extra cost, and they can be used in sensitive environments without the risk of explosion.**

10 NO ELECTRICAL CERTIFICATION REQUIRED

The installation, use and maintenance of the air motors are simple and safe, and do not require any particular certification for the operator. **Pneumatic motors are an excellent alternative to electric motors, both for the ergonomics and safety they provide and for their durability and flexibility.** All this at a cost that remains competitive.

ATEX AND EXPLOSIVE ATMOSPHERES

An explosive atmosphere, also known as ATEX (Explosive Atmospheres), is a mixture of air (oxygen in the air acting as an oxidant) and flammable substances, combustible in the form of various gases (methane, propane, ethylene, acetylene, hydrogen, etc.), fumes (carbon sulphate, ethyl alcohol, ethylene oxide or acetone) or dust (aluminium, starch, cereals or coal), which, after ignition, can spread combustion.

An ATEX zone can explode in the presence of an ignition source caused by excessively high temperatures or sparks. The use of electricity can be problematic in these dangerous atmospheres because of the risk of sparks and heat. The danger comes from electrical appliances (motors) as well as from the electrical network itself and all its connections causing potential ignition.

The danger of explosions in the industrial workplace is real and its effects can be devastating for both people and equipment. To avoid these risks, the priority is to prevent the formation of explosive atmospheres (ATEX) or to eliminate the danger of explosion caused by the use of electric motors by acting beforehand, especially when selecting equipment and setting up production processes.

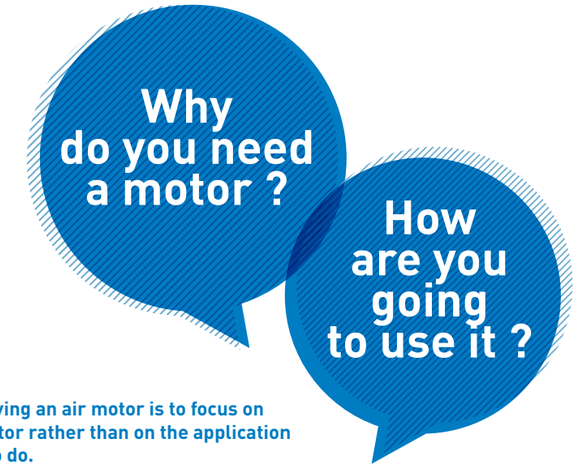
What are the advantages of an ATEX-certified air motor?

Alternatives to electric motors are particularly recommended in hazardous environments where the risk of sparks or high temperatures may ignite explosive gases, dust or fumes. In the absence of any electrical parts in an air motor, the probability of a spark or explosion in the presence of flammable gas is zero. In addition, when the motor is running, the expansion of air cools the air motor. The more it runs, the more it cools. It can therefore be used in high temperature atmospheres.

The use of air motors also allows you to eliminate the electrical network itself in the ATEX zone. However, the danger often comes from the network itself. Power supply cables can be damaged or simply worn out; the numerous electrical connections are weak points, as are the control and protection devices. A compressed air network is simple and completely safe, even if one of its components deteriorates.

Ensuring that an entire electrical system is ATEX compliant is considerably more complex and more expensive than the use of air motors.

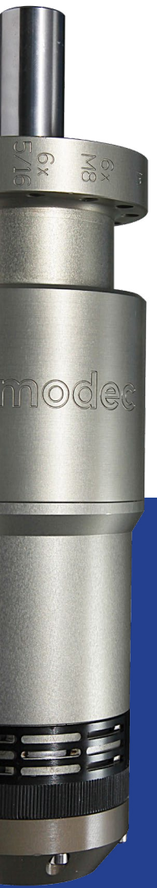
4 | HOW TO CHOOSE THE RIGHT MOTOR ?



A common mistake when considering buying an air motor is to focus on the mechanical characteristics of the motor rather than on the application itself and the work you want the motor to do.

For example, you might say, «I need a motor with X power» when in fact, only the torque, or only the speed, is important for your application. Similarly for the torque itself, depending on the application, only the starting torque will be important.

So the starting point should always be «What am I going to do with this motor» and, from there, define and refine the mechanics.



4.1.1 | SPEED, TORQUE, POWER

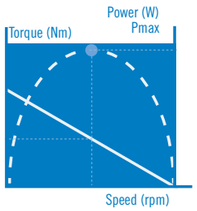
Speed (S), torque (T) and power (P) are related according to the equation

$$P = (T \times S) / 9.55$$

P = Power (in Watt)
T = Torque (in Newton Meters)
S = Speed (in Rpm)

The power is maximum when the speed is about half the speed. empty.
When the torque = 0 (no load applied to the motor), the speed is maximum (speed at no load), but the power is zero.
As the applied load increases, the torque increases and the speed decreases.
The power increases to a maximum called the optimum operating point where power is at its maximum.

When the motor stops because the torque demanded becomes greater than the maximum torque the motor can provide (stall torque), the speed is zero and the power is zero.



A COMPLETE RANGE OF MOTORS

Our range of compressed air motors is available in three families: Easy Duty, Standard Duty and Heavy Duty - adapted to different needs.

Easy Duty

Compact and lightweight, these motors do not have an integrated gearbox and deliver high speed and low torque.

Standard Duty

Well balanced between speed and torque, these motors are versatile and can be used in a wide range of applications thanks to the numerous flanges and shafts available.

Heavy Duty

For applications with high torque and requiring exceptional mechanical robustness in difficult conditions, the Heavy Duty range dedicates power to torque in a minimum volume.

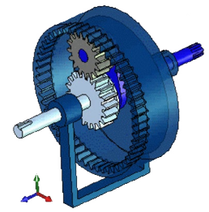
4.1.2 | A TOUCH OF MAGIC IN A BOX

1 | The gearbox integrated in the modec gearmotors makes it possible to reduce the speed and increase the torque to levels compatible with the application requirements. All this in a minimum space and with an efficiency close to 100%.

2 | A planetary gearbox is a relatively simple mechanism - one or more planetary gears orbit around the output pinion of the engine rotor and drive the output shaft. This has the effect of reducing speed and increasing torque. Different planetary gears can thus be stacked to achieve the desired speed and torque characteristics.

3 | Without reduction, a motor will have a very high speed but a very low torque.
If you set a reduction ratio of 2:1, the speed is divided by two and the torque doubles; if you set a reduction ratio of 4:1, the speed is slowed to a quarter of the initial speed while the torque quadruples, and so on.

Therefore, when choosing a motor, you need to be aware of these three elements and their mutual impact.



4.1.3 | AIR FLOW AND PRESSURE

Speed and torque levels can also be controlled by adjusting air flow or pressure. Reducing the air flow rate will reduce the motor speed. You can either reduce the air flow before it enters the engine by adding a progressive control handle, or - preferably - reduce the air exhaust, using a flow regulator on the exhaust port or hose. Placing the air flow reduction at the inlet will result in a slight decrease in starting torque and may create turbulence at the inlet point which can result in less stable operation, especially at low supply pressures.

Reducing the air supply pressure reduces the maximum torque that the motor can provide. To reduce the air pressure, simply set the required pressure at the pressure regulator on the FRL unit of the motor. Modec motors are designed to operate at a maximum air pressure of 6.2 bar.

CONCLUSION

Having a clear idea of what your air motor needs to do will help you and us understand the speed and torque requirements. That way, you can be sure that you are selecting a motor in the right power range and the right family, but also with the right features for the job you expect it to do.

Options and accessories

Our motors can also be equipped with options and accessories to improve their performance in certain environments and to improve the working conditions of the operators.

RIGHT MOTORS are the lightest and most compact, easy to integrate into a machine, they can be easily controlled remotely.

RIGHT ANGLE HEAD MOTORS, equipped with a 90° outlet, have a double advantage: they can be even more compact than straight motors under certain conditions (integration in mechanical systems), and they can have an even higher torque thanks to the additional reduction included in the right angle head.

MOTORS EQUIPPED WITH HANDLES can be easily and manually operated, just like portable tools. The type of handle will be chosen according to the need:

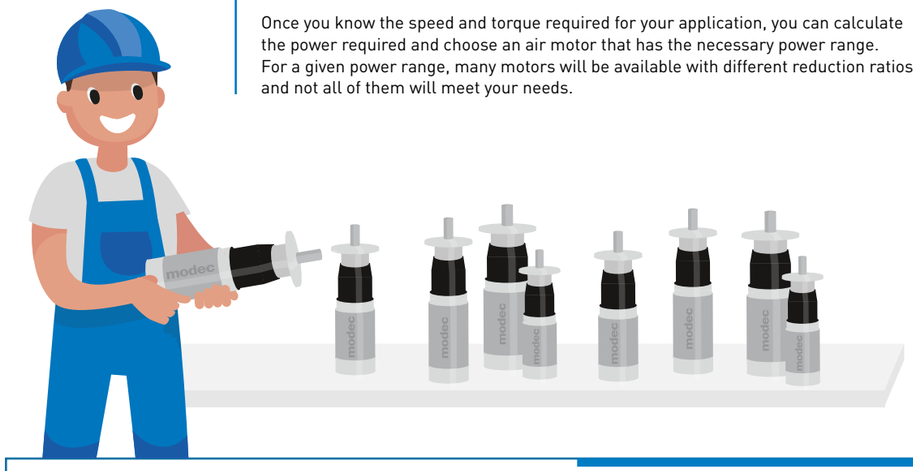
- Safety handle
- Progressive control handles

These two handles can be assembled together on the motor.

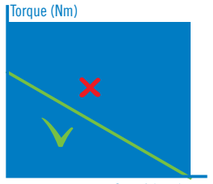
READY TO CHOOSE THE RIGHT MOTOR ?

CHOICE OF THE POWER RANGE

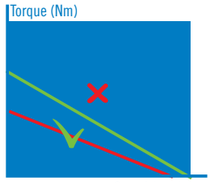
Once you know the speed and torque required for your application, you can calculate the power required and choose an air motor that has the necessary power range.
For a given power range, many motors will be available with different reduction ratios, and not all of them will meet your needs.



GET THE RIGHT RANGE OF WORK

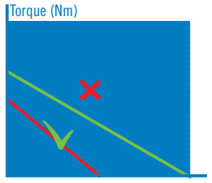


To be sure that the motor is adequate, you need not only the right power, but also the right reduction ratio. Simply plot the operating point of the application (speed and torque) on the torque/speed curve of each selected motor as shown. If this point is below the torque/speed curve, the motor will be able to do the job. But if the point is above the curve, the motor will not be able to do what you need.



Supply pressure adjustment

Once you've chosen a motor with the right power range and gear ratio, you can operate the motor at a specific operating point, as shown in the graph, by adjusting the air flow or pressure. If the torque is less critical, adjust the air pressure to obtain the correct operating point. If speed is less critical to your operation, adjust the airflow to reduce speed.



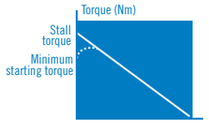
Adjustment of the feed rate

WHAT OTHER FACTORS MIGHT INFLUENCE YOUR CHOICE?

You have identified a motor - or most likely a list of motors - capable of performing the required function in terms of the power/torque/speed equation.

Now you need to consider other factors that could impact actual performance. The saying goes: «the devil is in the details», so do it right and you'll be ready for a happy and lasting relationship with your airmotor!

STARTING TORQUE



The starting torque of an engine is the maximum level of torque that can be applied to the engine at the time of starting. Above this torque, the engine will not start. This can be critical in lifting applications, for example, when the motor has to start to lift a load. This torque is often less than the stall torque. The starting torque given is the minimum measured torque. It can sometimes be higher.

ENERGY EFFICIENCY

If you want to optimise the energy efficiency of your operations, you want your motor to run at maximum power. In this case, **you need a motor that is close to your optimum operating point.** Working at maximum power also allows you to choose the smallest motor capable of performing the required function, which can be advantageous when working in a small space and at lower cost.

STALL TORQUE

Stall torque is the level of torque at which the engine stops, or stalls. It is important to know the stall torque to be certain that the motor will be able to handle the highest torque required by the application. Conversely, it may be important that your motor stops before it reaches a certain torque level to protect your machinery.
In this case you can ensure that you have a motor with a stall torque that does not exceed this value. A torque limiter can also be used in this case.

POWER RESERVE

For some functions, it is important to have a power reserve in case the torque level increases or changes. In such cases, a motor should be selected whose optimum operating point (maximum power) is to the left of the application's operating point. Thus, when the load (the torque demanded) increases, there will be no risk of immediate stalling, on the contrary, the power delivered will increase.

REDUCTION OF AIR CONSUMPTION

Under certain circumstances, the quantity and/or pressure of available air may be limited. In such cases, a motor should be selected with the optimum operating point to the right of the application's operating point so that the rotor speed (and thus consumption) is as limited as possible.

OTHER CRITERIA AND POSSIBLE ADAPTATIONS

TEMPERATURE

Our air motors can operate at temperatures as low as -30°C and as high as +150°C. However, at very low temperatures, attention must be paid to condensation or even small ice crystals caused by the additional cooling of the air in a cold environment.

SPECIFIC ATMOSPHERES

Whatever the working environment - dusty, radioactive, damp or explosive - our motors (which can be ATEX certified on request) **operate safely.** As long as you always use clean, dry and lubricated air, you won't have any problems.

CLEAN ENVIRONMENTS

Motors used in industries where a clean environment is paramount (e.g. pharmaceutical or nuclear industries) should **be equipped with an integrated air exhaust manifold to ensure that the air expelled from the motor does not contaminate the interior of the laboratory or factory.**

SEALED MOTORS

We can make sealed motors, capable of operating several metres underwater.

CONCLUSION

In short, if you want to choose the right air motor that offers you the best performance, safety and return on investment, start by analysing what you want the motor to do and go from there. And don't forget that we are always available if you need a little help!

5 | READY TO GO ?

Before you start your work, there are just a few installation steps left.

SAFETY FIRST !

Here are some safety rules to follow before using your air motor :

Adequate hearing protection

Air motors can generate noise when running and require adequate hearing protection (motor silencer, earplugs or earmuffs).

Adequate masks and goggles

Excessive lubrication can cause oil to be splashed into the atmosphere around the motor. Operators must wear suitable protective masks and goggles.

Use a SAT BOX !

In order to protect people and equipment, Modec recommends the use of a SAT BOX which, in addition to filtering, regulating and lubricating the air for the motor, has several important safety functions:

- **An emergency stop button that instantly** stops the motor as it cuts the upstream supply circuit and purges the downstream air network. Thus, there is no risk of residual energy causing the motor to start unexpectedly.
- **A safety key lock on the emergency stop button** so that the operator cannot restart without prior agreement following such a stop.
- **An automatic shutdown system** when the circuit pressure drops below 2 bar to prevent an unexpected restart.

Pictograms and precise instructions can be found in the user manual supplied with the motors. Compliance with these instructions is mandatory for all use of our air motors.

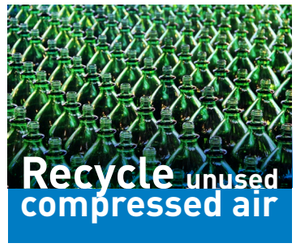
TO GO FURTHER IN EFFICIENCY

Several methods exist to maximise the efficiency of pneumatic solutions and some industries achieve spectacular results by recycling compressed air. In this way, most of the energy expended to produce compressed air can be recovered.

Air compression generates heat. Some industries use this warm air for heating purposes. They recover an important part of the energy used by the compressor.

When the compressed air expands inside a compressed air motor it cools down. This cooling is used to prevent the gears inside the gearbox from heating up. This ensures optimum operation and a long service life for the motor.

You can also use this cold air for other purposes in your process.



Some processes require large quantities of air at very high pressure. Even after use, the pressure of the exhaust air remains above atmospheric pressure. It is easy and advisable to use this compressed air with air motors to produce electricity for example.

Use compressed air to recover and store energy that is otherwise lost. Any unused mechanical energy can be recovered to compress air that can be stored and used. Compressed air is a safe, easy and efficient way to store energy everywhere.

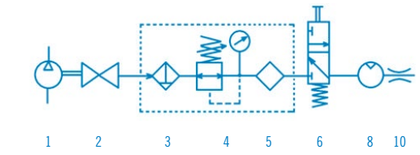
MOTOR INSTALLATION

PRELIMINARY CHECKS

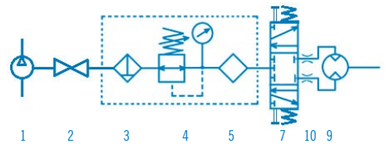
- The air pressure must not exceed the maximum operating pressure of the engine (6.2 bar).
- The air flow rate must be sufficient for the motor.
- The temperature should be between -30 and +150°C.
- A pneumatic safety switch must be installed to isolate the motor from the air supply.
- Each hose connecting to the motor must be equipped with an anti-whiplash cable to prevent any whiplash that could be caused by a broken or loose hose.
- The hoses must not be damaged or worn. Inspect them carefully before use: a broken hose can cause serious damage.
- The supply hose must be oil and abrasion resistant and suitable for the required air pressure.
- The length of the tubes should not be excessive (pressure drop).
- For reversible motors, the port opposite to the air inlet must be connected to the exhaust.
- A filtration, regulation and lubrication unit (FRL*) must be installed upstream of the motor (filtration must be 40 microns maximum and lubrication must be compatible with the motor used). Filtration units ensure that the air is clean, properly pressurised and lubricated.

CONNECTION OF COMPRESSED AIR MOTORS

Non-reversible motor



Reversible motor



1. Compressor
2. Isolation valve
3. Filter 40µm
4. Pressure regulator
5. Lubrication system
6. 3/2-way valve
7. 5/3-way valve
8. Non-reversible motor
9. Reversible motor
10. Exhaust regulator

Insufficient lubrication will result in reduced motor performance and vane life. To maximise the durability of your motors and guarantee their full power in operation, they should be lubricated with 50 mm3 of oil per m3 of air (1 drop = 15 mm3).

The pneumatic oil used must have a viscosity of 22 to 46 cSt depending on the ambient temperature (for example, at 40 °C, the viscosity of the oil should be between 22 and 30 cSt)

You are now ready to use your air motor safely and efficiently.

modec
moteurs & solutions pneumatiques

We hope you found this guide useful.
If you wish to go further, you can consult our website or contact us directly.

We will be happy to use our expertise to maximise your performance.