More on compressed air systems

THREE PRIMARY USES OF COMPRESSED AIR

- Power source;
- Part of a process;
- For control;

It is an inefficient source of energy, once considered free, though today it greatly contributes to the per-unit cost of a facility's products and should be used wisely.

Traditional compressed air system management

The general opinion is that the traditional management needs to be questioned and reexamined when dealing with compressed air systems. This type of management usually includes putting the plant production first, the compressed air supply needs to be maintained, over supply is considered acceptable, under supply not acceptable, and pressure needs to remain between certain minimum and maximum levels.

System management based on new insights

Newer insights point out that plant productivity (not production) needs to be a high priority, air demand must always be supplied, compressed air supply needs to be in balance with demand, and compressed air pressure must be stable and within predefined limits.

Compressed Air Systems Optimization Opportunities

- A generic compressed air system comprises three major areas –supply side components, demand side components, and a transmission system.
- The supply side usually consists of equipment for generation and treatment of compressed air, such as compressors, storage receivers, driers, filters, etc.
- The demand side consists of compressed air consumers.
- The transmission system includes the piping system and all additional components that connect the supply and demand side, such as driers, filters, tanks, control valves, etc.

Similar to the Steam System Optimization programme, one of the key elements in achieving results by optimizing a compressed air system, is using a systems approach in evaluation and understanding the system's state. This approach focuses on the entire system performance rather than on a single component efficiency exclusively.

Compressed air is defined as pressurized atmospheric air with molecules in constant motion, measured in kPa, bar or psi. It is a common method of transmitting energy to pneumatic tools and devices. Compressed air is also dependent on pressure, temperature and relative humidity. A key benefit is that compressed air energy can be stored, however, the usable stored amount is highly dependent on the tank's volume and pressure differential between storage pressure and minimum system pressure requirement. Another key point: as it is transmitted from one location to another, pressure loss is irrecoverable loss of energy.

Compressed Air System Optimization is usually based on the following targets and goals: cost effective reduction in energy use, improving system reliability, consistent pressure to support production and eliminating compressed air related downtime.

The three basic ways to optimize compressed air consumption are to produce the compressed air more efficiently, to consume it less, and to utilize the heat of compression.

Air compressors often do not run at full efficiency due to poor control and lack of storage receiver capacity, which is why properly implemented control strategy is needed for optimization. It is also necessary to minimize irrecoverable pressure loss, as well as reduce leakage loss in the system or eliminate inappropriate use of compressed air, in order to achieve system efficiency.

Compressed Air Systems Optimization Opportunities

Data collection & analysis:

Measurement system accuracy depends on human factors, connections, equipment such as wiring, cables, data acquisition hardware and software, along with measurement techniques.

Losses

Some of the most significant sources of wasted energy in a compressed air system are leaks, which sometimes take up to 25%-30% or even 50% of produced compressed air. Artificial demand, which is mostly due to higher operating pressure, unregulated CA use, leakage, motors etc. is also a source of wasted energy, amounting up to 15%, while inappropriate uses amount to 10% of total losses. Only 50% belong to production.

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There are two main categories of compressors, positive displacement and dynamic. Centrifugal (dynamic) are most common and most demanding when it comes to regular maintenance. When the system uses both categories, special attention to control strategy is needed, otherwise poor routine maintenance leads to expensive failures of major components.

When it comes to components, there are several known optimization measures such as using pressure transducers and high-speed sampling to capture pressure dynamics since preassure gauges have a slow response to pressure changes and minimizing the use of hoses for connections where possible or select their size based on the inside diameter and peak airflow rate. Hose barbs and pipe clamps should be avoided as they are dangerous, restrictive and often develop leaks. It is preferable to size the equipment based on peak and not average airflow rate.

It is necessary to maintain system operating pressure, otherwise, compressed air demand at leaks and unregulated air demands increase. Leakeage can be reduced by lowering system pressure, the target being the lowest optimal pressure for supplying productive air demands. Pressure limits form the operating envelope of the pressure profile. Since the high limit should not be exceeded on the demand side, use points that require high system pressure should be evaluated, piping use points which cause excessive pressure loss should be eliminated, dynamic supply pressure to end-use pneumatic devices should be regularly checked. Restrictions such as air dryers and filters can additionally impact compressor control.

CASO in North Macedonia

- Compressed air Systems Assessment was conducted within the GEF-UNIDO project in North Macedonia, in several companies, among which TITAN Cementarnica Usje AD.
- With help from the international CASO experts and facility's engineers, several potential opportunities for reducing energy consumption were identified, such as:
- Improving piping, changing controllers, regulating pressure & refill control, as well as evaluating dew point requirements after implementation of said measures on surge station; evaluating individual dust collector performance on all dust collectors; evaluating unloaded power, checking power factor and evaluating electrical supply & assessing power quality if needed on certain compressors; locating piping restrictions that cause excessive pressure loss, reducing average discharge pressure, investigating the cement dust particle size that will potentially enter the air compressor intake, repairing leaks etc.
- Additional potential energy savings opportunities identified include an evaluation of actual performance and the impact of winter season operation to determine if lower pressure dew point is truly required, upgrading intake air filtration etc.
- The findings for Usje showed that the present control and maintenance strategy provides good system efficiency, and any and all changes would be long term objectives.
- The assessment in the remaining companies is still in session.

IMPORTANT

The Gas laws: Boyle's, Charles' amd Amonton's, and the principles of absolute pressure, atmospheric pressure, gauge pressure, FAD or metric volume flow rate, are the basis on which compressed air system optimization opportunities are built.

Compressed air systems are dynamic, interactive systems, and this interaction usually impacts the overall system efficiency. It is necessary to consider a combined effect of demand side improvements and control strategy changes to achieve energy savings.