THE CUTTING EDGE

Vol. 41, No. 3 – March 2023

“Your Definitive Industry Resource” SM

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Ejectors The Only Moving Part on the Die!

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Ejectors

The Only Moving Part on the Die!

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Steel rule cutting dies primarily consist of three components: wood, steel cutting rule and ejectors. Have you ever thought about the only moving part on the die and how choosing the right ejector is key to the performance of the die? Ejectors are traditionally referred to in a generic term as the “rubber” or the “rubbering” on the die and they act like a mechanical spring when compressed/decompressed. The function of any ejector is to cleanly lift the cut substrate from the cutting rule.

So why rubber? Traditionally rubber-based products used in die ejection were not formulated specific to the die ejection application; rather the products were adopted by the industry but formulated with specific physical properties related to the intended use in alternate industries. Many of the physical properties in these rubber-based products lend themselves well to be used as an ejector on the cutting dies.

However, as machine speed technology has advanced, ejectors have continued to evolve beyond rubber-based products in order to keep up with machine output demands, and they are available in a variety of material options, as this article will discuss. The selection of the proper ejector material is critical to “balance” die output for each application since the ejector performance with consistent ejection forces and minimal compression set (Diagram 1) is key to determining the speed of the machine output.

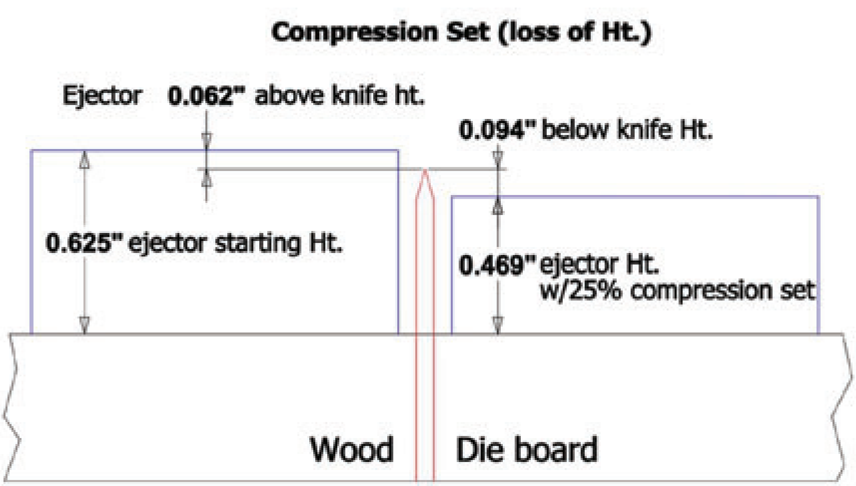

Diagram 1

Open cell rubber-based products are typically used in flatbed diecutting operations, but due to the lack of resilience in the material, they do not lend themselves well to rotary diecutting applications. Product formulations are blended into a dough-like material and, using a press/roll method, the formulation of material is converted into sheet form. The rolled sheets are then placed into mold chambers where the products are baked to produce a sheet to a given thickness with a textured skin surface.

During the manufacturing process, the internal closed cells of the material composition burst open, leaving a random interconnected cellular structure; thus the name—open cell rubber. The cellular structure does not provide separated individual cells, but rather a network of interconnected rubber tunnels that allow air to pass back and forth as the material is compressed/decompressed. This bellow-type flow of air can attract material fibers which cause the material to load up and densify, thus compromising ejector forces over time. The manufacturing process allows for multiple products to be formulated with varying densities, but typically produces sheets with a wider thickness tolerance and a broader range of ejection forces than other ejection products.

Open cell rubber products (Diagram 2) are manufactured with plasticizers to provide lubricity and elasticity to the rubber compound. Since the plasticizers do not bind chemically with the polymers, they tend to migrate or leach out of the product into the environment during the life of the rubber product. Plasticizer migration will cause the material to harden, crack and densify over time, compromising elasticity, thus impacting performance of the ejector. As the plasticizers migrate out of the product over time, they can become an anchor point for contamination and will break down certain adhesives used to secure the ejector to the dieboard creating a loss of tack.

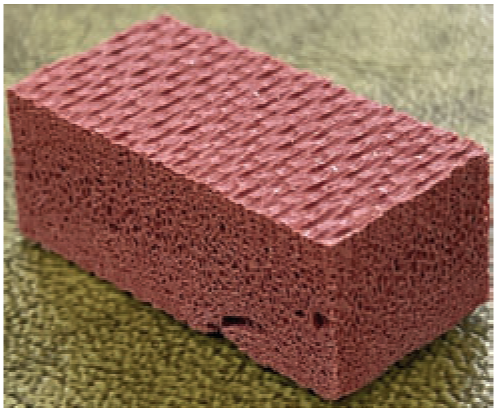

Diagram 2

The products are offered in both roll stock and sheet form in a range of thicknesses up to 1" (2.54cm). Varying industry requirements and manufacturing equipment parameters typically offer these products in 36" (91.44cm) wide roll stock or split into sheets 18" x 36" (45.72 x 91.44cm).

While these products usually involve a lower cost in use over other materials and provide an avenue for certain applications, the lack of consistency in the cellular structure resulting in random ejection forces and plasticizer migrations can be problematic. It is critical to take into consideration the material being diecut, overall impressions and other risk factors that can influence the function of the open cell rubber based during the life cycle of the die.

EVA (ethylene-vinyl acetate) is a lightweight, resilient and closed-cell copolymer which is "plastic/rubber-like" in softness and flexibility (Diagram 3). EVA can be used as an alternative to the traditional open cell rubber products for use in flatbed diecutting, but due to the high compression set characteristics of the material, it does not lend itself well to soft anvil rotary diecutting applications.

EVA rubber is produced in a similar fashion to open cell rubber products mentioned above. The final molding process uses heat and high pressure which can affect the density, resilience and overall quality of the finished product. The material exhibits a smooth, consistent surface with high energy absorption characteristics, superior moisture resistance and overall good physical properties. EVA is characteristic of taking a compression set, as the product is repeatedly compressed/decompressed since the products are typically formulated for cushioning or padding purposes used in footwear and packaging dunnage applications. It is important to evaluate the scope of the project when using EVA in flatbed diecutting applications, as the nature of the product taking a compression set will have a great influence on consistent ejection forces required to clear the product from the die.

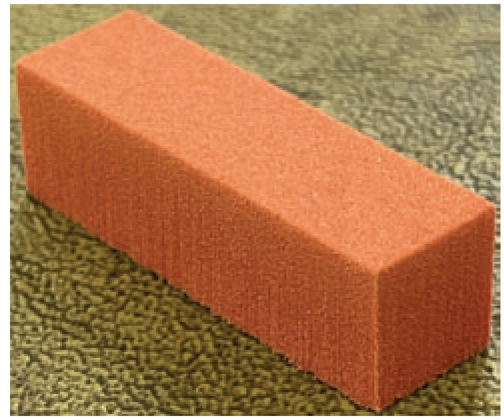

Diagram 3

Manufacturing equipment capabilities allow the product to be produced in a variety of densities with varying thicknesses supplied in both roll stock and sheet form. The products can then be sliced into varying sheet thicknesses per customer requirements.

EPDM (ethylene propylene diene methylene [monomer] is a closed cell rubber-based product which has been used in both flatbed and rotary diecutting applications for decades and can traditionally be considered the "workhorse" of the industry (Diagram 4). The product was originally developed for alternate markets with physical properties specific to the applications in the auto, construction and gasket industries. However, the resilience of the material related to tensile, tear strength and moisture/chemical resistance allows the material to function as a robust ejector.

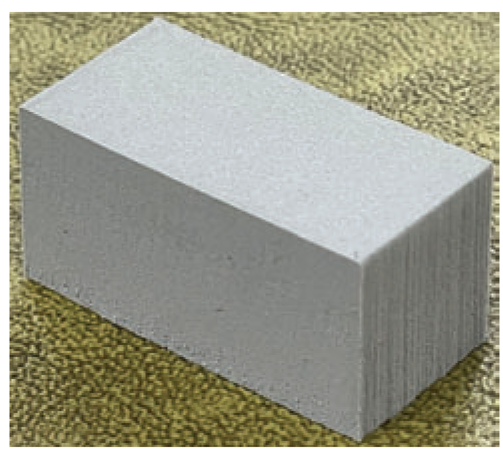

Diagram 4

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EJECTORS

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EPDM is created by forcing gas into the rubber formulations while in a liquid state. This causes the formation of thousands of tiny, gas-filled bubbles, with each bubble tightly sealed off, independent of other bubbles and not interconnected. Think of these bubbles as independent balloons tightly packed next to each other. The manufacturing process includes press rolling and oven baking the material into an expanded rubber bun stock which is then converted by slicing the buns into sheet stock.

Typically diemakers will order the product in a greater thickness than needed since the material is characteristic of taking a compression set (a loss of height up to 25% of the original thickness) based on manufacturers' technical data sheets. The compression set occurs as the material is compressed/decompressed with each cycle in the diecutting sequence, since the compression exerted on the material will burst the internal gas bubbles (balloons), causing the material to collapse.

Compression set causes the material to densify, lose elasticity and directly impact ejection forces required to consistently clear the product from the die to maintain required machine speed output volumes.

EPDM used for die ejection purposes is molded in bun stock form 42" x 52" (106.68 x 132.08cm) and is converted in sheets of varying thicknesses. Due to machine cutting capability limitations with converters, 42" x 52" (106.68 x 132.08cm) sheets are also split into smaller sheet size, for example 21" x 52" (53.34 x 132.08cm).

Microcellular polyurethane (PUR or PU) is not the same as open or closed cell rubber-based products and can be considered the "modern day" ejector used in both flatbed and rotary applications (Diagram 5). Polyurethane is a synthetic material and can be produced in a wide array of products with physical properties specific to die ejec-

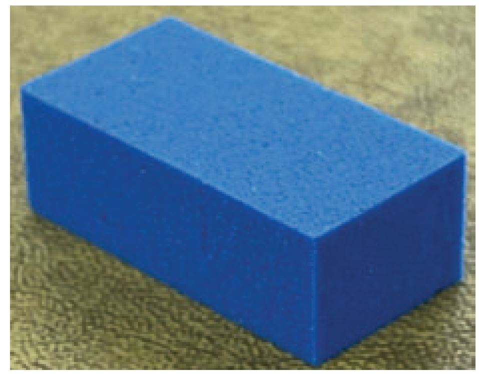

Diagram 5

tion applications. These physical properties provide consistent ejection forces, minimal to no compression set (loss of height), high resilience and elasticity allowing polyurethane to withstand significantly more cycles of repeated use at higher machine speeds.

The manufacturing process includes a polymer and a reactant that create an exothermic reaction when combined to produce the final product. State-of-the-art dispensing equipment uses process controls that tightly monitor each component and delivers a consistent metered shot to a closed mold cavity. Since the metered shot is cured in a closed mold cavity, the final bun produced has a very consistent and uniform microcellular strut like matrix. Cast buns are then sliced into sheets in the same manner as EVA and EPDM products mentioned earlier in this article. The polymer chemistry, dispensing equipment and molding process delivers parts with greater consistency in physical properties, which allows the products to outperform traditional rubber-based products by increasing machine output for the converter.

Formulations and machine molding capabilities determine the available sheet size. Typically, the products are offered in 18" x 36" (45.72 x 91.44cm) and 22" x 44" (55.88 x 111.76cm) sheet sizes with a range of any material thickness routinely used in diecutting applications.

Vulkollan® is a microcellular polyurethane known on a global scale for its exceptional performance to dynamic stresses where minimal compression set, high abrasion and tear strength is critical (Diagram 6). The product is molded in the same manner as the microcellular polyurethane products mentioned above, but uses a proprietary chemical system with an elaborate curing process (after the initial molding phase) that gives the product a toughness required to withstand automotive standards durability. The product is molded in a natural color in block form 10" x 20" (25.4 x 50.8cm) and is offered in a variety of densities. The blocks are sliced into any sheet thickness up to 2-3/8" (6.0325cm) required for tooling. Exposure to light will cause the material to transition from a natural white appearance to a dark brown color (Diagram 7). This color transition is purely cosmetic and will not affect the function of the material as an ejector. The product is a perfect candidate for flatbed/rotary tooling slot applications and other critical areas where clearing of scrap is critical.

Diagram 6

Diagram 7

The material choices available for die ejectors today offer the diemaker a variety of options to solve the most demanding diemaking challenges. Choosing the right combination of ejector materials for each application is crucial to "balancing the die." A properly balanced die allows the ejectors to consistently lift the cut product from the die. An unbalanced die with poor ejectors will result in cut product damage (board crush), compromising printability and improper clearing of scrap. Selecting the right ejector material combination for the application means less product waste and time on press, thus increasing output for the converter—"after all, ejectors are the only moving part on a die!"

Rich Calkins is a Certified Packaging Professional (CPP) through the Institute of Packaging Professionals, and Vice President of Monroe Rubber and Plastic, Inc. (MRP). Rich began his career in the packaging industry in 1988 with a privately owned solution-based packaging company providing returnable/expendable packaging dunnage solutions in corrugated, fiberboard, foam and thermoformed plastics. He continued his career in the industry with MRP, in 2008 developing MRP's polyurethane product lines through continuous innovation with the MRP team. Rich may be reached at 1-734-241-7101 or by email at rcalkins@monroerubber.com.