THERMOFORMING MACHINERY

The Thermoformers Resource

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Sheet Fed Thermoforming

Cooling the Formed Part

— by Michael P. Alongi —

The thermoforming process may begin with heating the sheet but acquiring the fastest cycle times is not solely based on how fast you can heat the sheet. In order to establish faster cycles, particularly with materials that have longer cooling characteristics (than heating characteristics); you must accommodate the cooling process. With several materials, the cooling time can be the deciding factor on how fast a product can be made, from start to finish, not the heating time. An improper method of cooling may cause scrap rates to increase, products to be less consistent and repeatable and increasing the chance of building unwanted stresses into the finished product and increase the shrinkage percentage.

One of the largest mistakes thermoformers make today is over-heating the sheet. By over-heating the sheet, additional cooling is needed or a longer cooling time is required. With the correct information on material heating temperatures and some simple infrared pyrometers to measure sheet surface temperatures, every thermoformer should know the optimal forming temperatures of each material they utilize. By heating a sheet most efficiently at its lower processing temperatures, you can only then cool it most efficiently.

Temperature controlled molds also play a large role in controlling the temperatures of the sheet and formed parts. Molds that are not temperature controlled will greatly effect cooling times as they simply dissipate heat much slower. When an application is run correctly, using properly designed water cooled molds, one major parameter of cooling is greatly simplified. You now have control of the tool surface temperature that will be a constant from cycle to cycle. With molds that are not water cooled, this control is gone making the cooling process much more sporadic and more operator dependent.

Most Common Cooling Methods

Most typical in heavy gauge thermoforming is the use of cooling fans or blowers; cooling fans are generally used for covering larger areas at higher CFM's (cubic feet per minute). Although many use so called "traditional fans", they are not all equal. Today's equipment manufacturers are using higher velocity fans producing more CFM's while motors get even more efficient. Different blade designs have also been introduced to gain even more CFM over older designs.

Blowers generally produce a lower CFM when compared to a fan but are used in applications where a more directional air flow benefits the cooling of the product. Blowers tend to be good for smaller parts, supplying forced air cooling in compact areas where traditional fans are too large and for cooling areas of parts that benefit from a directional air-flow. Depending on the products or applications a company produces, one should decide on the forced air cooling method that fits their products and materials best.

The key to cooling with forced air is not just in the fan or blower itself but also how many, where they are placed and how they are positioned. Not enough fans will limit cooling capabilities. When grouped together, fans or blowers in different locations and fans set at different angles can create different cooling effects on the formed part. Fans on opposing sides, facing each other, may reduce air flow across the part surface. Placement should be so air movement can escape and dissipate heat from the formed sheet rather than trap heat. Fans located above or near ovens will only extract hot air from the oven onto the part, therefore slowing the cooling process rather than using cooler ambient air. Properly designed doors and shields should be incorporated around oven structures in order to reduce the amount of heat near the cooling area.

The introduction of conditioned air is becoming more popular on numerous applications. Although expensive, the cool air not only cools parts faster but is also being used to help retain better material finishes. As we all know what different heat settings can do to a materials finish, the introduction of conditioned air is also beginning to play its roll in a products finish quality. These products are not only holding nicer finishes that were not possible in past years, they are also benefiting from faster cooling times and faster overall cycle times.

Compressed air devises are also used for higher flow - directional cooling but can also be quite expensive. On products that require quick cooling in specific areas or very hard to reach areas, compressed air may be the only source for cooling of a part. From hand held air guns to small directional nozzles the use of compressed air cooling may create significant efficiencies. The use of compressed air and the role it plays in the twin sheet process is also being used to cool between the two formed sheets.

Spray mist cooling is typically done with water nozzles producing a fine mist of water spread by fans or blowers. This is mainly used on non-decorative products to speed the cooling process. Although spray mist can shock products by introducing cold water to a hot sheet, which in turn can then cause stress within a product. Materials and final product specifications must be looked at closely as specific materials can react differently and costs of testing can become expensive and time consuming if this type of method is not optimal.

Introducing cool outside air - although not all companies can introduce cooler outside air systems due to location and climates, several companies are taking advantage of their location by introducing cooler outside air rather than the typical ambient plant air temperature. By the use of air duct systems in combination with blowers and/or fans, cooler outside air may be introduced to the part. Although this is rarely a constant parameter one can rely on, it can help reduce cycle times in particular seasons throughout the year allowing for an increase in efficiencies.

Post cooling or cooling outside of a machine may also be considered but is typically considered last as it adds additional handling and requirements outside of automated machinery therefore creating longer cycles and more resources. Some applications have used the complete submerging of a part into water, or the use of secondary fixtures designed to maintain part dimensions while being cooled again by forced air systems. Typically post cooling is used as a last effort.

As cooling plays a major role in many applications in our industry, it should not always be looked at as an equal parameter of a project. Each application can benefit differently or be affected differently by the method of cooling chosen. Not one method is best for every application, in some instances a combination is the most correct answer. All product characteristics and process requirements should be considered, the cause and effect and the cost-effectiveness of each. Regardless of each company's product lines, the cooling of the part should not be ignored. When an application's cooling time is one of the most critical factors, in order to maintain competitiveness and gain efficiencies, all parameters from over-heating to post cooling should be considered.

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