Druckluft effizient

# System Optimisation

**Roadmap for optimisation**

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In the age of rationalising industrial plants, the optimisation of complete systems is a very important tool to increase efficiency. This applies to compressed air technology as well.

Even if at the beginning of an inspection it seems that in the past decades not enough emphasis was placed on the planning and development of the relevant compressed air system and any possible extensions, at closer inspection the problem is usually revealed to be more complex. For example, in the past, the compressed air system was often considered the responsibility of departments which actually had nothing to do with the technology and was thus treated as a secondary concern. This "uncontrolled growth" was supported and even reinforced by the advantage of compressed air – that it is "accident-proof". That compressed air is one of the most expensive energies was often overlooked.

By inspecting the complete system with its diverse improvement options, quite considerable savings can be achieved at often very little expense. Several points have to be taken into consideration, although the emphasis here is on supplying ideas and practical assistance. Several ways to optimise a system within the frame of a complete system check are represented below.

## *Situation audit: assessing the actual state*

**The compressed air system consists of the following sectors:**

- **Production**
- **Treatment**
- **Distribution**
- **Consumers.**

In order to assess the system's condition, an initial overview of the actual state should be obtained by viewing the plant, room and pipe system diagrams. With the help of the available measurement technol-

**Compressed Air Facts**

ogy (Fig. 1), the relevant parameters such as volume flow rate, flow pressure, and compressed air quality (temperature, humidity, pressure) can be recorded. In addition, alternative values for the electricity consumption of the compressor (load/no-load measurements) with subsequent illustration of load profiles or the measurement of leaks can be carried out (see Facts Measurement technology).

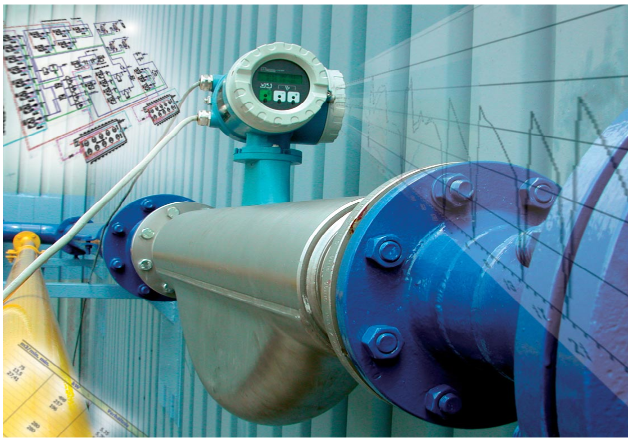

Fig. 1: Measurement technology

Particular attention has to be paid to the predominant system pressure. The most important user is often located at the end of the network (possibly supplied via a branch line) and is decisive for the pressure generated in the system. To some extent a "historically developed pressure level" is carried, which has originated primarily from network and plant extensions and which could be reduced at closer inspection, and through only minor changes in the network, e.g. through ring closures.

From the individual measurements cited above, valuable information about the system's condition (e.g. inlet and outlet air problems, overloading of processing units, cooling etc.) can be obtained. This opportunity should also be used to check the specifications for the compressed air quality required. All requirements which deviate from the usual standard (oil-lubricated air processed using refrigeration dryers, with simple filters of 1 µm particle size and 1 mg/m³ residual oil content, pressure dew point +3 °C), require additional investments and operating costs due to the treatment measures then necessitated. see Facts Air Treatment).

As soon as the specifications regarding amount, compressed air quality, necessary availability and the associated redundancy have been fixed, the system's durability can be checked for what can continue to be used with regard to condition, age, energy efficiency etc.

To assess the compressed air system downstream, it is prudent to estimate the distribution losses occurring in a leak check. These should normally lie between 15 and 40 % (rule of thumb).

Ascertaining leaks can either be calculated by maintaining the pressure in the distribution network while the plant is not operating, or, if this is not possible, be calculated from the pressure curves measured during operation. There is a mathematical analytical method available to do this. To estimate the leak potential during operation, an ultrasonic detection tool is helpful.

Another aspect is the higher level control of several compressors in a system and thus in a network. Large market innovations have become available in recent years with integrated processor technology so that it is always sensible to regard controlling and control technology separately.

According to up-to-date studies, no-load periods, for example at unregulated screw compressors of up to 30 % and electrical power required at no-load operation of likewise 30 % of the drive power are cited as starting points for a possible optimisation in connection with the use of state-of-the-art controlling and regulation concepts (see Facts Control).

The audit should be completed by a detailed report on all the work conducted and processes with relevant diagrams and illustrations of measurement curves, Process and Instrumentation Diagram P&ID (any analyses of saving potentials conducted), as well as formulating suggestions for optimisation.

## *Engineering – concept*

Particular attention must be paid to the overall concept when implementing the insights gained from the audit (effectively taking a wider view): it is obligatory to comply with frame parameters such as, e.g. legal regulations and possibly a given supply concept (e.g. for condensate).

The energy concept cannot be regarded as a separate unit, but has to be seen as linked to possible heat recovery and the synergy effects of other necessary energies, such as, e.g. nitrogen demand. Furthermore, it is important to correctly select the individual components including redundancies to be used in extensions, modernisations and new constructions in accordance with the overall concept.

With modern integrated control technology (keywords tele-service, remote monitoring and control) the service quality of the system can be boosted quite a lot. This usually involves guaranteeing the largest compressor unit or supplying the corresponding system redundancy. A corresponding reliability can be achieved by additional network connections.

Another important point is the overall concept of maintenance and service, which essentially co-determine any resulting expenses.

## Examination of complete system

When examining the in-plant measurement technology, particular care must be taken to use the technology sensibly. It has to be determined which permanent measurements of, e.g. energy consumption, leak detection, pressure losses, specific overall performance should be made to monitor the system alongside the "normal" plant measurements such as volume flow rate, pressure and pressure dew point. Corresponding to the measures involved, it might be prudent to carry out a cost-benefit analysis.

With regard to controlling, it has to be checked whether automatic regulation or an infinitely variable one should be installed (see Facts Control).

*Note:* According to the EU study "Compressed Air Systems in the European Union" an energy saving potential of approx. 20 % is realisable through employing efficient and higher level control systems.

## Reducing interfaces

Examining the organisational coordination of the compressed air system is also important. It should be checked whether it is sensible to consign the compressed air system its own organisational unit. The resulting cost transparency is one big advantage of this and thus better cost control. Up to now, compressed air technology has been knowingly or unknowingly billed at several accounts, which made it very difficult to check the costs incurred.

This can be changed if someone is put in charge of a project and thus of the costs in order to improve the organisation.

When conducting service and maintenance measures it is advantageous if the work can be planned in the long term. In practice this means preparing the necessary checklists and maintenance plans in plenty of time in order to ensure maintenance of the plant components without interruption (keyword fault management).

## Efficiency of compressed air production

To determine the efficiency, the m³ costs can be taken as a benchmark for energy/maintenance/capital. Determining the components via the specific output and service costs is also possible. A cross comparison with other consumers or projects with subsequent optimisation suggestions is to be recommended.

After these assessments, estimating the potential should be done including the calculation of additional internal costs, investment costs, replacement investments, operating costs and service and maintenance costs.

The next recommended step is to prepare a balance sheet of the compressed air system. This includes identifying the specific benchmarks, the degree of efficiency together with the affiliated network parameters.

The energy efficiency can be further increased by, e.g. examining heat recovery possibilities. When optimising the system, it is also very important to check for misuse of compressed air such as, e.g. cooling workers on hot days etc. This is to do with increasing workers' awareness of the issue.

Finally, the targeted improvements are put into practice.

Fig. 2: Compressed air system

## System follow-up – system optimisation

Here it is necessary to carry out basic examinations such as checking the energy efficiency with alternatives and the examination of existing energy forms such as, e.g. combined heat and power. Linked with this is the general examination of the existing operating and installation conditions and the maintenance friendliness.

It is not sufficient to optimise the system only once. Indeed it is necessary to regularly adjust the system to changing specifications (consumption, system pressures etc.). The changes in the system are caused by modifications which are not centrally co-ordinated. It is therefore very important that internal system modifications should have to be registered or even better have to be officially authorised first.

In practice in the past different control mechanisms such as cost controlling and systems to maintain performance have paid off repeatedly. System prognostication is a good tool used to compare today's requirements with future requirements.

## *Outsourcing the compressed air supply*

The pros and cons for this course of action have to be carefully balanced. The contractor's guarantee of an energy consumption per NM³ compressed air is one argument in favour of outsourcing compressed air. It is therefore in his interests that the system operates efficiently. Furthermore, it is ensured that the system will be in the hands of a specialist and that the firm's own staff are not burdened with unfamiliar tasks.

Arguments against outsourcing are that the key skills involved in optimising compressed air systems, planning new systems and maintaining systems are then lost to the customer. If the compressed air system is reintegrated at some point, these skills have to be built up again. (See contracting guidelines.)

## *Organisational changes*

In practice, it has been shown that management in general does not have a high regard for the compressed air system. However, those in charge of the system are usually to blame for this situation since they do not pass on important concerns to the management and thus lead a "wallflower" existence.

The personnel situation has to be examined. If necessary, staff have to be trained for the relevant tasks. Another possibility is to appoint someone to be responsible for compressed air.

## *Conclusion*

As well as the utilisation of individual energy efficient components for the production, treatment, distribution and use of compressed air, the optimum coordination of all the components with one another is also of particular significance. The sum of efficient components does not necessarily result in a reasonable overall result. The existing optimisation potential is also considerable.

Professional external help is probably often necessary here, but it is also important to ask the right questions before commencing the project, and when planning and implementing it.

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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:

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