GAS Technology™

Spring 2003, Volume 16 – Issue 1

ESC Energy Solutions Center

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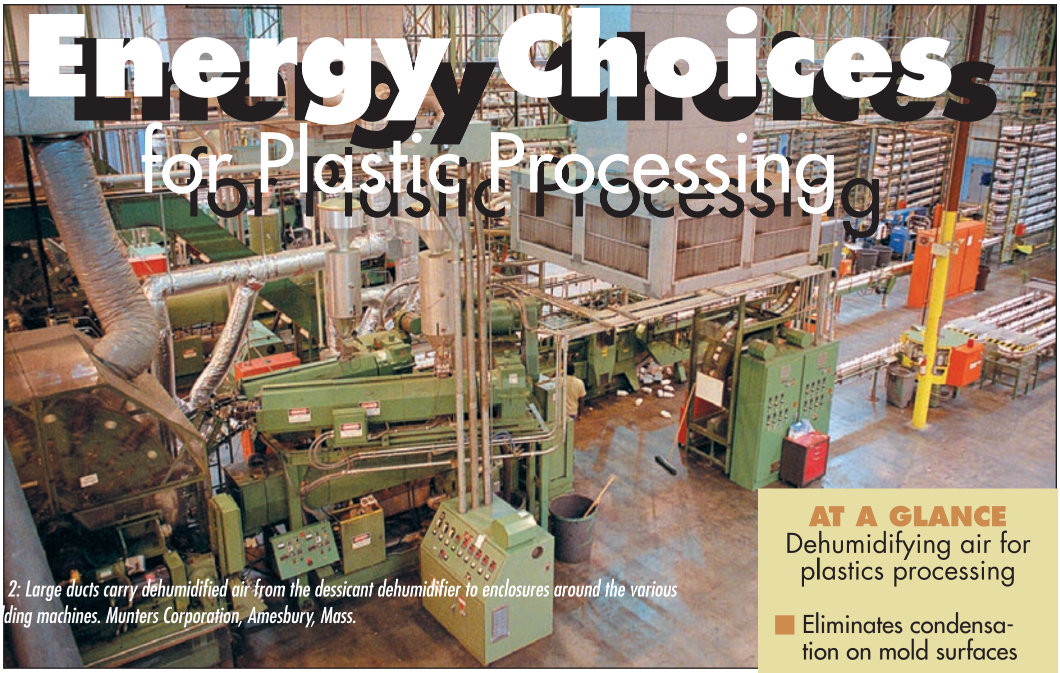
Energy Choices for Plastic Processing



2: Large ducts carry dehumidified air from the dessicant dehumidifier to enclosures around the various ding machines. Munters Corporation, Amesbury, Mass.

AT A GLANCE
Dehumidifying air for plastics processing

- Eliminates condensation on mold surfaces
- Prevents surface defects in molden plastic parts
- Minimizes energy costs

Graham Packaging is the world's largest processor of high density polyethylene (HDPE) products. When Graham acquired their Port Allen, La. facility from another company several years ago, production capacity for one-quart bottles they manufacture to carry Castrol motor oil was limited by the existing out-dated equipment. Graham quickly replaced the original blow-molders with machines that they designed and built internally. These state-of-the- art molders theoretically tripled the plant's capacity. Achieving that higher production rate in practice, however, depends partly on rapidly cooling the plastic below its softening point by using low-temperature water-glycol mixture for cooling the bottle molds.

These cold mold surfaces can create problems during the humid weather Louisiana is famous for. When chilled molds open to release the bottles, water condenses out of the humid air onto the cold surface. This condensation, often called "mold sweat", causes several problems:

- Bottle surface looks like "orange peel" because water droplets form bumps on the mold surface;
- Condensation accelerates corrosion, which increases maintenance costs;
- Most importantly, surface deformities forming around the water droplets prevent the proper adhesion of labels.

Graham's problems are not unique. They are, in fact, common wherever plastic-product manufacturers use cooled molding equipment.

In many plants, production managers opt to reduce mold sweat by holding their chilled-water temperature above the ambient dew point. Doing so, however, reduces the speed at which the thermoplastic hardens, ultimately slowing down production.

Rather than accept such a low production rate, Graham decided to bring in desiccant dehumidifiers manufactured by Munters Corporation in Amesbury, Mass. to dry out the air surrounding the molds. These units reduce the dew point of the air surrounding the molds, eliminating condensation and allowing continuous, high-speed operation.

Molding Process

The blow molding process begins with a "pre-mold," which is an open tube of thermoplastic extruded through a die. The material comes from a pressurized hopper heated to several hundred Fahrenheit—above the material's plastic temperature.

As the hot material leaves the die, two metal mold halves, shown in Fig. 1, clamp around it. Compressed air blown into the pre-mold tube's interior forces the material against the mold's interior surface. The plastic gives up heat to the cooler mold surface until it cools to below its plastic temperature and hardens.

Actively cooling the mold keeps heat from building up in the metal. It can also increase the production rate by reducing the mold temperature below ambient. The cooler the mold surface, the faster the plastic gives up its heat, the sooner it reaches its plastic temperature and the greater the molding machine's throughput.

Water droplets condensing on the mold's cold surface while it is open form pits and other features on the surface. The water, of course, flashes into steam as soon as the hot pre-mold hits it, but that steam becomes trapped between the pre-mold and mold. Pressure of the trapped steam holds the pre-mold away from the mold while the plastic

On the Cover:
Condensation on interior mold surfaces can ruin the finish on high-quality plastic packaging. To find out how gas-powered dessicant dehumidifiers solve the problem while raising production throughput, read the article on page A2. Photo courtesy of C ÚÖ ĊþÚÍÍ§})§ÃēÑÆ}Æ´Æs[ĊÆÚÖĈ3<J 5931 Ford Court Brighton, MI 48116

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Gas Technology is an educational supplement from the Energy Solutions Center, 400 N. Capitol St., N.W., Washington, DC 20001. Phone: (202) 824-7150. Web site: www.energysolutionscenter.org. David Weiss, Executive Director.
Comments may be directed to: Gas Technology Editor, Plant Engineering Magazine, 2000 Clearwater Dr., Oak Brook, IL 60523. Phone: (630) 320-7171. Printed in the USA.

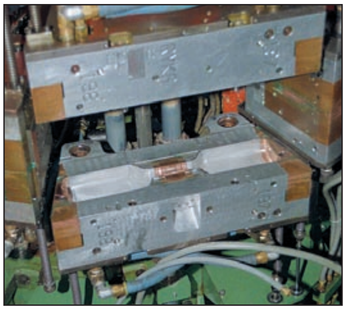

Fig. 1: High-speed automated molding of thermoplastic products uses dehumidifiers to blanket the mold area with dry air, preventing mold sweat and its problems. Munters Corporation, Amesbury, Mass.

cools, forming the unwanted ripples and pits that ruin the surface finish.

To prevent condensation, Graham installed enclosures around the molds to limit air intrusion, and piped desiccated air into the enclosures as shown in Fig. 2. The desiccated air starts out as ambient air pulled into a desiccant dehumidifier. One dehumidifier can serve several automated molding machines.

There are a number of ways engineers can reduce air's humidity. The least expensive and most reliable way of producing dry air in high volume is with a desiccant dehumidifier.

The system's heart is a desiccant wheel shown in Fig. 3. As process air flows through the wheel, the desiccant pulls water vapor from the air and traps it.

"The wheel is approximately 15 inches deep," says Jeff Siemasko, Manager of Marketing and Business Development at Munters, "rotating at six to ten revolutions per hour. The wheel acts like a sponge that works on a vapor pressure differential between the desiccant and the airstream. Water vapor is adsorbed into the pores of the desiccant. The wheel is made of ceramic fiberglass paper and resembles wound corrugated cardboard. This geometry allows for a large desiccant contact area with a reasonable pressure drop."

Process air passes through about 70% of the wheel's face. The wheel, made of titanium enhanced silica gel, adsorbs moisture from the air and delivers it both dryer and warmer.

"To get rid of that moisture," Siemasko continues, "a separate scavenger air stream that is typically taken from the outside is heated to between 250 and 300 degrees. This airstream is passed over a separate quadrant of the wheel to drive out the water vapor. This warm, wet airstream is then ducted to the outside. Simplistically, moisture is being transferred from one air stream to another."

"The process air stream would be the air stream that we're dehumidifying," explains Todd Bradley, President of dehumidifier manufacturer CÚÖȼþÚÍÍ§})§ÃēÑÆ}Æ´Æs[ȼÆÚÖĈof &þÆ»ÃȼÚÖ, M3. "The reactivation air is a separate air stream that's heated to continuously dry the water vapor off of the desiccant wheel.

"We use a desiccant dehumidifier coupled to a pre-cooling coil. The cooling coil cools the ambient or plant air then delivers it to the desiccant dehumidifier, which takes water out of the air, then delivers the air at the proper dew point directly into the mold."

The reactivation air has to be hot. "We take plant air or outside air, heat it up to about 280°F, and send it through about 30% of the desiccant wheel," Bradley continues, "then discharge it to the outdoors."

How do they heat the reactivation air to that high temperature? "The most cost-effective way is with a direct fired natural gas burner," says Bradley. "The burner is 99% efficient, so you get the most cost-effective heat that way. Other options are electricity, steam or thermal fluids.

"Natural gas is typically the least costly avenue," Bradley reports. "Electricity is almost always more costly. Steam would be another choice if it is available, but generally these facilities don't have a high-pressure steam boiler."

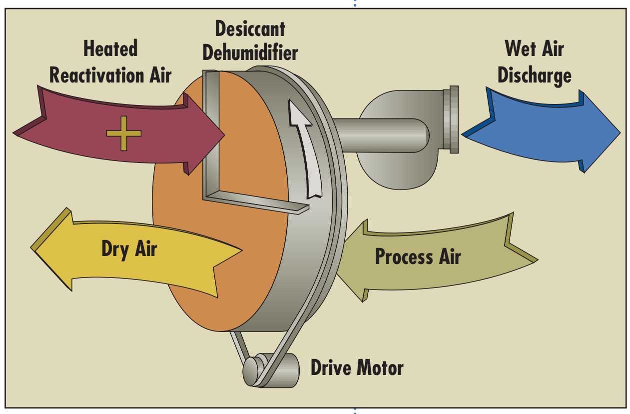

Fig. 3: Desiccant dehumidifiers work by transferring moisture from the process air to reactivation air across a desiccant wheel.

Thermal fluids, such as thermal oils, have a high specific heat capacity and don't vaporize at the temperatures involved. Since they don't vaporize, they can carry heat through pipes to a heat exchanger without building pressure. "Typically," says Bradley, "you have thermal fluids operating at 350 to 400°F without generating pressure."

The heat for the thermal fluid, of course, has to come from somewhere. In the end, you go back to the choice between natural gas and electricity, although burning fuel oil might be another option.

Direct-fired gas technology is very simple, easy to maintain and very efficient in the transfer of gas to heat. A gas burner upstream of the desiccant wheel produces the heat. Makeup air then mixes with the burner's exhaust gas to cool the stream to the proper temperature. The diluted exhaust then goes directly through the desiccant wheel, pulling out the moisture before exiting through a stack.

Natural gas' clean-burning characteristic makes it possible to use direct-fired technology without either fouling the desiccant wheel or carrying noxious combustion products into the mold enclosure.

Plastic-product manufacturers like Graham have found that surrounding their blow-molding machines with dry air speeds up production while improving yields. Dry air's low dew point allows them to cool their molds to a lower temperature so that the soft plastic hardens faster, while preventing condensation droplets from forming inside the mold. No condensation means no surface-degrading ripples and pits marring the finish, higher yields of good product and less scrap.

Using gas technology to dry the air means low pollution, low energy costs and high reliability. Ultimately, they can produce a better product faster and at a lower cost, all of which means more profit.