

AVK uses two-stage process by ENGEL to boost efficiency

Processing plastic flakes by the pallet

A new ENGEL technology means that a whole process step can be eliminated in the processing of recycled plastic materials; the recycled material is processed in the injection moulding process without the need for pelletising. AVK Plastics BV uses this technology to manufacture new pallets from recycled material. This technical innovation boosts efficiency in production and saves valuable energy. The reason for this is that 60 tonnes of post-consumer material are processed every day at the Dutch location in Balk; an achievement that is made possible by process optimisation. The demand for pallets which use "second life cycle" plastics is currently very high; and this is what prompted the capital outlay for new ENGEL duo 1500 and ENGEL duo 2300 machines featuring the innovative two-stage process.

"The demand for pallets continues unabated because the classic supply chains for wooden pallets have been massively disrupted by the crisis in Ukraine," as Vally Hoogland, Technical Operations Manager at AVK explains. It was decades ago that the company in the Netherlands established its strategic role on the recycled materials processing market. "Back then, we were looking to offer attractively priced alternatives by substituting existing products such as pallets and manhole covers. Today, the increased demand is driven by the pandemic and supply chain problems on the one hand and, of course, by the vision of sustainability and customers' higher demands in terms of hygiene on the other," says Vally Hoogland describing the current situation.

AVK currently deploys five ENGEL injection moulding machines which process the full range of recycled materials. Three dual-platen machines from the ENGEL duo series are used in production based on classic technology, where plasticising and injection occur in a single process step. The two latest injection moulding machines were delivered as a duo in the truest sense of the word and are based on the dual platen machine solution of the same name: an ENGEL duo 1500 and an ENGEL duo 2300, extended to include a technical innovation from ENGEL, the new two-stage process. This technology's highlight is already quite clear

from the name. Plasticising and injection are broken down into two independent but finely tuned process steps. In this way, an entire time-consuming and energy-intensive process step can be omitted.

Compact machine design thanks to two-stage process

The first process step involves plasticising material from post-consumer processing, which is supplied in the form of flakes. "The screw has a diameter of 135 mm, and it plasticises continuously," as Patrick Grüner, Business Development Manager Technical Moulding at ENGEL's Schwertberg site explains, "and the pistons are designed for a maximum shot weight of 30 kilograms at a stroke volume of up to 40 litres. The molten material is injected into the cavity in the second stage of the ENGEL duo injection moulding machine with a specially designed piston unit. Compared to the standard ENGEL machines, this technology can be housed in an even more compact machine design. This is why the new duo machine is also several metres shorter compared with the classic model from the same model series. "This was also an important aspect for us," explains Vally Hoogland, "because it frees up space for additional machine capacity at our location.

AVK exclusively processes recycled material. Vally Hoogland: "It's a blend of polyolefins that are partly obtained from post-consumer sources and partly from industrial waste. AVK collaborates with specialist suppliers here. Companies that collect residual materials and deliver as bales to the processor. The material is then washed and the metal separated. A float-sink process is used to separate the plastic content; it relies on different specific densities to separate the different raw materials. In downstream processing, AVK exclusively uses the portion that floats on the liquid medium due to its lower density. "With recycled material in particular, we draw on our years of experience to create the optimum mixing ratio of the different polyolefins," says Vally Hoogland, outlining AVK's know-how, which forms the basis for injection moulding of plastic pallets with defined properties, such as dimensional stability or load-bearing capacity. This is because the mixing ratio has a considerable influence on the melt/volumetric flow rate. Virgin material has a very constant value here, while recycled material varies massively." AVK has these properties analysed in advance in a test lab to determine the proportion of impurities and foreign substances. If the material is not compliant, additional material is admixed until it meets the desired properties. This mixing takes place on site at AVK. Vally Hoogland can report from many years of experience that recycled material

quality has continually improved over the years. However, it is important to understand that the material will never be single grade. It is not uncommon to find some disruptive materials in it, such as small stones or wood residues. "At the end of the day, the material package has to be right, because it naturally has a considerable influence on the injection moulding cycle of the ENGEL machines."

The shot weights for the ENGEL duo injection moulding machines featuring the integrated two-stage process are 28 kilograms in each case. However, these two machines now use stack moulds on which pallet halves are injected. The upper and lower parts are then simply clicked together. "Today, we use four moulds with this design to produce closed pallet models," says Vally Hoogland, explaining the technical background.

AVK started with manhole covers in the 1980s

AVK's first contact with recycled materials was back in the 1980s, when the Netherlands started to substitute cast-iron manhole covers. Plastic was increasingly being used as a material for road construction. At first, the manhole covers were produced from polyurethane to ensure lockable access to pipes. It was price considerations that prompted the company switch to recycled material. "At the time, this was new ground for us, because there weren't really many products made of recycled material at that time," as Vally Hoogland recalls. Later on, the company switched to polyamide as a recycled material. AVK developed its own material blend for this purpose in order to ensure the best properties for the product.

In 2003, the first customer enquiry for producing pallets reached the company. The order was processed using what was already a familiar and proven material as the basis at that time: recycled material. The business share accounted for by pallet production has grown steadily ever since. This has resulted in a portfolio with a large number of standard pallets of different dimensions, load carrying capacities and features. AVK even develops and manufactures custom pallets in-house.

Close collaboration between ENGEL and AVK in development

"There was very close cooperation between our development engineers and AVK during the development of the two-stage process," says Dr Thomas Köpplmayr, who was involved in

the development project in ENGEL's Plasticising Systems and Recycling Development department. And this development project was a win-win situation for AVK, as Vally Hoogland confirms from the customer's point view: "For us, ENGEL was the only partner with whom we could have implemented a project like this." AVK brought all its acquired skills to the table in the project, more specifically, knowledge of the technical requirement for continuous plasticising. "Both project partners contributed their know-how, which made it possible to build the newly configured piston machines on the basis of dual-platen technology," says Patrick Grüner. In particular, operations-specific details of the post-consumer material to be processed were very important to ENGEL, while AVK was keen to implement plastic flake processing in a way that lent itself to series production. In the "hot phase" of the project, joint project meetings were held every week to discuss the technical challenges. "The hot phase was in the period of Covid restrictions at the time," as Bas de Bruin, account manager at ENGEL Benelux, recalls. Contact with AVK was first established back in 2007, and the first ENGEL injection moulding machines were then delivered in 2015 with modified equipment as predecessors to the injection moulding machines with the integrated two-stage process. "We really put the time we invested to good use in developing the new two-stage process," and, as Vally Hoogland goes on to say: "We are aware of the added value that this new technology means for us and see a huge amount of potential for our production and for further cooperation with ENGEL here."

Greater acceptance of post-consumer products

AVK is strongly in favour of "end-of-life-care". Vally Hoogland hopes to see "far greater acceptance of post-consumer products" on the markets in future. Plastic is an excellent material, he says. But you need to dispose of it reliably at the end of its service life to avoid it entering the environment. "If there is a completely closed recycling loop at some point, I can think of a whole bunch of products where recycled materials will be valuable input materials for an additional value-added stage." Especially considering the fact, from AVK's point of view as a processor, that oil also needs to be factored into the bottom line as a raw material in the recycling process; after all, starting with the crude oil that is extracted and transported, you first need to create the basis for a synthetic material at the refinery in what is a very energy-intensive process. Vally Hoogland is certain of one thing: "If you make an honest

appraisal of the data in this analysis, recycled plastic has a significantly better CO₂ footprint compared with virgin material".

Lower energy input compared with the series production machine

The capital expenditure has paid dividends for AVK in several ways, especially when it comes to the new machine's energy consumption. This is because there is an issue specific to the production plant resulting from the existing infrastructure – restrictions in terms of the power supply from the local energy provider. The two-stage process has significantly reduced the connected loads of the machines compared to standard models. "We have expanded significantly in the past few years and the energy demand has grown to match. If we had connected two conventional injection moulding machines, we would have had to have the energy supplier install a new power supply, and this would have entailed very high costs for us," as Vally Hoogland confirms. "We don't need such high pressure for our pallet production processes and, in line with this, we don't need the high plasticising capacity that accompanies it. The special machines can make do with a significantly smaller screw which is powered by smaller drives." In figures, this translates to 585 amperes as opposed to 900 amperes. On top of this, the functional approach of plasticising with the piston unit is far more energy-efficient because the process is continuous instead of first starting plasticising and then stopping it again when the process is finished. "High current peaks simply no longer exist because the cycle time is perfectly okay as a time slot for plasticising the high shot weight." This means that the machine combines various benefits: the coordinated plasticising capacity on the one hand and a coordinated shot volume on the other. "This is a decisive advantage of the two-stage process because these two parameters can be adjusted individually," says Patrick Grüner adding the reasoning behind this. In contrast, both parameters need to be adjusted at the same time on a standard machine and taking the mutual dependencies into account.

Any overall appraisal of the energy benefits, also needs to factor in the ability to eliminate an entire plasticising step. For example, there is no need to produce regranulate by additionally melting the material at 250 °C followed by cooling. It takes twice as much energy to produce the final product – no less than 0.45 kWh per kilogram of material. But with flakes, the material is processed directly after the melting process.

The next evolutionary stage: processing agglomerates

"The next stage of development will be the use of materials that are even more difficult to process, recovered from recycled film material," says Vally Hoogland, outlining the technical challenges for the near future. A similar process is already being presented in collaboration between AVK and ENGEL at the K show in Düsseldorf. This machine is additionally being equipped with filtration and degassing to enable the processing of recycled materials with a lower degree of purity. Foreign plastics with a higher melt point, or impurities such as wood, aluminium and paper can then be filtered out of the recycled materials and gaseous impurities from detergent residues or printing inks removed. Instead of the piston unit, a second screw is being used here to feed the melt into the cavity.

ENGEL is also already working on digitalising the two-stage process, as Thomas Köpplmayr reveals. iQ weight control will then be used to validate quality in the series production process by reference to the part quality; this, in turn, ensures a constant moulded part weight in combination with a controlled and immediately adjustable injection volume. iQ weight control identifies fluctuations in the raw material while adapting the injection profile, the switchover point and the holding pressure for each cycle to reflect the current production conditions.



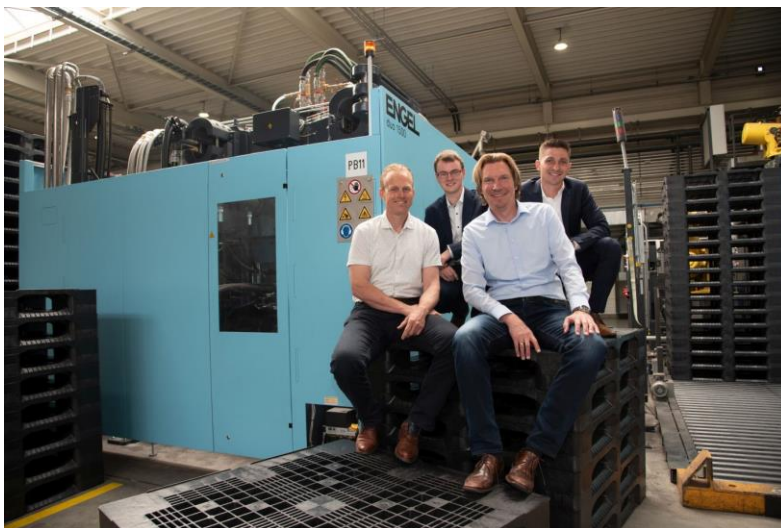
Comparing sizes: The new ENGEL duo 2300 with the two-stage process is several metres shorter than an older machine from the same model series right at the end of the production floor. This is also an important purchasing criterion for AVK.



ENGEL duo 1500: 28 kilogram shot weight. Plasticising takes place continuously during the cycle, while the cavity is fed by a piston unit. The pallets are taken off and deposited automatically.



Challenging production: the pallets are made entirely from post-consumer material.



Sustainability by the pallet load: Vally Hoogland (AVK), Dr. Thomas Köpplmayr, Bas de Bruin and Patrick Grüner (ENGEL, from left to right) in front of the ENGEL duo 1500 with the two-stage process.

Pictures: ENGEL