

Review of PETinar Tethered Caps: Design, Produce and Inspect!

A well-tuned quartet by Heike Fischer

On March 24th, 2022 PETplanet Insider presented its latest online conference. PETplanet invited speakers from three companies, Universal Closures, z-moulds and Intravis to talk about their experiences and assessments of the current situation of tethered caps. The three presenters, Mark Smith (Universal Closures), Michael Fink (z-moulds) and Sascha Baumanns (Intravis) know each other from joint projects that editor Ruari McCallion has already reported on in PETplanet Insider magazine. This well-tuned quartet gave a stimulating and highly informative performance at the event.



Mark Smith, Technical Director & VP at Universal Closures



Michael Fink, VP Sales & Marketing at z-moulds



Sascha Baumanns, Head of Sales at Intravis

Design tethered caps

Mark Smith started his presentation with a brief introduction to the EU legislation (EU 2019/904), the Single-Use Plastics Directive (SUPD). He summarised that Article 6 of the SUPD sets rules for beverage bottles up to a volume of three litres. Specifically, he stated that unintended loss of caps or lids should be prevented from July 3rd, 2024 on, and that caps must be attached to the bottle. In concrete terms, this means that a 25N tear-off resistance must be given. Mark went on to talk about the pros and cons of existing closure sizes, such as PO 1881, most common for CSD, and the challenges of the new design for a tethered solution.

Mark went on to say that in cooperation with Coca-Cola, Universal

Closures has designed a solution for the new size GME 30.40, which can also be used for tethered applications. The GME 30.40 preserves the internal bore diameter of PCO 1881 but offers a weight reduction of ~1.2 g through external design optimisation and material elimination. Research on the GME 30.37 revealed that, despite the shortened neck, this design does not offer sufficient technical performance, especially regarding carbonated retention and opening performance, and it lacks the physical space required to accommodate 'net zero' closure tethering technology.

Mark went on to ask if every closure and finish can be tethered? He pointed out that this is possible in principle, but that to design a tethered closure, the goal should be to find a zero-net solution that does not affect

any key functions such as weight, capping application, manufacturing, tooling design and finally customer interaction. Universal Closures already have a lot of tethered solutions for many different applications. Mark presented two different closure solutions.

First, he introduced the Eagle solution: a closure based on GME 30.40 with a screw top design, and which is useable for any beverage, including CSD. It meets requirements such as clearance to finish opening, a repeatable and intuitive operation as well as an opening self-holdback. Three principal challenges have been overcome: shell integrity for high CSD performance has been maintained, as have the finish clearance before tether articulation and the compatibility with capping system and cross closure. "A key part of achieving a

tethered closure on such a finish, is to make sure that you can raise the closure from its finish before you begin the articulation of the actual tethering. If you begin articulation too soon, you simply clash with the threads and it's very difficult for the consumer to open cleanly," Mark explained. The second closure Mark showed was a hinge-mould-closure (HMC) design. It does not work for CSD products, but is suitable for still beverages, water, and dairy. It is designed for short neck finishes like 29/25. In this closure a "natural tether" is given. It comes with a hinge tension in the design which gives the closure a natural spring effect that stays open over the centre at up to 220 degrees. There is no mechanical hold-back, it stays in that position. The challenge here which was successfully overcome, was to ensure that the cap is fully functioning on an existing threaded 29/25 finish.

Mark concluded his presentation with a question: what's next after tethering? He pointed out that tethering is just one way in which the plastics packaging industry could move towards reducing its environmental impact. He mentioned that a closure design from a single resin type will simplify recycling. In addition, he added that more recycled material should be used and more reusable packaging systems like RefPET bottles should be implemented.

Moulds for tethered caps

The second speaker was Michael Fink from z-moulds. Michael briefly introduced his company and proudly announced that z-moulds would have a sales and service team in the US from April 2022 on. z-moulds, as a mould making specialist for caps, helps cap designers like Universal Closures, to develop the best design for any tethered cap application. All global testing standards are possible in the approved z-moulds laboratory. Finally, after designing, testing, and developing, z-moulds supports the inline work at its customers' premises. Michael explained the patented z-slides technology. It differs from other mould systems in the following aspects: the front of the mould has a complete flat parting line. Centring of the cavities is not necessary. The cavities and sliders are located inside the mould. The mould itself is centred with guiding bars; this

results in an almost wear-free system. Each cavity is accessible from the front. The entire cavity stack can easily be pulled out so that each part of the cavity can be replaced (eg. core, cooling top, slider). The 70 mm frame of the mould stays the same for all kind of closures. It is a completely modular system. Also, the cavity pitch remains the same, and in addition the same hot runner system can be used.

New requirements arise for the tethered caps. Michael said that the z-slides technology is still used but it must be extended. The sliders need to be higher, because the parting line for a tethered cap design is moving up. By changing the angles on the demoulding face, where the height is increased to a distance of 15 mm, it is possible, for example, to produce a 29/25 closure design entirely on the cold half of the mould. The extended z-slide technology can easily be implemented in the existing z-slides system. The extended z-slides system can be used for closures with an outer diameter of 25-33 mm and a cap height in the slider of a maximum of 15 mm. Most standard necks like PCO 1881, PCO 1810, 29/25 mm and 30/25 mm are compatible as well as new neck finishes like 26/22 mm, GME 30.37, GME 30.38, GME 30.40, GME 30.41 and 25 mm.

Michael concluded that all z-moulds technologies like the z-slides, z-slides extended, and the z-folded system are compatible with each other. That means the systems have always the same pitch between the cavity, it is possible to use the same hot runner, and most mould plates are the same. In addition, they have the same mould accessories and last but not least the same cooling system. For Michael, the high flexibility of the systems is also a contribution to sustainability. He concluded: "It is better to use the existing equipment and cover the new requirements by making just simple changes."

Inspect tethered caps

The last speaker to take the microphone was Sascha Baumanns. Sascha is Head of Sales at the German-based company Intravis GmbH. With a subsidiary in Atlanta, USA, as well as global service and sales points, Intravis is very well known for its inspection systems for the plastic

packaging industry. Sascha pointed out that Intravis systems all over the world inspect an average of about 20,000 beverage closures – every single second.

After this impressive statement, Sascha started to present Intravis' inspection solutions for tethered closures. The new tethered closure designs which focus on compatibility with existing production equipment as well as on high added value in terms of user experience, result in new design features and therefore need new inspection solutions.

The first of the three inspection systems presented by Sascha was the CapWatcher Q-Line, with the Q standing for Quality. This system is an inline solution suitable for the inspection behind an injection moulding or compression moulding machine. The CapWatcher Q-Line inspects 100% of the produced closures. The system is equipped with eight cameras, a micro-hole inspection, as well as a special temperature measurement. Altogether, the CapWatcher Q-Line gathers 144,000 cavity related product information every minute which helps to optimise the production process. As one example, Sascha explained, that the temperature measurement of each closure in combination with cavity number reading offers unprecedented possibilities in monitoring the performance of the mould.

Sascha went on that a repeatable positioning and separation of the closures is both a fundamental requirement and the key for a reliable inspection. To assure the correct and soft separation, the CapWatcher Q-Line is equipped with a form fitting lateral star wheel. And for the positioning? Intravis now uses a newly developed Artificial Intelligence for its inspection modules which no longer needs a perfectly aligned closure for a properly done inspection.

Another important feature is the contactless high-voltage inspection for detecting micro-holes in the injection point. These holes can lead to inconveniences for the end consumer since the bottle becomes leaky or foreign substances enter the bottle. A conventional micro-hole inspection still uses a metal wheel to dip into the closure, making it impossible to inspect fea-

tures inside of tethered closures - such as the re-closing functionality. In terms of the contactless variant, the closures slide under the inspection unit without the need for immersion or any contact. This is a great advantage in terms of process stability, and also a hygiene factor, Sascha said.

Three cameras are used for the inner inspection of the closure. A large focus is placed on the important, functional elements. The scope of inspection includes the integrity as well as cosmetic aspects of the sealing surface, the seal cone, the closure aids, the thread, the area between the closure and the tamper-evident band, as well as the tamper-evident band itself. Moreover, functional elements, such as hinges or locking aids, are taken into account during inspection.

To offer a complete outer inspection, the CapWatcher Q-Line transports the closures hanging on a vacuum belt. Four cameras inspect 360 degrees of every closure whereas the fifth camera inspects the headplate from the bottom. The outside inspection pays special attention to the new features of tethered closures - no matter whether they are moulded hinges or slitted elements. Short shots, flashes or defects caused by worn blades can be identified at an early stage. All these inspections are summarised in a clear and intuitive software user interface which also displays the machine condition and provides deep, statistical analyses. The CapWatcher Q-Line brings the quality laboratory inline.

Sascha continued by presenting the IntraOne. The smart camera solution is particularly space-saving. Thus, it can for example easily be integrated into the feeder of the capper before the filling process. With a dedicated inspection setup, the system is able to inspect closures for deformation, colour or dimensional accuracy, as well as the key functional elements inside the closure which could be damaged during the transportation and after the initial inspection at the closures producer.

The third system presented by Sascha was the CapWatcher FC. It assures the quality of closures in the outfeed area of the filler after they are applied to the bottles. The system is equipped with seven cameras and inspects the filled bottles for proper closure fit, important features of tethered closures such as hinges and bridges, colour, the gap between the closure's tamper-evident band and the bottle's neck support ring, as well as the correct fill level of the filled bottle. As a highlight, the Cap Watcher FC also offers an inspection of the closure's application angle on the bottle.

At the end of his presentation, Sascha summarised how the presented vision solutions help at different stages of the production process: Whereas the CapWatcher Q-Line measures the closures with a repeatability of two-hundredths of a millimeter right after their production and the IntraOne supports the process right before the application of the closure

to the bottle, the CapWatcher FC is used at the outfeed of the filling line to inspect the closures after their application to the bottle. Overall, Intravis offers a solution for every step of the closure process, and these solutions can be combined with the rest of the high-performance inspection systems. Intravis provides for the plastic packaging industry: From the preform, to the closure, to the PET bottle in the blow moulding machine, to the labelling of the filled bottle, and finally with the CapWatcher FC in the outfeed area of the filling line - all inspection systems are available from a single source. In connection with the IntraVisualizer, an analytics software for production quality data, this offers the possibility of traceability and documentation of the packaging quality in each individual production step. Finally, Sascha pointed out that all inspections are in accordance with Ceti Quality Guideline No.18.

After these three very interesting presentations, a lively discussion began. The PETplanet Insider Team would like to thank the speakers and the numerous international participants for their interest. On the PETplanet homepage you will find all information: a video recording of the PETinar, as well as the presentations of the speakers for download. For further information, please do not hesitate to contact us!

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