How to Improve Forming and Save Energy

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Pneumofore

Life cycle cost: we always win

How to Improve Forming and Save Energy

«Depending on local conditions, almost 50% of the glass cost is energy». This basic principle is the key to understanding why it is so important to reduce the use of energy during glass container production. Reducing energy costs allows us to work on the largest component of finished product cost. Energy is an essential component in glass manufacturing and it comes in many forms. In this article, we examine the electrical power, used to generate the huge flow of compressed air necessary to operate the IS machines of every manufacturer.

The generation of compressed air, in both high and low pressure lines, is achieved using air compressors and it is common to find utility rooms with 600-800 kW of installed power in glass factories. The total compressed air consumption depends on the specific settings of the IS lines thus making every single glass factory a unique case.
However one element is common to all glass works: the generation of compressed air takes a big bite out of the power bill of the factory.
Let's make a simple calculation:
Cost of power: approx 0,12 Euro/kWh (in Italy).
Assuming 8.700 working hours in one year, hence every single kW costs 1.050 Euro/year.
If we go back to the total consumption of the air compressors and we assume that we have an installed power of 800 kW with a real power consumption of approx 700 kW (depending on the loading/unloading cycles and assuming approx 90% on loading condition), than the pure cost of the energy used by air compressors is 730.000 Euro/year.
Of course, energy cost varies significantly from one country to another and it can be very different. Unfortunately, energy in Italy is one of the most expensive in Europe and there are no signs of improvement on this issue. However, even adapting the energy cost to what is typical in France, one of the best cases in Europe, and considering a value of 0,07 Euro/kWh, the same calculation would produce a total cost of approximately 426.000 Euro/year. Still a serious amount of money.
Thus the question: is it possible to use less air and to shut down part of the air compressors?
The answer is yes and the purpose of this paper is to analyze the use of vacuum not as a replacement of compressed air but as a combined force able to reduce the consumption of air and, at the same time, to help the forming process of the containers.

What do these bottles have in common?

Picture 1 - 66cl capacity beer bottles, Chinese and Italian production

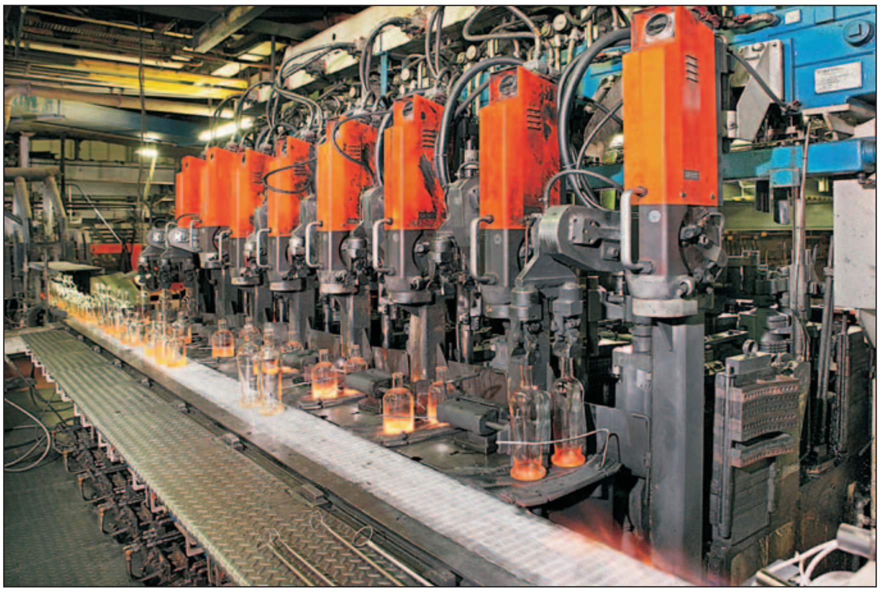
Very little if we exclude that they are both made of glass and they have the same capacity of 66 cl.
The bottle on the left is made for Tsingtao, probably the most popular Chinese beer, available almost everywhere including Chinese restaurants all over Europe and other countries. Tsingtao is the fifth largest brewery in the world with a total volume of 50 Million hectoliters in 2009.
The bottle on the right is the proprietary bottle of "Birra Peroni", a common Italian beer, found in every super market.

Picture 2 - 522 grams vs 283 grams

The weight difference is astonishing (-45.7% of glass) and there is a lot of "technology" and development to go from the green bottle weighing 522 grams for 66 cl. to the amber bottle that uses only 283 grams of glass for the very same capacity. This "technology" covers every single aspect of container making and starts from the right mix all the way to the lehr. However in the IS lines one essential player in light weight containers manufacturing is the use of vacuum assisted forming.

Vacuum on the blow side

The use of vacuum on the blow side is one of the most common applications. It has been in use for years, it requires moulds with



Picture 3 - IS machine in operation producing different containers (courtesy of Bottero S.p.A.)

vacuum vents and channels and the IS machine must be arranged for the use of it. Today, all IS manufacturers propose vacuum on the blow side as a standard feature. Vacuum is achieved through a series of tiny venting holes connected to channels in the sides of the mould and are evenly distributed on the upper part of the container beginning at the height of the shoulder of the bottle and going up towards the neck. They are often hidden in the engraving, when this is present, and in this case vacuum also helps the movement of the glass inside the small groves that will give the bottle its proprietary look. The diameter of the vacuum venting holes varies from a minimum of 0,4 mm to a maximum of 0,7 mm. The diameter is an option of the mould maker and it depends on the container shape and use.

Vacuum works as an additional force, together with the blow of compressed air and the combination of push & pull of the two actions helps the forming process by increasing its speed, contributes to an even distribution of the glass on the side of the container and allows to reduce the gob weight.

Removing the air that remains entrapped between the side of the container and the side of the mould also helps to remove the heat from the mould keeping its temperature under control.An additional benefit of the use of vacuum is that it allows to slightly reduce the use of compressed air that is, at least partially, replaced by vacuum. Reducing the blow of air reduces the use of compressed air thus saving energy.

One of the systems used to show the "vacuum at work" in glass forming is to stop the action of the blow head of the IS machine. In this case only vacuum is used to form the container. The effect of a good vacuum on the blow side is so strong that it is possible to complete the forming of the container using only vacuum. Unfortunately it is not possible to use only vacuum in the standard production because the containers would be still too hot at the end of the forming. Nevertheless it clearly shows how and to what extent vacuum can influence the forming process.

Vacuum on the blank side

Vacuum can be used on the blank side with very interesting advantages in compressed air savings as well as in the quality of the container and in the production speed.

The idea is to "pull down" the gob with vacuum instead of "pushing down" the gob with the settle blow. In this case vacuum can almost replace the use of the settle blow and experiences gathered with Quantum Engineered Products have demonstrated that the use of vacuum on the blank side may dramatically reduce the settle blow angles from usual 35/40°, down to 4 to 5°. That is about saving 85 - 90% of compressed air and time dedicated to this operation.

Cost of vacuum and cost of air

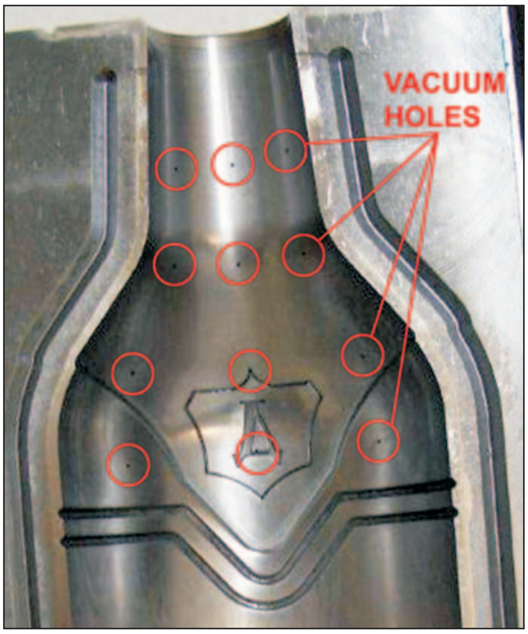
It is extremely difficult to evaluate the cost differences comparing flows. However it is possible to compare the cost of a specific operation when it is made with vacuum or when it is made with air. In short and without entering in too many details, we can state that, if and when a specific operation can be done using vacuum instead of air, than the cost to produce that energy is about one fourth of the cost to produce compressed air.

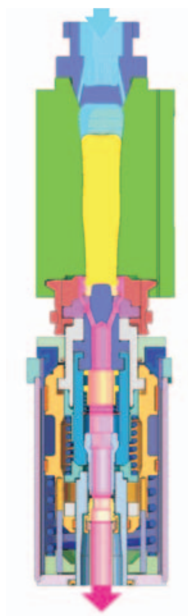
Producing vacuum efficiently

Contrary to compressed air, vacuum is difficult "to be seen", often misunderstood and even more often regarded as a "secondary utility". Furthermore, while compressed air is always produced by centralized systems, vacuum is often produced "on board" with small pumps thus not taking advantage of the possible savings of a centralized system.

Vacuum can be produced in several ways and our experience has shown that very often it is produced with poorly engineered equipment or with obsolete technologies loosing, in this way, the advantage of an alternative and cheaper force to compressed air. A vacuum pump is a piece of technology and it deserves the engineering and know-how of a high technology equipment. First of

Picture 4 - Glass mould with vacuum venting holes in the upper part (courtesy of Busellato Glass Moulds Srl)

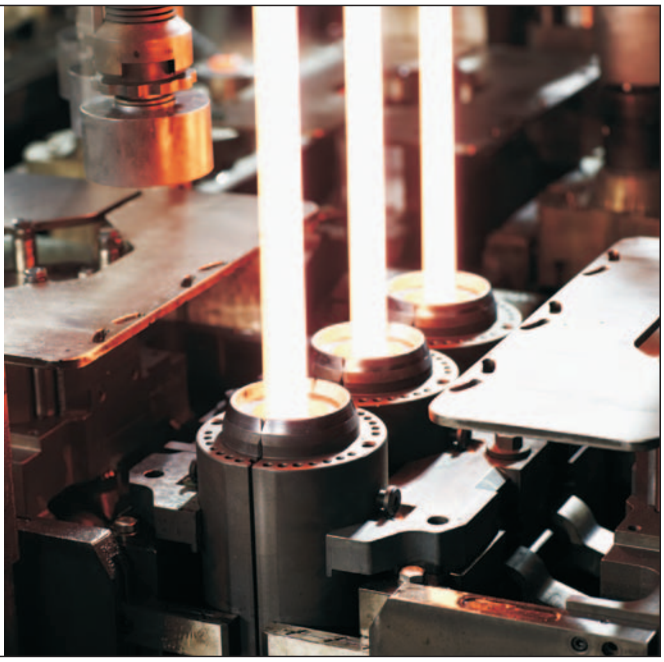




As the glass fills the finish, the vacuum also helps to cool and set the finish. With this process, the finish can be made and set with reduced settleblow. By using the vacuum to help load deeper and set the finish, the gob will flow better and easier into the finish.

Picture on the left:
Blank mould with vacuum loading
(courtesy of Quantum Engineered Prod.)

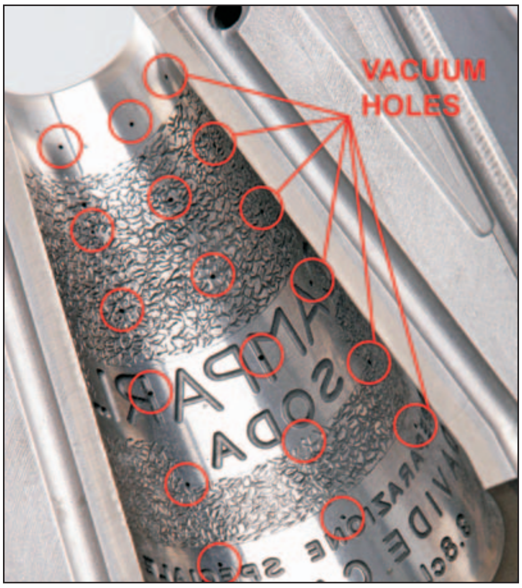
Picture on the right:
Loading gobs entering the blank moulds
(courtesy of Emhart)



all, a vacuum pump must be a vacuum pump from the very beginning of the project. The use of reversed compressors or "any" pump can bring unpleasant surprises in terms of efficiency or Life Cycle Cost of the equipment.
The rotary vane technology used in Pneumofore pumps is, by far, the most efficient way to produce vacuum in industrial applications. A rotary vane pump is designed to be a vacuum pump, while rotary screw pumps are generally compressors "transformed" into pumps. The efficiency and the consistency of performance of a rotary vane pump is just an impossible target even for the best liquid ring pumps, either with water or oil sealing liquid.
The rotary vane technology is based on the sliding movement of vanes inside the slots of the rotor. The total contact surface between the edge of the vanes and cylinder is much smaller than the total contact surface between the two screws between them and the inner surface of the cylinder. When the rotary screws come to the end of their life they must be replaced bringing a significant repair cost. A rotary vane pump can be disassembled and, after re-polishing the cylinder, will deliver again the original performance.
Pneumofore offers a wide range of rotary vane pumps, result of 85 years of experience in vacuum and hundreds of installations with thousands of pumps in operation all over the world. From polar climates to tropical locations air cooled rotary vane vacuum pumps keep delivering the same solid performance year after year of operation offering the lowest Life Cycle Cost available in this market.

Mauro Ferrero is Director of Sales at Pneumofore since 2007. His technical education and intense commercial experience make him a successful manager and member of the Pneumofore Council. The hollow glass industry is one of his strong application fields, also due to his continuous presence at related worldwide conferences and fairs. Direct contact ferrero@pneumofore.com

Picture 5 - Mould with stipped finishing and vacuum venting on all the surface (courtesy of Strada Srl)



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