FAQ2 – Efficient compressed air system –

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This FAQ give a short explanation to the following question: what are the main energy saving opportunities in pressurized air systems?

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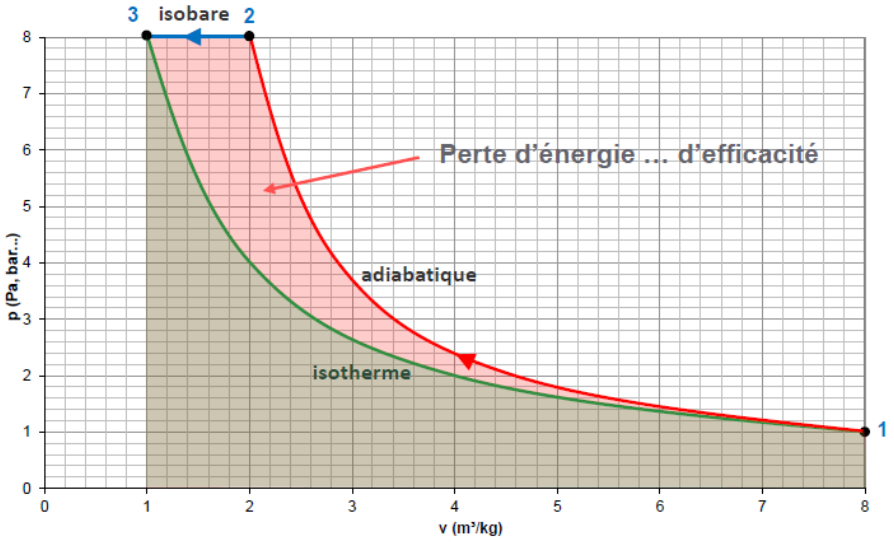
What is compressed air

Compressing air in industry is very expensive.

As we reduce the volume of the air, the pressure will increases. If the temperature doesn't change (isothermal process), it means that an efficient heat exchange happens. In contrast, an adiabatic process is where a system exchanges no heat with its surroundings (Q = 0). The reality of the compression is neither isothermal nor adiabatic: the air temperature increases and a large amount of heat is produced. But of course compression happens: pressure increases!!



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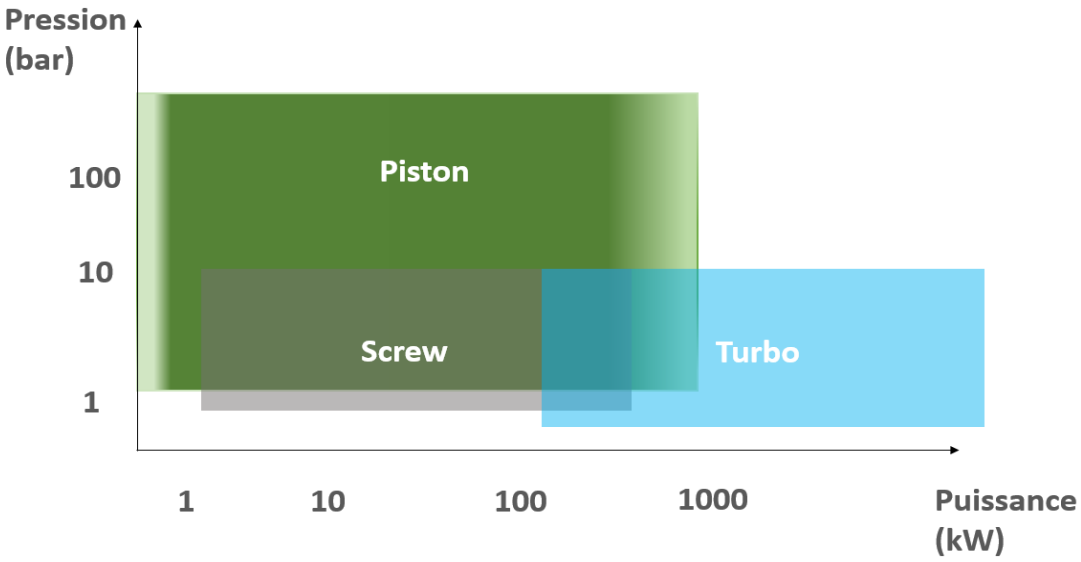
Main part of the equipment is:

- Compressor
- Dryer
- Tank

In the following section, we will discuss about energy savings related this equipment.

In industries, the screw compressor are the frequently used in industries because of their typical pressure (5-10 bar).



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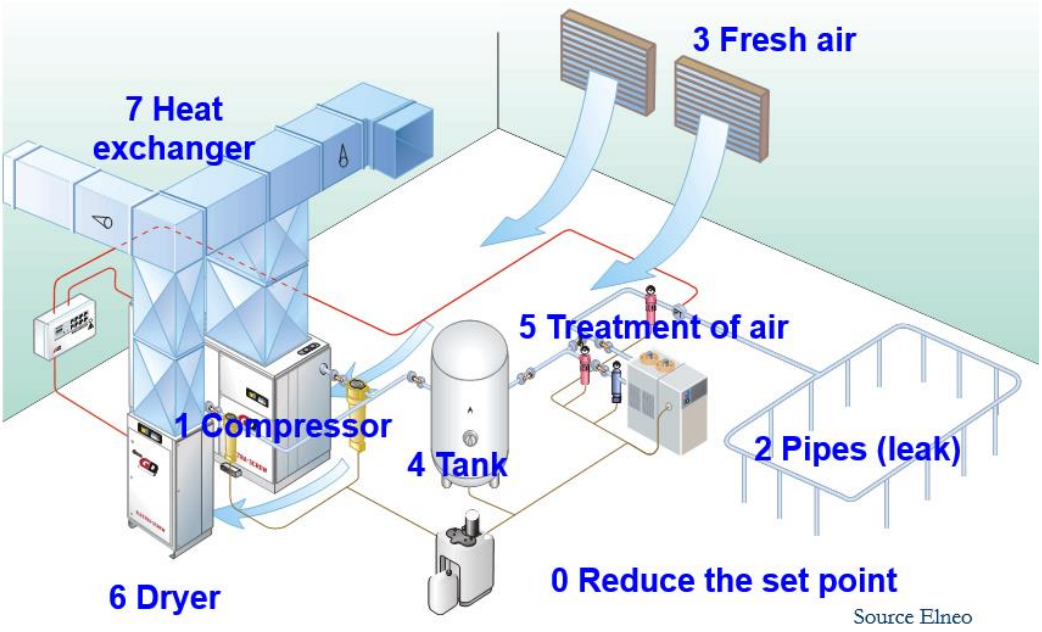
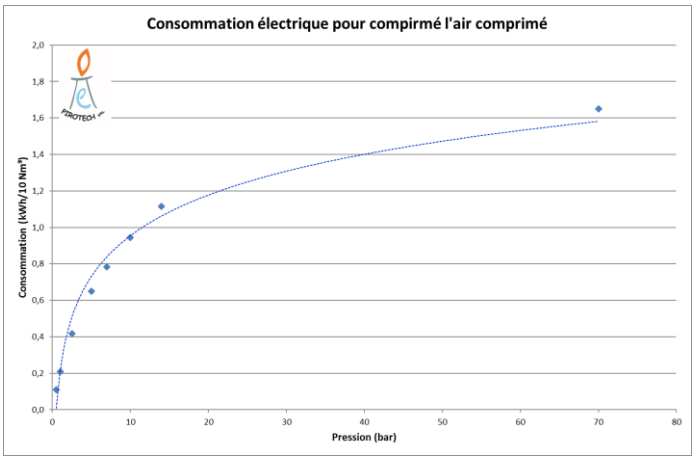
Energy savings on compressed air

In this section, we will discuss about the most frequent energy savings in compresses air.



1. Reduce Set point

Energy consumption of a compressor increase with the level of pressure of the air. We observe that we need about 1 kWh of electricity to produce 10 m³(N) of compressed air at 7 bar.



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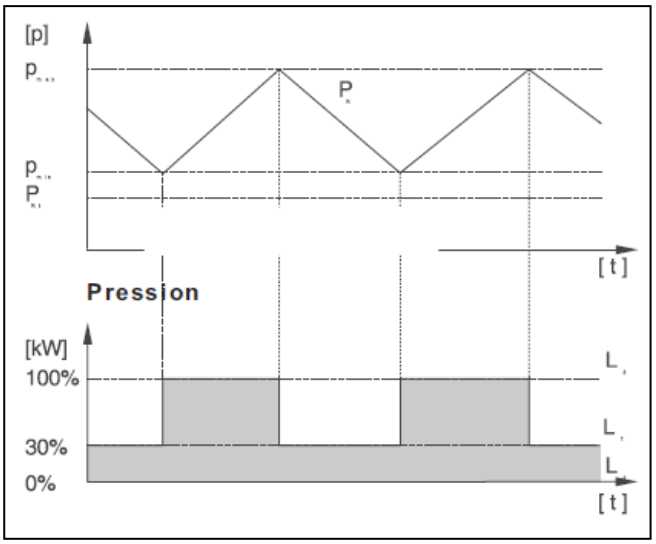
Pression bar	1 étage # Nm³ pour 1 kWh
0,5	91
1	48
2,5	24
5	15
7	13
10	11
14	9

It means that reducing the pressure (set point) of the air allows significant and costless energy saving. For instance, reducing the pressure of 1 bar (7 → 6 bars) allows to save 7,1% (=(14-13)/14)) of energy

2. Regulation

Most of the small compressor (<10 kW) does not have variable speed drive (VSD). It means that when there is no demand of air, the compressor still consume electricity (30 to 50 % of the nominal power).



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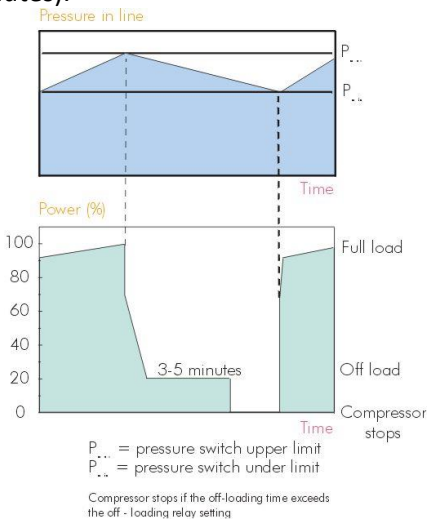
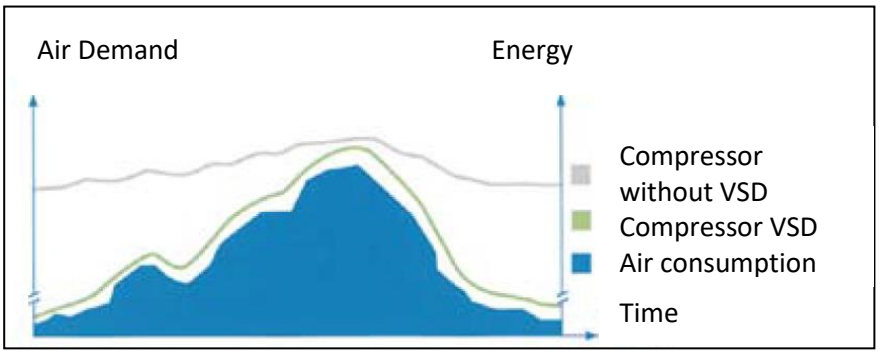
To save energy on this equipment without VSD, a timer allows to shut down the compressor after a fixed delay of waiting (typically 3 to 5 minutes).



Where compressors serve a varying process load, a simple way to vary the delivered quantity of air is with a damper or a valve in the outlet. This reduces the amount of air but increases the pressure drop and that represents energy loss. With a variable speed drive, the supply can be adjusted to match demand.



3. Leaks management

Check first:

- ✓ fittings and joints (particularly quick connections)
- ✓ purges
- ✓ safety valves
- ✓ filter valves
- ✓ flexible tubes
- ✓ jacks and speed-connections

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The following table allows to calculate energy savings from leaks reparation.

Air flow through a hole (m³(N)/hour)

Rel Press (bar)	Diameter of the hole (mm)						
	0,5	1	2	3	5	10	12,5
0,5	0,2	0,8	3,3	7,4	20,6	82	128
1	0,3	1,2	4,8	10,9	30,2	121	189
2,5	0,5	2,1	8,4	19,8	52,6	211	329
5	0,9	3,5	14,1	31,6	87,7	351	548
7	1,2	4,7	18,7	41,9	117	466	729

Example: A leak through a hole of 0.5 mm, not repaired during one year (8760 h) consumes 1,2*8760 = 10512 m³(N) i.e. 1000 kWh of electricity.

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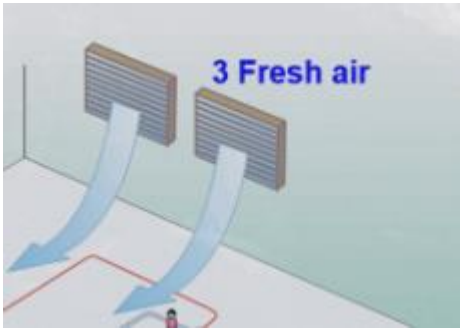
4. Input air



Fresh and cold air supply for the compressor improve the efficiency of the equipment because:

1. Efficiency of a motor decreases with the ambient temperature
2. Efficiency of compression increases with the density of the air (colder)

5. Dimension of the tank

- The tanker allows to reduces the number of start-up cycles of the motor.
- The ideal volume of a tank is the volume that the compressor provides in one minute.

A tank is never too big! The only limit is this price!

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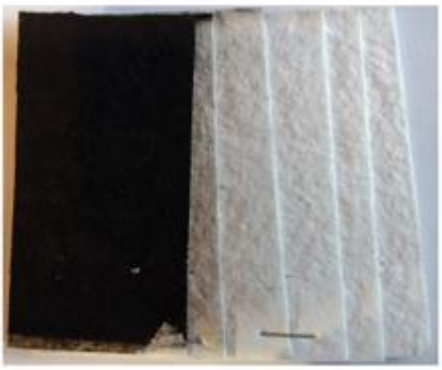
6. Air treatment

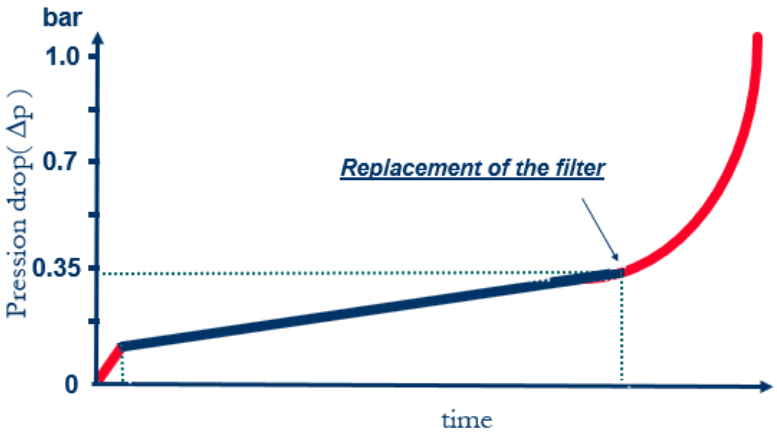
Compressed air contains:



- ✓ millions of micro particle-sized particles
- ✓ water vapor (g/m3)
- ✓ oil (mg/m3)
- ✓ compressor wear particles
- ✓ traces of heavy metals

!! Following the theory of ideal gas, an 8-bar compressed air contains 8 x more impurities!

$$\frac{p_o . V_o}{T_0} = \frac{p_1 . V_1}{T_1}$$



As a dirty filter increases the pressure drop and the increases the electricity consumption, we recommend to regularly replace the filter (depend on the production but at least once a year).

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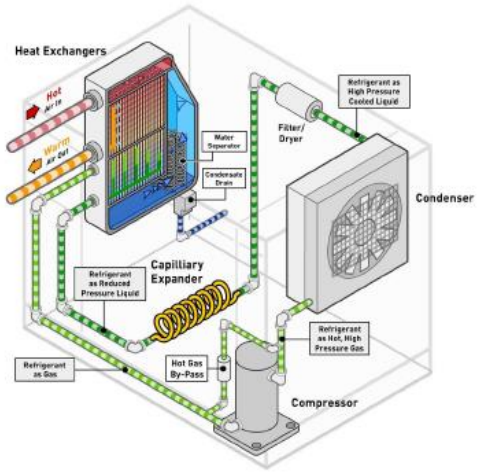
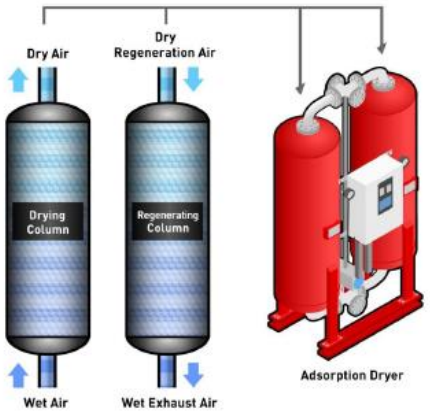
7. Dryer

Drying air allows to prevent water condensation in the pipes. It exists two main dryers in industries: compressing dryer and absorbing dryer





Compressing dryer

Absorbing dryer

Compressing dryer works on the base of a refrigeration equipment. It colds the air bellow the due point to condensate the water.

Absorbing dryer works with a dessicant substance that fixes the water of the air and must be regenerated (heating).

This second dryer is less efficient on energy but allows to produce air with lower humidity. It is also used if a part of the compressed air network is outside the building (where the temperature could be bellow 0 in winter) and the where the condensation risk is higher. .

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8. Recovering heat

Producing compressed air generates a lot of heat that can be recover. Remember that more than 80% of the energy produce by a compressor is dissipate under heat.

A easy way to earn energy is to extract the heat from the equipment to warm the building, as shown on the pictures bellow. No heat exchanger id needed!

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9. Using compressed air

Compressed Air Consumption of different tools under 6 bars (liter (N)/minute)

	Dimension	Flow (litre(N)/min
Sand cleaning tool		1500
Metallization tools		700
Drilling machine		
	6 mm	350
	12 mm	850
	1"	2200
	2"	3200
	3"	3500
Blower		250
Motor (until	5 CV	1000 /CV

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4th March 2020

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