Compressed air energy savings in the glass industry

Fig 5. An energy monitoring dashboard provides real time feedback

Pascal van Putten* describes how energy management data plays a huge role in creating employee awareness about responsible energy use in a glass plant.

In glass packaging plants, compressed air is a key utility for the production of virtually any type of glass container. In a typical glass packaging plant the demand for compressed air can easily exceed 30,000 to 35,000 Nm^3/hr. At 1 to 2 cents per Nm^3, and given the fact that most plants operate 24/7, this results in an annual energy bill of €3 to 6 million(1). With these figures, every percentage counts, and proper management of compressed air pays off rapidly.

Since compressed air accounts for about 30% of the total electrical power consumption of a glass plant, it makes sense that reducing compressed air consumption is a priority. Most glass plants have separated compressed air networks: A high-pressure network (between 5 and 7 bar) for driving the machines and a low-pressure network (between 2 and 4 bar) for blowing into the moulds.

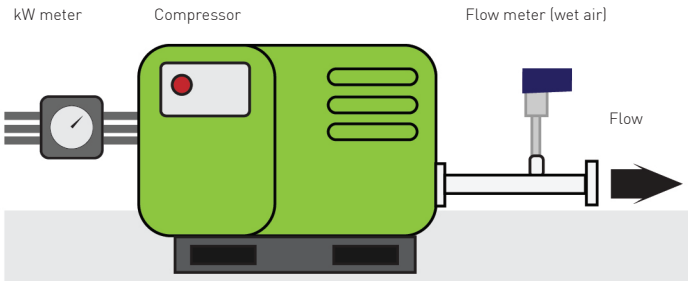

Fig 1. Permanent condition monitoring of a compressor with kW meter and Flow meter (suitable for wet compressed air).

Common issues with compressed air systems in glass plants are:

- Bad efficiency of centrifugal compressors, due to lack of maintenance.
- Bad overall efficiency, due to wrong configuration of the control system.
- High inlet temperatures of the compressors due to the location of the compressor house.
- Old pipework with too many branches, due to add-ons over time.

(1) The 1...2 Eurocent is an European average number, based on various studies. Costs can be influenced by kWh price for electricity, running hours, compressor efficiency and demand fluctuations.

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- Leakages in production equipment.
- Downtime waste of compressed air during machine maintenance, mould exchange.
- Misapplication of compressed air: cooling in the processes downstream or near furnaces is commonly found.

Compressed air flow meters provide data to maintain efficiency in the machines and compressors as well as rapidly detect any compressed air leakages. Compressed air flow meters can also put a financial number on misapplications and help to calculate the potential return on investment. They should be a three-in-one type combined with pressure and temperature measurement, to get the complete picture. Combined with an overall energy monitoring system, they help plants to establish energy savings. In some cases, 30 to 50% energy savings on compressed air have been reported. The next segment of this article highlights some practical examples.

Fig 2

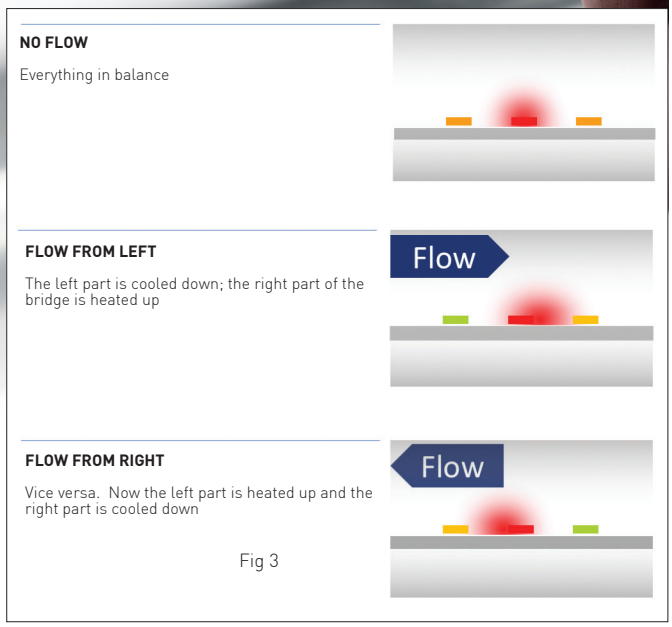
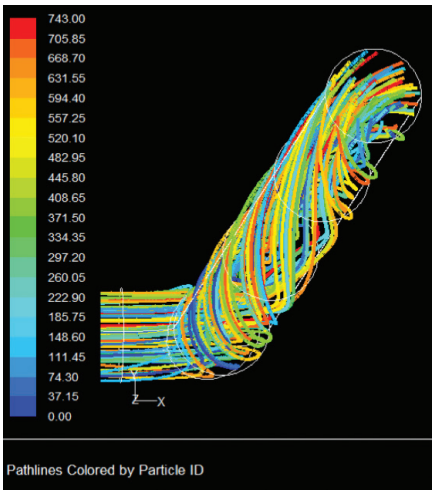


Fig 3

▶ Fig 2 and 3. Bi-directional three-in-one flow meter and the bi-directional measurement principle



▼ Fig 4 . Wrong installation can result in errors. In this CFD simulation, the swirl is shown, which occurs right after a double 90-degree elbow

Compressor control system

Compressors in most factories are installed in dedicated compressor rooms. The compressor rooms can contain multiple types of machines, grouped together. Most compressors in glass plants will be oil free. Typically, centrifugal compressors combined with screw compressors are used, which generate compressed air for the high and low pressure network.

Common issues when combining centrifugal machines with screw compressors are related to the master control system, or the lack thereof. In some older plants, cascade type controls are found, which may lead to unwanted blow-off of the centrifugal machines, or short-cycling of a screw compressor when demand changes.

A flow meter is needed to determine the real demand profile at the main header. This is a crucial step to determine the right combination of compressors and the optimal control sequence. A properly configured sequencer can make the right decision which compressor combination is best to meet the actual demand. There are also sequencers available which combine flow and pressure measurement, to make the right selection of compressors.

Condition monitoring

A flow meter combined with a kW meter can be used to calculate efficiency, which is the most common key performance indicator to check the condition of a compressor over a longer period. It is important to realise that this type of efficiency trending is not the same as official performance testing. One must be aware that an official performance test at the compressor manufacturer's test lab will show different numbers than in the field. When installed, there are external factors which can result in another efficiency number. For example, centrifugal compressors are sensitive for inlet temperature and inlet pressure. An undersized fresh air supply duct or extreme heat in the compressor room can influence the performance dramatically. One should always consult an independent compressor auditor before skipping to a conclusion regarding the efficiency.

As centrifugal machines are sensitive to inlet pressure, temperature, intercooling and backpressure, it is beneficial to monitor their output flow continuously. For example, when the inlet filter will be clogged the output flow at a given input power will go down. When it reaches a certain number, it is time to change the filters. The efficiency data will also reveal intercooling issues, inlet temperature-related issues. In one case, a flow meter combined with kW meter saved a glass plant around €35,000 per centrifugal machine per year. This required an up-front investment of €5,000 per compressor. The return on investment was less than two months!

Flow meters

Flow meters can be placed downstream, in the supply lines to the production machines. They can detect changes in air demand in real time. When flow data is correlated to machine output (in containers per day) an 'air/product' efficiency ratio can be determined. This

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ratio is a key performance indicator used to compare identical production lines, or even compare multiple glass plants on their performance (***Fig 1***).

Issues found with flow meters include:

- Major air leaks in or under the (hot) IS machines, which cannot be seen;
- Reverse flow due to wrong supply pipe design;
- Waste of air during machine maintenance and stops.

Bi-directional flow meters

Bi directional compressed air flow meters can sense the direction of the compressed air flow. This is important when monitoring complex networks with multiple compressor rooms. In these cases, due to pressure fluctuations in the network and changes in demand, the compressed air can move back and forth into receiver tanks. If this is ignored, wrong conclusions can be drawn which may lead to wrong measures. In factories with ring networks and/or multiple compressor rooms, bi-directional flow meters are the prescribed technology for proper measurement (***Fig 2/3***). Issues that can be revealed include Leaking non-return valves on compressors; Leaking gaskets on air treatment equipment and interference of large air demand with low air demand at certain branches in the network.

Accuracy

Insertion style flow meters are easy to install without having to shut the compressed air system. However, to have these meters take accurate measurements, a straight length of pipe before and after their location is necessary.

It depends on the type of object (bend, two bends, diameter change) and how much length is required to straighten out the flow profile. In complex cases, VPInstruments can help determine which locations are best to install the flow meters, to gain accurate and representative data. CFD is used to predict the measurement error (***Fig 4***).

But how accurate do you need to be when just recording trends? In case of a systematic error, flow meter can always be used to trend the demand, and to see the ratio between leakage and production flow. This is always far better than not trending the demand at all.

Creating awareness

In a modern production environment, energy management data plays a huge role in creating employee awareness about responsible energy use. Real time or daily feedback of efficiency numbers to the production floor, combined with an incentive programme can help to reduce the general waste of compressed air and other utilities. When displayed in the right manner, an energy dashboard will inspire the employees to reduce energy consumption. Factories that offer incentives to reward people for their savings plans create a winning environment for energy savings; it becomes part of their daily habits (***Fig 5***).

Conclusions

- Flow meters and energy monitoring systems are key to reduction of compressed air consumption in a glass plant.
- Combining three-in-one mass flow meters with kW meters provide a powerful KPI to trend compressor performance.
- Factories that implement continuous awareness and offer incentives to reward people for their savings plans create a winning environment for energy savings. ■

***CEO, VPInstruments, Delft, The Netherlands**
www.vpinstruments.com