A guide to bio-resins

Bio-resins can be very challenging to process compared to the common resins they typically aim to replace. This of course can make producing good parts very difficult and sometimes impossible. What are the most important considerations?

BIO-RESINS

Source: Refork/Mold-Masters; ©photolink; ©fotofabrika - stock.adobe.com_[M]-Kuebert

Obviously, many bio-resin grades differ from one to the other. Some can be easier to process than others, but it is common for many to have narrow process windows due to thermal or shear sensitivities.

Additionally, if the hot runner design is not optimised for bio-resins this can create its own difficulties or worsen existing ones. Taking the flow pattern into consideration, it is therefore important to eliminate hang-up spots and consider other critical design requirements.

Let us take a look at typical processing challenges: When moulding with bio-resins, a wide range of visual defects can appear based on the processing characteristics of the material and the hot runner configuration used. These defects include:

- Jetting
- Streaking
- Splay
- Flow marks
- Knit lines
- Burn marks
- Stringing.

Ensuring mould quality requires extensive testing and experience

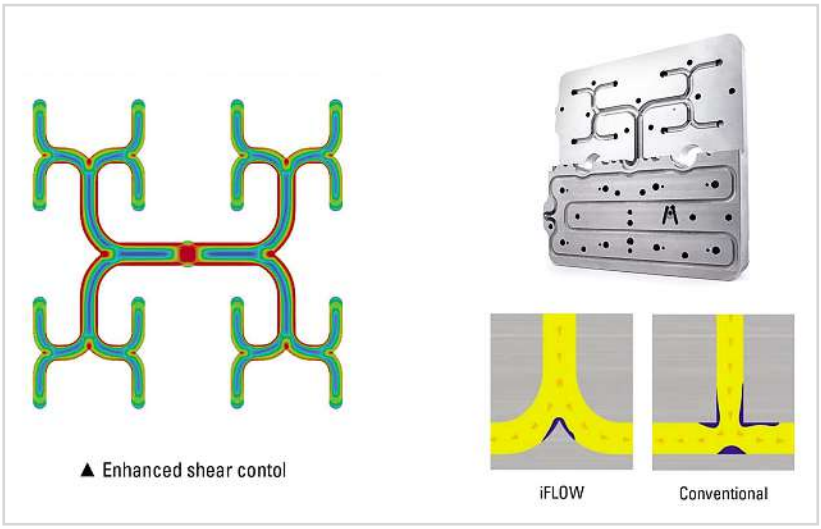
Mold-Masters has spent extensive time testing a wide selection of these materials in its R&D facility and through its partnership with the University of Massachusetts. In addition, the experts worked with leading converters and brand owners to select resins and to define a priority test sequence. This research has as allowed the company to evaluate and understand the unique properties of bio-resins and effective processing requirements. Moreover, Mold-Masters has a variety of real-world bio-resin application experience which includes high cavitation production tools that have been in long term production.

The company's successful bio-resin application relates directly to the experience gathered during tests and its ability to pull information from a comprehensive applications library. This data directs

Refork developed a blend of bio-resins that is suitable for injection moulding technology supplied by Mold-Masters.

Source: Mold-Masters

Source: Mold-Masters



The iflow manifold technology features enhanced management of melt characteristics including shear, temperature, pressure drop and more.

the team to select the correct product line(s) and assists them in designing the most optimum solution given the material at hand.

Hot runner design essentials: Dealing with processing challenges

Mold-Masters' hot runners, controllers, co-injection and auxiliary equipment have been successfully used to process a range of bio-resin applications. These applications include a wide variety of consumer products: utensils, plates and bowls, cups, pens, golf tees, gardening accessories and more.

Part of this successful implementation is the result of the manufacturer's ability to incorporate a range of solutions that are well suited to overcome the processing challenges associated with bio-resins and help ensure application success, including sensitivity to shear and temperature.

Source: Refork

Refork utensils based on bio-resins include a selection of forks, knives and spoons. Mold-Masters adjusted the injection moulding process to meet all challenges.

To overcome this challenge Mold-Masters incorporates its iflow manifold technology (diagram, left). According to the company, this offers enhanced management of melt characteristics including shear, temperature, pressure drop and more. The manifold's two-piece brazed construction provides extensive flexibility to allow for design optimisation. Runner channels are carefully milled and polished, with curved transitions on each half of the manifold plates, before being brazed together. This eliminates sharp corners and dead spots.

The designers at the Canadian company also have the freedom to incorporate patented melt flow geometry, flow path options and runner shapes to further optimise the design to the specific application. The results from the customer perspective is enhanced part quality, excellent repeatability and minimal scrap, Mold-Masters claims.

Temperature sensitivities: Maintaining precise thermal control

Thermal management is a consideration that is just as important as the hot runner design itself. Both of these elements work hand-in-hand to complement the other. Mold-Masters achieves precise thermal control in two ways. The first of these is the heat profile of the hot runner system. The second is the hot runner temperature controller.

The hot runners' thermal profile is optimised by the design team, who are able to adjust the position of the heater elements in order to achieve the best possible thermal balance across the whole system. Part of that solution is the company's brazed heater technology. The brazing of these embedded heater elements eliminates any gaps between the element and the steel. This helps to avoid any potential for cold spots, while ensuring highly efficient heat transfer.

When it comes to maintaining precise temperature control it is essential to utilise a high-quality hot runner temperature controller. Mold-Masters TempMaster-Series controller line incorporates APS control technology. This proprietary auto-tuning algorithm automatically adapts to the process variables of each zone. The result is precise control accuracy that minimises process variability.

Bio-resins for co-injection and other advanced applications

In addition to the many common traditional mono-layer bio-resin applications, bio-resins can be incorporated into more complex and advanced applications such as co-injection multi-layer.

Mold-Masters' co-injection technology utilises a proprietary nozzle design that allows for two different resins to be combined into a single three-layer melt stream. By incorporating a high-performance barrier as the core layer in packaging products, co-injection extends shelf life, maintaining freshness and flavour up to five times longer than mono-layer blends. From a processing perspective, co-injection increases productivity by eliminating the need for secondary processes and minimising scrap. According to the company, it can also minimise the use of expensive barrier materials which can make up as little as two percent of the moulded part weight. The co-injection technology is ful-

ly customisable to create a barrier to moisture, gas or light for containers of all shapes and sizes without any penalty to the moulder's existing cycle time. The precise process control enhances moulded part properties by adjusting barrier layer placement and thickness to ensure uniform distribution.

Bio-Resin Co-injection is suitable for many packaging applications. One example has been in making single-use coffee capsules.

Case study: Sustainable single-use utensils made from bio-resins

Utilising a proprietary bio-resin blend, the company Refork uses injection moulding to produce sustainable single-use utensils. The bio-resin material consists of wood flour (the primary material is sourced as waste from the wood industry), PHA binder and various renewable minerals to enhance mechanical properties. This special blend is fully biodegradable in home compost, soil or marine environments. Refork utensils include a selection of forks, knives and spoons.

Refork made sure its proprietary blend would be suitable for injection moulding by involving Mold-Masters at an early stage. That process involved testing various biopolymers (PLA, PBAT, PHAs) to act as the binder. There were several key variables that needed to be achieved for the end product to be a success. These included:

- High biodegradability
- Good mechanical properties
- Acceptable for food contact
- Good processability
- Visually appealing (color/texture)
- Suitable for mass production
- Higher HDT (heat deflection temperature) point.

There were three key challenges during the injection moulding process that Refork needed Mold-Masters to overcome:

- Prevent material degradation (the bio-resin material tended to degrade quickly during the injection process as a result of the biopolymer binders and wood flour).
- Achieve a consistent cycle time that could be scaled to mass production.
- Minimise the injection pressure to allow system compatibility on a smaller machine.

Mold-Masters supplied several optimised Master-Series hot runner systems (hot halves), in sizes that depended on the production capacity needed for each product. This included 48 and 24-drop production hot halves and a 4-drop hot half for R&D testing. The manufacturer's TempMaster M2+ hot runner temperature controllers were used to maintain tight process control.

Mold-Masters worked closely with Refork to supply solutions that allowed the company to achieve all of its goals. Not only was Refork able to process its unique material, but Mold-Masters' hot runners were able to achieve a consistent cycle time, minimise scrap and decrease the required injection pressure by 500 bar, allowing the moulds to be operated with smaller machines. The company's hot runners are currently used by Refork to produce over twelve million bio-resin utensils on a monthly basis (corresponding to 151 million items per year). *AST*

www.moldmasters.com

Source: Mold-Masters

Manufacturers need to overcome certain challenges associated with bio-resins.