A Matter of Choice

Reduced air costs using optimized compressor controllers

What does an air center have in common with a symphony orchestra? The answer is that overall quality is not judged on outstanding soloists but rather on the harmonious performance of the whole. Experienced compressor manufacturers such as Kaeser are now able to offer tailor-made, highly economical compressed air supplies to the beverage industry. As well as the correct design and planning of a compressor package, it is not just the master controller, but also the internal controller that plays an important part in more efficient air production.

In the main, there are five internal modes of control that are used: Dual Control, a full load-idle-stop/start control; Quadro Control, that varies between full load-idle and full load stop/start; Vario Control, that controls the compressor continuously according to compressor load; Proportional Control, that regulates using the inlet valve and Variable Speed Drive. Three of these variants have proved themselves in practice to be the most effective: Dual Control, Quadro Control and Variable Speed Drive in the form known as Sigma Frequency Control (SFC).

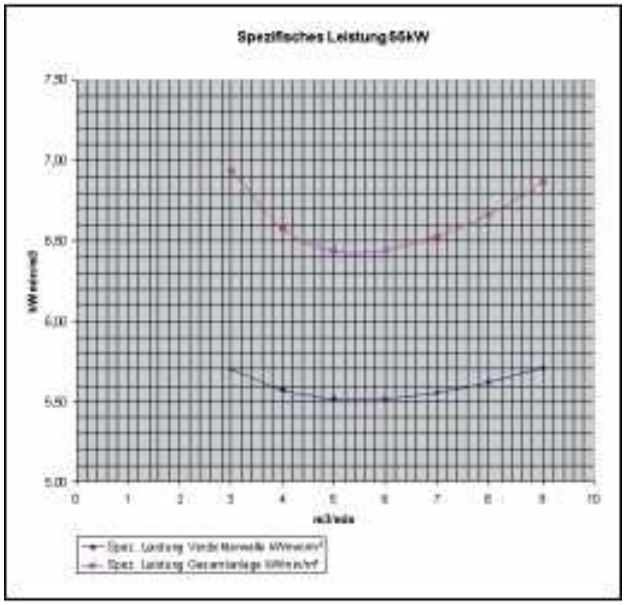
Efficiency at a reasonable price: Dual and Quadro Control

One of the most efficient and reasonably priced types of control is Dual Control. If the air demand fluctuates severely then a form of control that can automatically choose between full load-idle-stop/start operation is recommended (Quadro Control) This intelligent variant is only slightly more expensive and can reduce the power consumption of the compressor at a 50 percent duty cycle compared with full load to less than 60 percent.

A control with a large variation width: SFC variable speed drive

In certain applications the use of variable speed drive can be of advantage. When a defined minimum pressure limit in the air system is reached, the compressor starts and its speed varies in accordance with changes in the air main in an attempt to maintain constant pressure. If air main pressure continues to rise, despite the compressors lowest speed, the compressor is vented when the maximum pressure limit is reached and switches to idling mode for approximately one minute If the pressure does not fall to the minimum limit during this period then the compressor package is stopped. Theoretically the motor starting frequency is infinite because it is stopped and started at a low speed. However, such machines still need a short run-up and run-down period of approximately one minute. For this reason, motor starting frequencies of > 1/min should be regarded as unrealistic.

Whereas the definition of the power characteristic for Dual and Quadro Control is relatively simple, several influences play an important part on variable speed drive packages. Because a characteristic curve is followed for a certain speed range, the power characteristic of the package should always be represented such that specific power over capacity (speed) is shown. Only this form of representation reflects the actual power characteristic of a variable speed drive package. Graphs that only show power over capacity only represent the power characteristic in a linear form. This means that they do not visually show the true costs of a control type and can lead to errors in the assessment of costs. The electrical efficiency of the motor, the frequency converter and the airend over the speed range give the specific power characteristic of the package at the particular air delivery concerned, referred to the overall power consumption of the package. It is represented as a curve in the shape of a U.



Influence of electrical losses on a screw compressor's performance/speed ratio

The advantage of the Kaeser SFC system is that it can be fitted to 15 different compressor models. This has proved to be particularly advantageous when individual compressors are allocated directly to a compressed air consumer, such as is the case of inert gas production. The user can select a suitable compressor package for almost all applications. Air stations that include a variable speed compressor can be finely tuned to exactly match demand.

Thanks to careful design and selection of airend and drive system, industrial compressors are able to reach stands of efficiency hitherto unknown. The Kaeser model DSD 141 SFC, for instance, with a 75 kW motor turning the airend at 1800 min^{-1} can continuously deliver almost 15 cubic metres per minute at 7.5 bar.

A tailored air center concept

During the planning of an air center, the minimal pressure fluctuations of only ±0.1 bar can be efficiently utilized. However, indispensable conditions for this are sufficient buffer capacity that should not be reduced at any price, and pressure fluctuations that are limited to the control range of the variable speed drive system.

a) Conventional concepts

Conventional splitting solutions that divide the air demand of a factory between one compressor package and a standby or between two compressor packages of the same size and a standby do not correspond to the state-of-the-art anymore. These configurations can only offer the advantage of a smaller floor space requirement. When one takes into account the cost of a standby package, then not even the cost of investment is lowest. Power costs, idling mode costs, controllability and the flexibility of these configurations must be regarded as worthy of improvement from the modern point of view or even as being inadequate. In other words; a modern air center should never be designed this way these days.

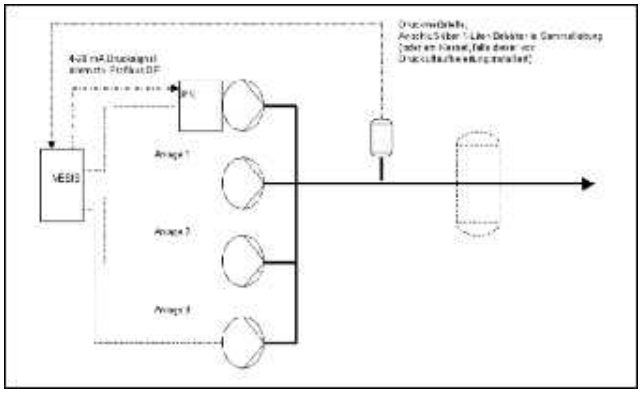
Quite often our competitors offer a configuration in which a base load compressor, a standby compressor and a variable speed drive compressor of the same size are intended to cover the compressed air consumption. What they always forget is that a variable speed drive machine cannot regulate the air supply down to zero, so that so-called control gaps are created. The result is high power costs and sometimes even higher investment costs. In addition, there are increased idling costs - not the controlling compressor's but those of the subordinate compressors - inferior controllability and restricted flexibility. According to the modern understanding of air main networks such configurations must be regarded as being design errors.

b) Up to 30 % power savings with optimized splitting

In contrast, compressor package splitting as practiced by Kaeser has proved to be very efficient. Two or three small, dual controlled peak load compressors of the same capacity combined with larger medium load and peak load compressor packages, whereby the overall capacity of the peak packages must be a little larger than the following package. With this configuration the power consumption during idling is reduced to one to two percent of the overall power consumption of an air center. Compared with conventional solutions, up to 30 percent of the power consumption can be saved in this way. In addition, considerable savings can be achieved because of the use of smaller compressors and, therefore, smaller standby compressors, because of the lower purchase price. The optimized controllability of this system even allows flexible matching of the compressor packages to heavily fluctuating air consumption. The only disadvantage lies in the rather larger floor space requirement, a fact that is easy to accept in view of the advantages listed above.

SFC: an alternative to splitting

Another interesting way of matching the performance of an air center precisely to the air demand of the user is to use SFC system. Maybe the investment costs for this solution are a little higher, but the return on power costs, idling costs and controllability and flexibility can be set up individually and are well worth it. However, care must be taken on all peak load concepts to ensure that the conventional division of base load and peak load functions is more or less overridden. This means that the peak load, or better, the variable speed packages attain the highest runtimes, sometimes up to 8760 hours annually because they are started first and stopped last. It is wrong to believe, however, that with variable speed packages a master control system can be saved, because obviously, in all multiple compressor package configurations the interplay of the individual compressors in an air center must be coordinated carefully. These systems can include intelligent master sequencers such as MAC 41, MVS or VESIS.



Compressors linked via Profibus DP with network-capable VESIS master control system and a linked SFC package

The way to improved economics - ADA and KESS

The capacity of the compressors already installed is important during assessment of the economics of various compressor package configurations. Compressors reach varying degrees of efficiency according to their size under full load and partial load conditions.

By no means can know-how on these interrelationships save the detailed calculations that are required where the concrete design of an air center is concerned. These are made easier with the help of a detailed air demand analysis (ADA) and Kaeser's computer-aided energy saving system (KESS).

Individual check

The solutions introduced here show the optimal variant in each case. Of course, changes can be made here or there, depending on requirements, so that a tailor-made concept can be offered to the user. In this regard, however,

technical control criteria such as the consideration of certain control ranges or compressor package capacities can never be ignored, otherwise a control gap could occur.

Further criteria that must be considered during design are the influence of air receivers and their size, fluctuations in air consumption, their prevalence and rate of rise or fall. In this respect, Kaeser has a wide range of options. Available are three master control systems, five programmed control modes in Sigma Control, the internal compressor controller, 15 compressor packages of different capacity that can be supplied with SFC as standard, 29 screw compressors of different capacities together with the use of airends in the correspondingly most economical speed range. This enormous selection ensures that the right configuration for every user can be found. Because of this multiplicity an air demand analysis and an evaluation according to KESS should precede the planning of an air center. This simplifies the selection of right variant for each application, helps to prevent design errors and saves considerable costs.

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