Energy analysis – flow measurement - leakage calculation

DS 500 mobile – energy analysis according to DIN EN. 16001. If we talk about operational costs of compressed air plants we are actually talking about the energy costs as they make up about 70 to 80 % of the total costs of a compressed air plant. Depending on the size of the plant this means considerable operating costs. Even in smaller plants this may quickly add up to 10 000 to 20 000 € per year. This is an amount which can be considerably reduced - even in case of well operated and maintained plants. For sure this also applies to your compressed air plant! Which actual costs per generated m³ air do you actually have? Which energy is gained due to the waste heat recovery? What is the total performance balance of your plant?

How high are the differential pressures of single filters? How high is the humidity (pressure dew point)? How much compressed air is used?

Although compressed air is one of the most expensive energy resources companies often experience enormous energy losses in this sector.

They are mainly caused by the following factors:

- Disuse of the waste heat
- Leakages of up to 50%
- Missing compressor control systems
- Pressure losses

Lots of plants are not adapted to the actual demand or they are in need of repair. Leak curring programs could save up to about 1.7 million tons of emmissions of carbon dioxide per year. (Source: Fraunhofer Institut, Karlsruhe). So there is a considerable amount of possible energy savings slumbering in the compressed air lines of lots of enterprises. In order to open this up the waste heat which occurs during compressed air generation should be used for heating rooms or for hot water generation. Furthermore, it is important to optimize the control of compressed air stations because this will lead to considerable energy savings in any case. Also the restoration of an ailing or no longer suitable compressed air supply will pay off already after a short period of time. Losses due to leakages within the pipework can cause extreme costs.

This table shows the annual energy costs caused by leakages:

Hole diameter	Air loss at:		Energy loss at:		Costs involved at:	
mm	6 bar (l/s)	12 bar (l/s)	6 bar (kWh)	12 bar (kWh)	6 bar (€)	12 bar (€)
1	1.2	1.8	0.3	1.0	144	480
3	11.1	20.8	3.1	12.7	1,488	6,096
5	30.9	58.5	8.3	33.7	3,984	16,176
10	123.8	235.2	33.0	132.0	15,840	63,360

(Source: Druckluft-Effizient, kW x 0.06 € x 8000 working hours per year)

Energy resources like electricity, water and gas are usually monitored and therefore the costs are transparent. Water consumption, for example, is measured with consumption meters and a water leak is usually found quickly due to the visibility of the leak. Compressed air leaks on the other hand are often not noticed and can „silently“ cause a lot of unnecessary costs, even during production downtime or over the weekend.

It is not unusual to have the compressors running continuously in order to establish a constant pressure within the system. In case of compressed air systems which have grown during the years the leakage rate can be between 25 and 35 %. They are the busiest consumers of compressed air, working all around, 365 days a year.

Not included are the hidden costs of producing clean and dry air. Refrigeration and desiccant driers are producing dry air with high running costs involved. Air that is then later lost through leaks within the system.

At constantly rising energy costs these potential energy savings have to be implemented in order to stay competitive within the market. Only if the consumption of single machines and plants becomes known and transparent for all it is possible to make use of possible savings. When introducing an energy management system according to DIN EN 16001 in the first step all consumers have to be recorded. So the user obtains a survey on the single consumptions. Only this transparency enables a targeted action and a saving of energy.

For compressed air systems this means in the first step to detect leakages and to remove them.

Especially for the complete monitoring and consumption analysis of compressor stations and compressed air lines CS Instruments has developed a portable measuring system, the DS 500 mobile.

DS 500 mobile meets with all requirements for analysing a compressed air system.

In addition to the evaluation of standard sensors like for example flow, pressure dew point, pressure, differential pressure, absolute pressure and temperature sensors, also the connection of all kinds of third-party sensors like e. g. PT100, PT1000, 0/4..20 mA, 0-1/10 V, pulse, RS 485 Modbus etc. is possible.

One of the main advantages of DS 500 mobile is the possibility to connect not only clamp-on ammeters but also external current meters, water meters or heat meters. So the current costs can be included very accurately in the analysis.

Determination of typical key figures of a compressed air station

Chart recorder

DS 500 mobile enables an intelligent energy analysis in a quick and easy way. The data will be indicated immediately in the display.

For this purpose just the costs in € per kWh (please consider day and night tariff) have to be entered.

- **By means of a mathematical function typical calculations can be carried out like for example**
- **Costs in € per generated m³ of compressed air**
- **Specific output in kWh/m³**
- **Consumption of single compressed air lines including summation**
- **Indication of Min-Max values, average value**

If the minimum values rise continously over the years this is a clear signal that the leakage rate increases. This can easily be determined by carrying out the measurements in regular intervals.

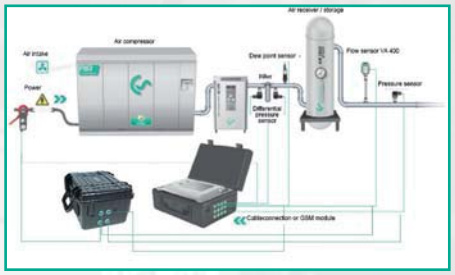
Consumption analysis including statistics at the touch of a button

Besides the compressed air also all other energy costs like current, water, vapour etc. can be recorded in this evaluation. This creates transparency.

So all energy and flow meters for compressed air, gas, water, vapour and so on can be recorded and evaluated. The customer gets the costs in €uro. On the big 7“ colour display with touch panel all information are visible at a glance. By means of the evaluation software CS Soft Basic all data can be evaluated online at the PC via a USB stick or Ethernet. Additionally to the consumption analysis as daily/weekly or monthly report an alarm can be sent by e-mail or SMS in case of an exceeding of the threshold values. The measured data can be retrieved all over the world via the Webserver, GSM module. **How is this done in practice?**

Step 1: Measurement

It is a special advantage that up to 12 compressors can be measured with one DS 500 mobile at the same time.



Step 2: Analysis

2.1) Compressor analysis (current-/power measurement)

The energy consumption of every single compressor is measured by means of a clamp-on ammeter. The produced compressed air quantity is calculated by the software on a basis of the performance data of the compressor which have to be entered.

The following parameters are calculated additionally: Energy consumption in (kWh), load-, unload-, stop time, compressor load in %, number of load/unload cycles, specific energy in kWh/m³, costs for 1 m³ in €.

2.2) System analysis (current measurement and real flow measurement)

The system analysis has the same function like the compressor analysis, however, it additionally offers the possibility to measure the actually produced resp. used quantity of compressed air by means of the flow sensor VA 500.

With the additional „real flow measurement“ the leakages and therefore the cost share of the leakages in comparison to the total costs in € can be determined.

2.3) Leakage calculation

The leakage calculation is done during the production free time (shutdown, weekend, holidays). The flow sensor VA 500 measures the supplied quantity of air. During the down time the compressor delivers compressed air in order to keep a constant pressure.

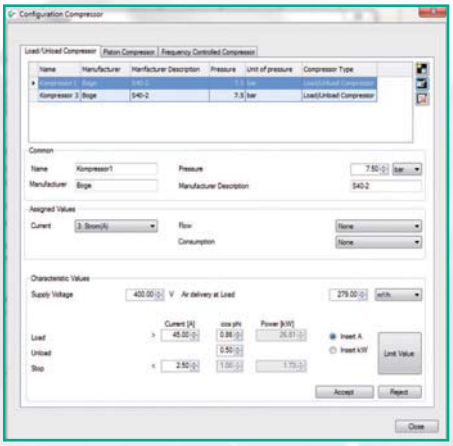
According to statistics even if production is carried out day and night there is at least one short period of time during which all load is switched off. By means of this data the software defines a leakage rate and calculates the incurred leakage costs in €.

Step 3: Evaluation at the PC with graphics and statistics

3.1) Entry of necessary parameters

Specific data have to be entered before the analysis is carried out:

- **Selection of compressor type (load/idle resp. variable speed drive controlled)**
- **as well as entry of the performance data according to data sheet**
- **Period of measurement**
- **Costs in € for 1 kWh**



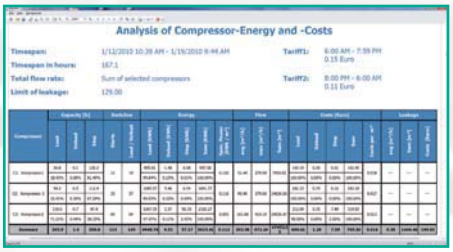
3.2) Graphic evaluation with day view and week view

Everything at a glance: The user gets a day and week view of all stored measured data with his company logo (can be easily integrated) at the touch of a button. By means of the zoom and the crosslines function pleak values can be determined.

3.3) Compressed air costs in €

At the touch of a button the user gets all important data like e. g.:

- **Energy costs**
- **Compressed air costs**
- **Leakage costs in €**
- **Compressor data with load/ unload time**
- **Specific energy in kWh/m³**
- **Costs per m³ in €**



4) Measures

Based on these analysis some measures should be carried out in order to optimize the compressed air system. These measures may differ from system to system, however, normally there are the following possibilities:

- Please check whether there are leakages in the compressed air system and localize them. Usually they occur at weld seams and junctions. (50 holes with a diameter smaller than 1 mm may cause costs of 11 000 Euro per year).
- By means of the load/unload analysis and the pressure profile the compressor regulation and adjustment should be optimized. Modern compressor operation systems help to minimize the unload times. (During unload times the compressor takes up about 30 % of the full load energy, however, it does not release any air)
- Please reduce - if possible - the pressure (a pressure reduction of about 100 kPa saves 8 % of the energy).
- Reduce the input temperature (a temperature reduction by about 10 °C can save 3 % of the energy).
- Optimize the pipe system by avoiding unnecessary pressure drops.