Energy analysis - consumption measurement - leakage calculation

DS 500 mobile - Energy analysis according to DIN EN 50001

If we talk about operating costs in compressed air systems, we are actually talking about the energy costs, because the electricity costs make up about 70-80% of the total cost of a compressed air system. Depending on the size of the system, this means considerable operating costs.

Even in smaller systems, this may quickly add up to 12,129 $ to 24,258 $ per year. This is an amount which can be considerably reduced – even in case of well operated and maintained plants. This will also apply to your compressed air system without a doubt!

Which are your actual costs per generated CF air? Which energy is gained due to the waste heat recovery? What is the total performance balance of your plant?

What is the differential pressure of individual filters? What is the humidity (pressure dew point)? How much compressed air is consumed?

Although compressed air is one of the most expensive forms of energy, there are often enormous energy losses in factories, especially in this area.

They are mainly caused by the following factors:

- **Disuse of the waste heat**
- **Leakages of up to 50%**
- **Missing compressor control system**
- **Compressed air losses**

Lots of systems are not adapted to the actual demand or they are in need of repair. Leak curing programs could save about 1,7 million tons of carbon dioxide emissions per year. (Source: Fraunhofer Institut, Karlsruhe, Germany).

So there is a considerable amount of possible energy savings slumbering in the compressed air lines of lots of enterprises. To tap into this, the heat generated during compressed air generation should be used to heat the space or to heat water.

Furthermore, it is important to optimise 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 after only a short period of time. Losses due to leakages within the pipe network incur high costs.

This table shows the annual energy costs incurred by leaks:

Hole diameter	Air loss at		Energy loss at		Cost at	
Inch	87 psi (1/s)	174 psi (1/s)	87 psi (kWh)	12 bar (kWh)	87 psi ($)	12 bar ($)
0.0016	1.2	1.8	0.3	1.0	174	580
0.0047	11.1	20.8	3.1	12.7	1.798	7.368
0.0079	30.9	58.5	8.3	33.7	4.815	19.552
0.0120	123.8	235.2	33.0	132.0	19.146	76.586

(Source: compressed air efficiency, 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 precisely measured with consumption meters. Contrary to compressed air, a water leak is visible for all to see straight away and therefore fixed immediately. Leakages in the compressed air network „blow out" unnoticed, even on weekends and during production stops.

The compressors continue to run during this time just to maintain a constant pressure in the network. For mature compressed air networks, the leak rate can be between 25 and 35 percent. They are the most industrious consumers working 365 days a year.

Not considered in these considerations are the costs of "producing clean and dry" compressed air. Refrigeration and adsorption dryers dry the air with significant operating costs, which then "blows out" uselessly.

With ever-increasing energy costs, these potential savings must be used more and more to stay competitive within the market. Savings potential can only be exploited if the consumption of individual machines or systems is known and made transparent for all.

When introducing an energy management system according to DIN EN 16001, all consumers have to recorded in the first step. This gives the user an overview of what is being consumed. This transparency makes it possible to deliberately intervene and save energy. In compressed air systems this means, in the first step, to detect and eliminate leaks.

Especially for the complete monitoring and consumption analysis of compressor stations and compressed air lines we developed a portable measuring system, the DS 500 mobile. DS 500 mobile meets with all requirements for analyzing a compressed air system.

In addition to the evaluation of standard sensors such as for example:

- **Flow meters,**
- **Pressure dew point,**
- **Pressure,**
- **Differential pressure,**
- **Absolute pressure,**
- **Temperature sensors**

The connection of all kinds of third-party sensors such as: (Optik)

- **Pt 100**
- **Pt 1000**
- **0/4…20 mA**
- **0-1/10 V**
- **pulse**
- **RS 485 Modbus etc.**

is also possible. One of the main advantages of DS 500 mobile is the possibility to connect not only clamp-on ammeters but also external power meters, water meters or heat meters. As such, the current costs can be included very accurately in the analysis and typical figures of a compressed air plant can be determined.

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 CF of compressed air**
- **Specific output in kWh/CF**
- **Consumption of single compressed air lines including summation**
- **Indication of Min-Max values, average value**

If the minimum values rise continuously 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, vapor etc. can be recorded in this evaluation. This creates transparency.

So all energy and flow meters for compressed air, gas, water, vapor and so on can be recorded and evaluated. The customer gets the costs in $uro.

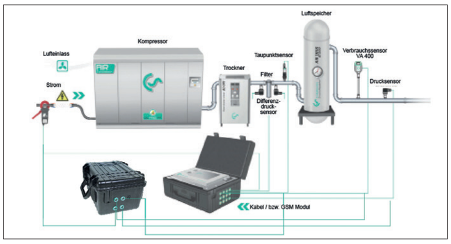
On the big 7" colour display with touch panel, all information is visible at a glance. By means of the evaluation software CS Soft Basic all data can be evaluated online at the PC via a USB stick or Ethernet.

Additionally to the consumption analysis as daily/weekly or monthly report an alarm can be sent by e-mail or SMS in case of threshold value exceedance.

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,**
- **Idle,**
- **Stop time,**
- **Compressor load in %,**
- **Number of load/unload cycles, specific output in kWh/CF,**
- **Costs in $/CF**

2.2) System analysis (current measurement and real consumption 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 consumption 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 carried out during production-free time (shutdown, weekend, holidays). The flow meter VA 500 measures the actual supplied quantity. The compressor delivers compressed air during this down time, in order to maintain a constant pressure.

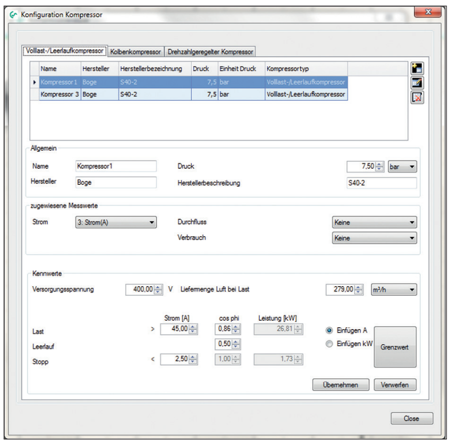
According to statistics, even if production is carried out day and night, there is at least one short period of time during which all load is switched off. By means of this data, the software defines a calculated leakage rate and calculates the incurred leakage costs in $.

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:

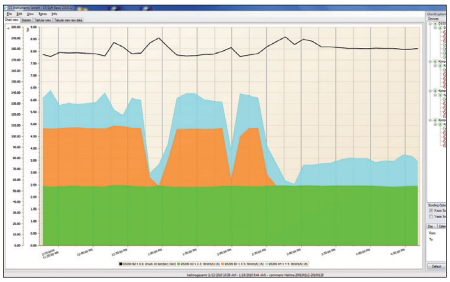
- **Selection of compressor type (load/idle resp. variable speed drive controlled)**
- **As well as entry of the performance data according to data sheet**
- **Period of measurement**
- **Costs in $ for 1 kWh**



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 cross lines function peak 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.:

- **Electricity costs**
- **Compressed air costs**
- **Leakage costs in $**
- **Compressor data with load / idle times**
- **Specific output in kWh/CF**
- **Costs per CF in $**

Energie- und Kostenauswertung

Zeitspanne: 12.01.2010 10:39 - 19.01.2010 09:44
Zeitspanne in Stunden: 167,1
Durchfluss Gesamt: Summe ausgewählter Kompressoren
Leckagegrenzwert: 128,00
Tarif 1: 06:00 - 19:59, 0,15 Euro
Tarif 2: 20:00 - 06:00, 0,11 Euro

Kompressor	Auslastung [h]			Schaltungen		Energie					Durchfluss			Kosten [Euro]					Leckage		
	Last	Leerlauf	Stopp	Starts	Last / Leerlauf	Last [kWh]	Leerlauf [kWh]	Stopp [kWh]	Summe [kWh]	Spez. Leistung [kWh / m³]	avg [m³/h]	Max. [m³/h]	Summe [m³]	Last	Leerlauf	Stopp	Summe	Kosten pro m³	avg [m³/h]	Summe [m³]	Kosten [Euro]
C1: Kompressor1	30,8	0,1	136,2	11	19	995,81	1,48	0,08	997,38	0,126	51,44	279,00	7900,82	142,19	0,20	0,01	142,40	0,018	---	---	---
	18,43%	0,08%	81,49%			99,84%	0,15%	0,01%	100,00%					100,00%	0,00%	0,00%	100,00%				
C2: Kompressor 3	54,2	0,5	112,4	33	57	1685,57	5,46	0,74	1691,77	0,116	90,46	279,00	14626,06	242,33	0,75	0,10	243,18	0,017	---	---	---
	32,41%	0,30%	67,29%			99,63%	0,32%	0,04%	100,00%					100,00%	0,00%	0,00%	100,00%				
C3: Kompressor2	119,0	0,7	47,4	69	69	2267,35	2,57	56,35	2326,27	0,093	161,68	414,19	24926,47	312,09	0,35	7,49	319,92	0,013	---	---	---
	71,21%	0,44%	28,35%			97,47%	0,11%	2,42%	100,00%					98,00%	0,00%	2,00%	100,00%				
Zusammenfassung	203,9	1,4	296,0	113	145	4948,74	9,51	57,17	5015,41	0,112	303,58	972,19	474533,5	696,61	1,29	7,59	705,50	0,016	9,18	1416,43	195,72

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 0.039 inch may cause incur of $ 13,341per year).**
- **By means of the load/idle analysis and the pressure profile the compressor regulation and adjustment should be optimized. Modern compressor operation systems help to minimize the idle times. (During idle times, the compressor takes up about 30 % of the full load energy, however, it does not release any air)**
- **Reduce the input temperature (a temperature reduction by about 50 °F can save 3% of the energy).**
- **Optimize the pipe system by avoiding unnecessary pressure drops.**