

Pneumatics

What is Pneumatics?

Pneumatics is the science of using compressed air or another inert gas to do work. It is like hydraulics, which uses liquid (e.g., water or oil). Compressing air means that you put it under pressure. Often, this means squeezing it into a small space or forcing it to work against some external pressure. Compressed air contains energy – the energy used to compress it is transformed into **potential energy**. When the pressure is reduced, the air and the energy it stores is released.



When you fill a balloon with air, you're also filling it with potential energy.

Balloon-powered paper airplanes are a great, simple example of pneumatics that you can even try at home. Attach a balloon to a paper airplane with the opening at the back of the plane. Blow up the balloon but don't tie it, then let it go. Your plane will fly around the room powered by the air you compressed into the balloon. When you let go of the end, you release the pressure on the air inside, allowing it to rush out. This rushing air propels the plane forward. Or you can make a rocket using a tube (such as a paper towel tube) and a long, thin balloon. In each case, you're using the power of compressed air to make something move.

How Pneumatic Systems Work

Pneumatics is used in several different industries, including manufacturing, robotics, transportation, dentistry, banking, construction, demolition, and agriculture. The pneumatic systems used in these industries typically have five major components: a **compressor**, a **reservoir**, **valve(s)**, a **circuit**, and an **actuator/motor**. Many also have a sixth component: **filters**. Our air contains water vapor, particulates, and other additional substances that could interfere with the working of the system. Filters make sure that such contaminants are removed before the air is used.

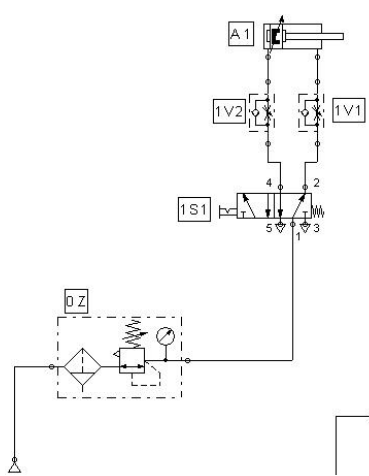
A compressor does just what you'd expect: it compresses the air (or other gas) that will be used to power the system. A typical pneumatic system compressor puts about 100 pounds per square inch (psi) of pressure on the air. For reference, most car tires are filled to a pressure of 30 to 35 psi. Compressors pressurize the gas by reducing its volume, basically squashing the air into a smaller space.



Compressors pressurize air.

The compressor sends the pressurized air to a reservoir, which is a chamber that stores compressed air for later use. Reservoirs ensure that pneumatic systems can continue operation without interruption and that operators don't have to wait for the system to compress air before work can begin.

Valves control where the air goes and when. They can be opened or closed to shuttle compressed air to different parts of the system. A valve controls when air leaves the reservoir and other valves throughout the system determine the direction of that air.



A pneumatic circuit. Note the arrows showing flow direction and the actuator, marked A1.

Applications of Pneumatics

The circuit is simply the collection of tubes through which air passes. It travels from the compressor to the reservoir, through open valves to the actuator/motor. It can't get where it needs to go without a circuit of tubes. Some systems are more complex than a simple 5-part arrangement, so circuits can transmit air to various reservoirs, in opposite directions, or to different actuators at different times.

Finally, the actuator/motor is the component that uses the compressed air to do the work. It converts the potential energy of the pressurized air into kinetic energy and force. Actuators can be, for example, **pistons** (cylindrical chambers containing a cylindrical sliding piece of the same diameter as the chamber), grippers, suction devices, airbags, mechanical arms, ramps, or rotating motors.

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Tractor trailers, trains, and buses use air brakes.

Pneumatics are also found in various parts of the transportation industry. One of the most well-known examples is air braking systems in trucks, trains, and buses. Typical air brakes operate as a **triple-valve system**. A basic triple-valve system has three stages, **charging**, **application**, and **release**. At rest, with no air pumping through the system, the brakes are engaged. During the charging phase, air is pumped into the system until it reaches a specific pressure. At this point, they are released and ready for

use during driving. In the application phase, the brake is depressed, opening a valve that allows air to leave the system. This reduces the air pressure, thus allowing the brakes to engage. Finally, to disengage the brakes, air pressure is increased in the release phase.

Small machines, such as dentist drills use pneumatics. Air is pumped through a circuit to a motor that rotates an axle, spinning the drill bit. Other devices that make use of pneumatics in this way include grinding and polishing tools used in, for example, jewelry manufacture.

If you've ever gone to the drive-through at a bank, you've seen pneumatics in action. Those tubes that they send your money and receipts through are pneumatic tubes. They can be pressurized to move containers in two different directions. At one end of a system of tubes, a compressed air pump either forces air into the tube or sucks air out of the tube, pushing or pulling the container within. Banks aren't the only places that make use of such systems. Department stores use them to move money from checkout stations to a central hub. Hospitals use them to quickly transport medicines between departments.

Pneumatic systems are good at helping people both build and destroy things. Pneumatics can power many different types of construction equipment, including drills, screwdrivers, hammers, digging tools, saws, and nail guns. In demolition, pneumatics powers the jackhammers used to break up concrete or rock.



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Advantages of Pneumatics

Pneumatic systems have many advantages over hydraulic and electronic systems. Pneumatic systems, due in part to the compressibility of gasses when compared to liquids and in part to the reservoir system they employ, tend to work faster than hydraulic or electrical systems. Pneumatic systems can also be lighter than hydraulic systems, making them ideal for hand-held devices such as dental drills. Electronic systems run the risk of electrical shock or an electric spark generating a fire. This risk is all but eliminated for both pneumatic and hydraulic systems. Similarly, fluids release heat, automatically cooling fluid-powered systems. Electrical systems can overheat if used for too long. One extra advantage pneumatic systems have over hydraulic systems is that some hydraulic fluids are flammable, while air is not. In addition, in the event of a leak, an air system is free to refill, while hydraulic fluid costs money. Pneumatic systems are also gentler than hydraulics or electronic motors. A hydraulic system could never be used to milk cows or lift glass plates with suction. Similarly, in manufacturing, pneumatic grippers can hold more fragile pieces than could a hydraulic gripper. In the specific case of air brakes, there's no chance of running out of fluid as air can easily be resupplied from the environment. Furthermore, if there's a leak in a pneumatic braking system, the brakes engage. If a hydraulic braking system leaks, the brakes won't engage.

Reading Comprehension Questions

1. What is pneumatics?
2. What
3. What
4. Why are reservoirs important?
5. Give 5
6. What are McKibbens?
7. How
8. List 3 agricultural uses of pneumatics.
9. List

Extension Questions

10. Find and list 3 additional applications of pneumatics not covered in this reading.
11. Give one example of a pneumatic system you encounter in your everyday life. How does it work?
12. Choose

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TWF READING

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