

World in motion

In its quest to manufacture biodegradable coffee capsules more efficiently and to the desired quality, German firm Bio-Caps has enlisted the help of an Austrian injection moulding systems supplier. **Noli Dinkovski** reports

It's without question that the capsule format has established a firm foothold in the coffee market over recent years. But while the demand for premium coffee options continues to grow, criticism of conventional capsule systems has also increased – largely due to the high levels of aluminium and plastics waste.

One German-based capsule manufacturer has made it its mission to address this issue. Bio-Caps produces biodegradable coffee capsules from a patented, innovative biopolymer that is not only compostable but is also said to provide an excellent oxygen barrier, preserving the coffee's aroma for several months.

Sustainability alone, however, is not enough – as the company acknowledges, production must also be economical and efficient. To achieve this, Bio-Caps relies on a novel range of injection moulding machines, which provide the foundation for competitive manufacturing achieved by what is claimed to be a winning combination of extremely short cycle times and maximum precision.

The requirements for an eco-friendly coffee capsule are immense. Aluminium capsules offer an almost perfect barrier against oxygen and moisture, but their production is resource-intensive and environmentally questionable. Plastics capsules, on the other hand, are often not easily recyclable or decompose only slowly. This is why Bio-Caps developed the biopolymer Terrablend. Made from renewable raw materials and combining the advantages of both worlds, it is compostable and is purported to protect the coffee just as effectively as aluminium capsules.

Bio-Caps produces biodegradable capsules that decompose within just 12 weeks in specialised industrial composting facilities with high temperatures and humidity, as well as home-compostable capsules that break down in regular garden compost without special conditions in less than six months.

Dimensional deviations

Home-compostable bioplastics in particular pose significant technical challenges. The capsules must be manufactured with high precision in order to function seamlessly in standard coffee machines. Even the slightest dimensional deviation could cause the capsules to deform or leak during brewing, says Norbert Kuhl, chief technical officer of Bio-Caps.

"The biggest issue is capsule warpage under heat – the dimensional accuracy has to be perfect to ensure compatibility with every machine," explains Kuhl.

Another critical factor is the material's high crystallisation rate. "It hardens extremely quickly – we need machines that can inject within 90 to 100 milliseconds to fully fill the mould," Kuhl adds.

It was at this point that conventional

injection moulding machines quickly reach their limits, meaning Bio-Caps required a solution that combines maximum speed, precision and efficiency.

After extensive market research, the company opted for fully electric Engel E-motion injection moulding machines. "Engel was the only supplier able to provide a fully electric machine capable of achieving these extremely short injection times," Kuhl emphasises.

The E-motion machines stand out for their short cycle times thanks to highly



Left to right: Bio-Caps' Konstantin Rezdelenko, Norbert Kuhl and Martin Wassmer with an E-motion system



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Norbert Kuhl, Bio-Caps



dynamic electric drives. They are also described as offering high precision for dimensional accuracy without warping, clean operation (due to fully electric technology without hydraulic oil and an encapsulated toggle mechanism), and energy efficiency through lower consumption and optimised motion sequences.

According to Bio-Caps, the E-motion machines deliver precisely the performance it requires. Their all-electric drive technology enables not only extremely high injection speeds but also outstanding repeatability and process stability, the company suggests. These machines are

specifically designed for short cycle times and are particularly well-suited for high-volume packaging applications, it adds.

One decisive factor for Bio-Caps was that Engel offers fully electric high-performance machines without hydraulic injection units. “I don’t want a single drop of hydraulic oil in my production,” says Kuhl. “Eventually, there would inevitably be contamination, and that simply cannot happen in hygienic production for food-grade products.”

In addition, the closed toggle lubrication system prevents oil mist in the mould area, keeping the parts clean.

Risk management

By using multiple smaller machines with eight- to 16-cavity moulds instead of one large system with 36 cavities, Bio-Caps was also able to decrease production redundancy and boost efficiency. “A large machine with 36 cavities may appear economical at first glance – but if it goes down, the entire production stops,” Kuhl explains. “With our concept, we distribute the risk across several machines and significantly increase annual output, because a 160-tonne machine allows for shorter cycle times than a 700-tonne one.”

“With our set-up, we produce 340 million capsules per year,” adds Martin Wassmer, head of development and automation at Bio-Caps. “If we used a 36-cavity solution on a 700-tonne machine, it would only be 190 million – and at twice the investment cost.”

Another key to the success of Bio-Caps’ production lies in precise temperature control. The capsules must cool extremely quickly to be demoulded without warping. “We run everything cold, with a water temperature of around 15°C, and rely on a high-performance cooling system,” explains Konstantin Razdelenko, head of design and development at Bio-Caps.

Each mould consumes around 20 sq m of water per hour, enabling the company to achieve a cooling time of just 0.9 seconds. “Our parts come out of the machine only slightly warm to the touch – and that makes a huge difference in cycle time,”

Wassmer points out. “They can be processed further immediately after demoulding, without the need for additional cooling. This not only saves time but also significantly reduces energy consumption.”

Bio-Caps claims to pursue a comprehensive sustainability strategy that goes far beyond the capsules themselves. The company focuses on 100 per cent renewable energy sources (wind, hydro, and solar power), climate-neutral production through carbon dioxide offsetting, and minimal raw material consumption thanks to optimised processes.

“We’d rather pay a bit more for green electricity than save money at the expense of the environment,” says Kuhl.

This mindset is also well-received by customers, he maintains. “Many of our clients are actively seeking sustainable alternatives to aluminium capsules,” Kuhl adds. “We see an enormous growth potential here.”

EcoVadis award

Thanks to its innovative biopolymers and resource-efficient production, Bio-Caps was awarded the EcoVadis Platinum Medal in December 2024 – a distinction held by only 1 per cent of companies worldwide. Engel also holds this important certification, which serves as a key indicator for both suppliers and customers.

The introduction of the Engel E-motion machines went smoothly, recalls Kuhl. “Our collaboration with Engel has worked extremely well right from the start,” he says. “We were closely supported throughout the entire project phase and received machines that perfectly match our requirements.”

Looking ahead, Bio-Caps will continue to rely on Engel’s technology to expand its production capacity. “With the E-motion platform, we have a solution that guarantees maximum flexibility and outstanding efficiency for years to come,” adds Wassmer.

Bio-Caps says it can demonstrate that sustainability and high-performance production are not mutually exclusive. By using fully electric Engel E-motion injection moulding machines, the company claims it is able to manufacture biodegradable coffee capsules efficiently, precisely, and in an environmentally friendly manner.

According to the German-based firm, this combination of innovative materials, resource-efficient production, and state-of-the-art manufacturing technology positions it as a pioneer in the sustainable packaging industry. It’s certainly without doubt that as the coffee market continues to grow, Bio-Caps is ideally positioned to offer a sustainable alternative with its eco-friendly capsules – delivering perfect coffee without the guilt. **EP**

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