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High performance cooling

Extrusion blow moulding has become more economical with the application of cold compressed air.

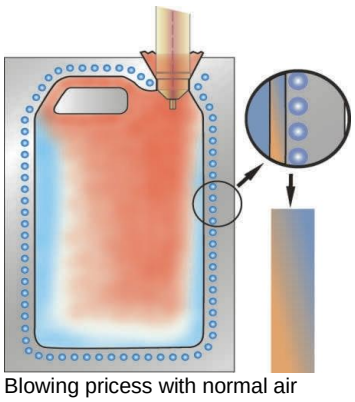
Compressed Air Chiller (CAC) – drastic reduction of cooling times in the extrusion blow moulding process and increase in production of up to 30%

Kundl (A), October 10th, 2023: Blue Air Systems, an Austrian-based company, founded in 2010, located in Kundl/Tyrol supplies the plastics industry with innovative technology. Core subject is climate technology with solutions for extremely dry and cold air for energy efficient processing in the plastics industry.

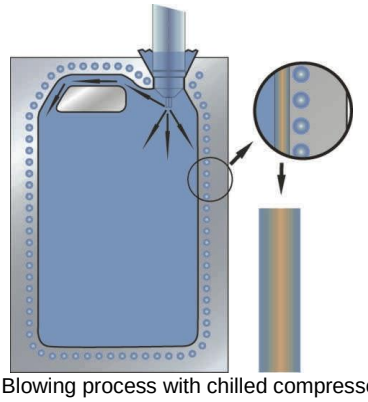
Blow moulded products are blown by compressed air and cooled by chilled water in mould cavities. Heat is transferred from the outside surface of the part to the mould surface. The internal surface of the blow moulded (hollow) part remains at a much higher temperature during the mould cooling process. The big difference between the outside and the inside surface temperature causes material stress.

The wall thickness distribution is never equal in a blow moulded part. The mould cooling is not equal on the mould surface either. Heat transfer from heavy parts of a blow moulded product through a limited mould surface is not equal to that of thin-walled parts through large surfaces. This in fact causes more material stress and distortion in blow moulded products.
Material stress leads to a bad product quality and the product may fail leak, load, or drop tests. Blow moulders are often forced to increase the wall thickness by up to 10% to pass the tests. Increasing the weight is combined with higher material cost and longer cycle time.
The cooling time, which is the longest part of the total cycle time and the blow moulding process, is often extended to get the heat from the part all the way through the wall to the mould, but a difference in the temperature is always expected. Extending the cooling time slows the production and shrinks the profit.
Lowering the chilled water temperature in the mould leads to a limited improvement. It is suggested to use pure chilled water at a temperature not lower than 6ºC [43ºF]. The chilled water flow rates are to be at a high rate to create turbulent water flow in the mould cooling channels.
Adding antifreeze to the chilled water to achieve a very low temperature has its disadvantages. Antifreeze agents normally have low thermal conductivity which lowers the heat withdrawal from the product in the mould and most of them have high viscosity which lowers the water pump performance and reduces the water flow rates.
Post cooling with internal exchange of air is applied in some cases to get rid of excessive heat inside the part after the moulding process. This in fact requires more equipment and one more step in the production. It also requires more floor space in the manufacturing facility.

Some of the stress could have taken place during the mould cooling and in the transition between the mould and the post cooling station.



Blowing pricess with normal air



Blowing process with chilled compressed air

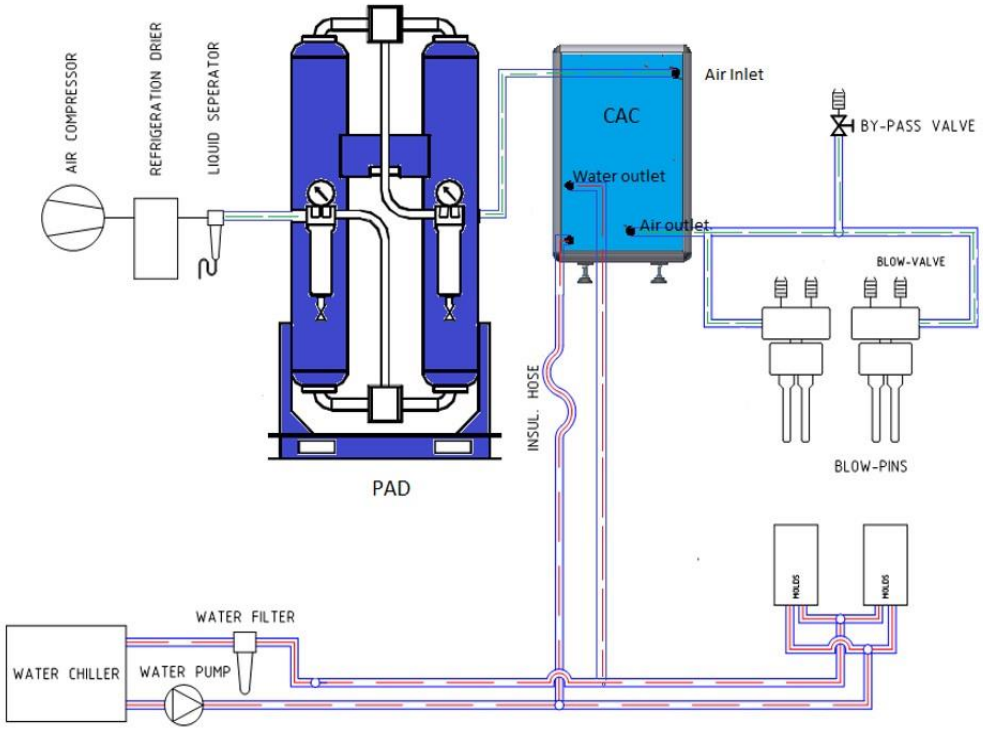
Exchanging chilled air inside the product during the cooling time to withdraw heat from the internal surface reduces the material stress and dramatically reduces the cooling time. The proper air distribution inside the product is very important to achieve the desired improvement. Blow pins and blow needles can be specially designed for individual products to guide the air to areas with thicker walls and areas which are not very well cooled by the mould. Turbulent air flow inside the product is also a very important factor. Blow valves can be designed to form the product with the highest air pressure available for the process and then drop the air pressure while chilled air is being exchanged inside the product. Sufficient pressure must be kept inside the product during the entire cooling time to keep contact between the product and the mould. Increasing the air flow improves the results but the relation between air flow and cooling time is not linear. Exchanging the air volume inside a product 10 times might lead to a production increase of 10% but a 15% production increase might be the result when the air is exchanged 20 times during the cooling time. Limiting factors such as limited size of the blow pin or the blow needles might not allow for a high rate of air exchanges. Compressed air cost must be taken in consideration. It is a fact that better cooling results are achieved with lower chilled air temperatures. However, the relation between air temperature and cooling time is not linear either. Lowering the temperature from 20ºC [68ºF] to 5ºC [41ºF] might lead to a production increase of 10% but a production increase of 15% might be the result when the air temperature is further lowered to -10ºC [14ºF]. Air temperatures below -40ºC [-40ºF] are proven to be disadvantageous.

A system injecting liquid Nitrogen or liquid Carbon Dioxide in a form of mist inside the product has proven to be very expensive and not ideal for internal cooling. It is difficult to guide the mist to the desired areas in the product and the accuracy of the injected amount of liquid is very difficult to achieve cycle after cycle. The system is also hazardous and complicated. The dependence on liquid supply and the increasing liquid prices are also factors to be considered.

The ideal and most profitable blow moulding process is that which includes an internal cooling system with acceptable air flow, acceptable temperature, not higher than 5ºC [41ºF] but not lower than to -35ºC [-31ºF], and good, turbulent air distribution.

Extrusion blow moulding – a remarkably improved production method with the CAC

The Compressed Air Chiller is used to chill the compressed air for the blowing process to a temperature of -35°C (-31°F). The units are set up in the existing compressed air line.



The compressed air must be dried to a dew point lower than -40ºC [-40ºF] before it is chilled in the heat exchanger (evaporator) of the integrated chilling unit. This is achieved with a process air dryer (PAD) The CAC units require a good quality of compressed air supplied with a pressure dew point not higher than 10ºC (50ºF) and an oil content lower than 0.05ppm. This is a standard air quality in a standard compressed air supply system with refrigeration dryer, a functioning moisture separator and standard oil filters.

There are 5 sizes of the CAC refrigeration unit, starting from 120 Nm³/h (71 cfm) to 540 Nm³/h (318 cfm). To choose the needed volume of chilled air, a calculation is done by using the number of parts produced per hour, the blowing pressure, and the volume of the product.

Supplied CAC systems to many convinced customers prove the high economical advantage

The highest production increase and reduction in cooling time can be achieved, when the CAC is applied to a product that has a longer cooling time.

Jerry Can:

Weight:	2.100 g	Compressed air consumption:	190 m³/h
Volume:	25 l	Compressed air temperature:	- 36°C
Material:	HDPE	Cycle time before:	39 sec.
Cycle time reduction: 20%		Cycle time after:	31,3 sec.

Production increase: 25 %

Jerry Can:

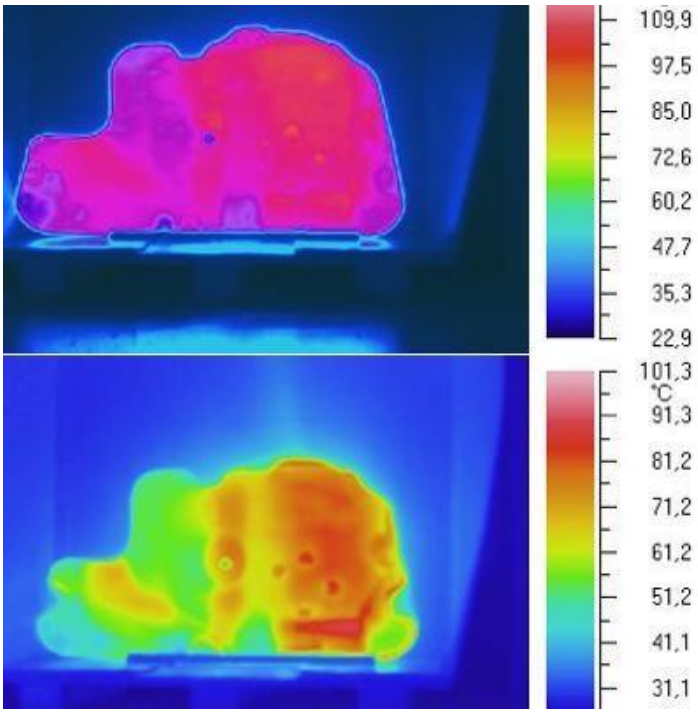
Weight:	450 g	Compressed air consumption:	107 m³/h
Volume:	10 l	Compressed air temperature:	- 34°C
Material:	HDPE	Cycle time before:	22,2 sec.
Cycle time reduction: 27%		Cycle time after:	16,2 sec.

Production increase: 37 %

Oil canister:

Weight:	50 g	Compressed air consumption:	150 m³/h
Volume:	1 l	Compressed air temperature:	- 34°C
Material:	HDPE	Cycle time before:	10 sec.
Cycle time reduction: 16%		Cycle time after:	8,4 sec.

Production increase: 19 %



Subtitles:

Picture 1: Blow moulding process with regular blowing (Air = red) and with chilled saturated steam (Stream = blue)

Picture 2: Set up CAC

Picture 3: Product example: Blow moulded part for Automotive

Contact

Blue Air Systems GmbH

Achenfeldweg 8

A-6250 Kundl/Tyrol

Austria

Tel.: +43 (0) 5338 211 71-0
Fax: +43 (0) 5338 211 71-20

Email: info@blue-air.at
Website: www.blue-air.at

Managing Director: Bernhard Stipsits

Blue Air Systems at a glance

Blue Air Systems GmbH, founded in 2010 and based in Kundl/Tyrol (Austria), supplies the plastics processing industry with innovative technology for energy saving. Blue Air Systems, the leading innovator, has over 30 years of experience with effective, air-based process solutions for plastics technology.

In the core field of **air-conditioning technology**, Blue Air Systems stands for solutions with cryogenic or dry air for **energy-efficient processing** for the plastics industry and other industries.

Blue Air Systems develops not only high-quality, but above all safe and easy-to-use solutions that require as little energy and maintenance as possible. The company's product-supporting services include **application and service-oriented advice** for processors.

The main products and applications in air conditioning technology include systems for **mould cavity dehumidification (BAS-MSP and BAS-DMS series)** and **internal product cooling (BAS-CAC series)** for effective cooling of blow-moulded parts using extremely cold and dry compressed air (-35ºC) (process volumes 120 to 540 Nm³/h). BAS-CAC significantly reduces material stress and cooling times by up to 50%.

In the field of **material handling**, Blue Air Systems offers a comprehensive range of compressed air-based resin dryers for efficient and gentle **material processing (RDM, RDX and RDL series)** based on the **Venturi principle**. The use of the compressed air available from the company is a very economical alternative to conventional drying systems, such as adsorption dryers. The compressed air technology with process volumes from 0.5 to 1,000 litres guarantees the best drying results - grain by grain, with minimum operating costs and virtually maintenance-free production.

A worldwide **network of sales and service centres** through representatives ensures optimum support for users and long-term value retention of the solutions used.

Constant **growth**, **references in more than 35 countries worldwide**, **innovative technologies** and a **high quality** make Blue Air Systems a globally established and reliable partner for the plastics industry. Blue Air Systems has 15 employees (2023) and an export rate of about 98%.

Blue Air System – Total Energy Savings