Druckluft effizient

Air Distribution

Energy saving in air distribution

An optimum compressed air distribution is an energy pipeline like an electricity cable which transports compressed air energy with as few losses as possible, i. e. with the lowest reduction of the

- flow pressure (pressure drop due to narrow points in the pipeline)
- the air quantity (leaks) and
- the air quality (rust, welding scale, water etc.).

Pipeline system

In practice, compressed air tubes (main and distribution lines) are frequently selected without sufficient knowledge and without taking energetic issues into consideration with the result that in 80 of 100 firms (EU study), often 50 % and more of the compressed air energy are destroyed before they can reach the usage points.

The correct planning of a network has direct influence on the performance of the machines and the costs of producing compressed air. Select the correct diameter taking into account the flow rate required and the permissible pressure drop. The pressure drop from the air receiver in the compressor room to the final connection point should not exceed 0.1 bar. In an optimally designed compressed air network, the pressure loss is split into:

$\leq$ 0.03 bar for the main line
$\leq$ 0.03 bar for the distribution
$\leq$ 0.04 bar for the connection
$\leq$ 0.3 bar for connection equipment

Just as the economic efficiency of the compressor is documented, the operating efficiency of air distribution should also be documented – missing documentation always means wasted energy.

Main line (ML):
Connects the generator system (compressor room) with the distribution system. The main line should be sized so as to allow reserves for future extensions.

Distribution line (DL):
This distributes the air within a consumption sector. It can be designed as a branch or ring line, or as a ring line with integrated branch lines.

Compressed Air Facts

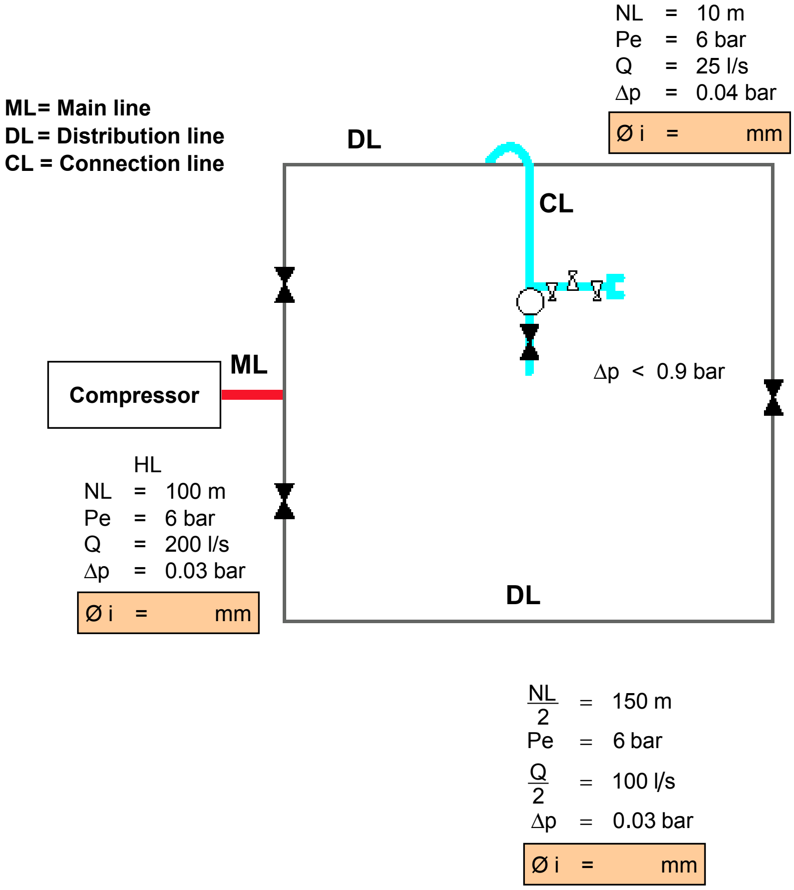

Fig. 1: Naming of piping segments

Explanation of terms deciding factors

Flow pressure

In spite of decades of awareness training by the manufacturers, the majority of compressed air tools are only driven with a flow pressure between 3 and 5 bar, that is 1 to 3 bar too low. The manometers on the controllers and maintenance units before the tools show the static pressure. But this does not drive the tools, the dynamic flow pressure does.

Other adverse effects on the flow pressure occur if the pipe diameter is too small or the pipe system has too many bends. Furthermore, when designing the system, the corresponding equivalent lengths have to be planned for all connectors.

Connection line (CL):
This is the link between distribution and machines or dispensers/points of use. The joint between the connection line and the distribution should be at the top in order to avoid condensate exiting with the air.

Connection equipment:
These system components are frequently the critical points of a system and also require careful attention. Couplings, hoses, coils or maintenance units often result in enormous energy wastes due to wrong design. In addition there are many connections here within a limited space which can leak.

Air quantity

In compressed air distribution systems which have grown over the years, are made of widely differing materials, with different, suboptimal diameters, more or less corrosion-free materials and very different types of connection, the rate of leakage can be between 25 and 35 %. Leaks cost a lot of money. They are the busiest consumers working 365 day per year.

Air quality

Corrosion- and oxidation-proof premium pipelines are preferable which have been specially developed for compressed air applications. A system should be selected so that the quality of air generated by production and treatment is not impaired by the pipeline even after a long period of time.

Flow pressure at tool (P_e bar)	Air consumption %	Measure	
8.0	125	throttle controller	waste of energy
7.0	111		
6.3 bar	**100 %**	**optimum performance**	
6.0	96		
5.0	77	increase pressure	disproportionate decrease in productivity
4.0	61		
3.0	44		

Table 1: Annual energy costs due to leaks

Hole diameter mm	Air loss		Energy loss		Costs	
	at 6 bar l/s	at 12 bar l/s	at 6 bar kWh	at 12 bar kWh	at 6 bar €	at 12 bar €
1	1.2	1.8	0.3	1.0	144	480
3	11.1	20.8	3.1	12.7	1488	6096
5	30.9	58.5	8.3	33.7	3984	16176
10	123.8	235.2	33.0	132.0	15840	63360

(*) kW x 0.06 € x 8000 Bh/a

Table 2: Annual energy costs due to leaks

Internal pipe diameter	Pressure drop	Investment costs	Energy costs to compensate the pressure drop
1. 90 mm	0.04 bar	→ 10000 €	→ 150 € p. a.
2. 70 mm	0.2 bar	→ 7500 €	→ 600 € p. a.
3. 50 mm	0.86 bar	→ 3000 €	→ 3270 € p. a.

Table 3: Costs resulting from selection of too small diameters

Storage

Another influencing factor for the air quality and quantity is the storage of the compressed air. Compressed air storage straight after production also called "central storage" influence the air quality to the extent that the direct condensate is removed. Furthermore, storage makes it possible to meet requests for much larger quantities of air within a short time than the compressor could provide immediately. There is also the possibility – depending on the use involved – of "decentralised storage" directly at the point of use. Further information on storing compressed air can be found in the "Druckluft effizient“ facts Control and Treatment.

Costs

When comparing the investment costs, the material and assembly costs of the different pipe systems should be compared as there is no generally valid formula for the correct pipeline material. For this reason, priority should be given to the individual demand case with its respective technical requirement.

With the exception of stainless steel, the costs of various pipeline materials do not vary widely, the differences are so small that they can be negated in the annual amortisation amounts/depreciation amounts.

However, selecting the correct nominal width is decisive. Considerable consequential costs can arise if the diameter is too small. Whoever tries to save on acquisition costs here, has to pay for this in consequential costs (see Table 3).

Refurbishment of air distribution systems

Generally, a pipeline inspection should not be delayed for economic and ecological reasons. But such an inspection should also be conducted step for step and not in haste.

Large saving potentials in compressed air distribution can be determined based on a quick rough diagnosis as follows:

- air quality
- leaks
- pressure drops.

Does the **air quality** meet the requirements?

Alongside the type of treatment, this is mainly a question of whether the pipe system is corrosion-free. Does the air at the points of use still correspond to the values (produced) at the production outlet? Carbon deposits/water, rust or zinc dust (even if only in subsections) often make additional expensive maintenance work necessary at each extraction point as well as a centralised treatment.

Are there **leaks** in the system?

By recording the load at the compressors and comparing this with the existing extractions, the quantity of leaks can be determined. It is vital to consider both "opened" and "closed" points of use, since leaks at the connecting equipment and in the machines may falsify these measurements.

The impact on the tools of supercharging can also be regarded as "leaks". A tool which needs 6 bar, but is charged with 7 or 8 bar wastes considerable additional amounts of air.

How high is the **pressure drop**?

This can arise due to too small diameters. In networks which have grown over time, more and more points of use have been added to longer and longer main lines without these having been redimensioned in accordance with the requirements. Perhaps, only the compressor capacity has been increased. After the diagnosis has been made taking into account all three criteria, an economically sensible refurbishment can be determined. Either, certain parts or sectors should be refurbished or, if all the negative phenomena coincide, a new network may be the most economic solution from the cost/benefit aspect. Such refurbishments often cost much less than years of wasting energy – the payback periods are very short.

An economic concept can be designed by any specialist compressed air company!

Often, a meticulous observation using measurements of the complete system from production and treatment through distribution right up to the mechanisms of the machines is a time-consuming necessity, which, however, pays off lucratively for a company – regardless of the type and size – quickly and long-term.

The maintenance of the most expensive energy source which is also vital to production should done as diligently as it really deserves!!!

dena Deutsche Energie Agentur

Fraunhofer Institut Systemtechnik und Innovationsforschung

VDMA Drucklufttechnik

The campaign "Druckluft effizient" aims to motivate the operators of compressed-air systems to optimise their systems and save substantial costs. It is conducted by the **German Energy Agency** (dena), the **Fraunhofer Institute Systems and Innovation Research** (Fraunhofer ISI; project management), and the **Federation of the Engineering Industries** (VDMA) with support of the Federal Ministry for Economics and Labour (BMWA) and the following industrial enterprises:

Atlas-Copco	BEKO Technologies	BOGE Kompressoren
domnick-hunter	Energieagentur NRW	Gardner Denver Wittig
GASEX	Gebr. Becker	Ingersoll-Rand
Kaeser Kompressoren	Legris – TRANSAIR	METAPIPE
Schneider Druckluft	systemplan, Karlsruhe	Thyssen Schulte – MULTIPLAST
ultra air	ultrafilter International	ZANDER Aufbereitungstechnik

Further information can be found at **www.druckluft-effizient.de**