ALUMINUM CANS: A lesson in product **development**

Despite its simplicity, today's aluminum beverage cans embody several innovations that illustrate the importance of taking a comprehensive approach to product design. Through continuous improvements over the past 40 years, this widely used product (hundreds of billions are used each year) has features that accommodate a range of design requirements from functionality to ease of use, sustainability, and brand identity. Although cans are a mature product, perhaps even beyond their peak, both the body and the lid have features that can serve as useful history lessons for future products of mass consumption.

All aluminums are not created equal, and the can body and lid constitute a case in point. The body is made of the soft alloy 3004 (contains 1% Mn and 1% Mg), which makes it easy to form. Early attempts to make can bodies included traditional deep drawing and innovative methods of impact extrusion. But drawing and ironing (D&I) proved most cost effective. D&I transforms a 5½-in.-diameter, 0.011-in.-thick blank into a cylindrical can using two drawing operations followed by three ironing passes through die rings. And all of this happens at the rate of five can bodies/second. Through years of material refinement (reducing inclusion impurities in the material) and process parameters (die-ring material, geometry, and spacing), the can-wall thickness was progressively cut to less than 0.004 in. This is enough to safely contain carbonated beverages. They normally exert 45 psi, 90 psi during pasteurization, and 110 psi in the trunk of a car in summer, and withstand the vertical loads of 24 filled cans stacked above it during shipping.

D&I also creates highly polished surfaces that can be decorated with colorful, eye-catching logos — a marketer's delight and source of brand identity. Geometrically, can bodies conform comfortably to the grip of a human hand and contain the standard 12 oz of liquid. The bottom-edge contours were developed through extensive FEA to transfer the vertical load from can to can without highly localized stresses that would cause buckling.

Meanwhile, the can lid is made of the alloy 5182 (contains 4% Mg and 1% Mn) which is stronger and harder to form than the can-body alloy. This is needed to accommodate the easy-opening feature and contain the carbonation pressure. As you lift the tab, a crack opens at one end of a line scored in the lid. The crack quickly moves along the curved score line, letting the tab be bent down. (With a sensitive touch, you can feel the can decrease in diameter slightly as the pressure is released and the can returns to its unstressed dimensions.)

The secret of the tab opener's ease of use is the score line: When a score is too thin, it can rupture or leak prematurely; too thick and it takes too much tab-lifting force to open the can. The score line is actually an indentation created by a punch forced into the lid. The draft angle of the indentation punch plays a critical role: too small and cracks might form under the punch, leading to leaks; too large and the punch load increases, making the score line less defined.

Regardless of the differences in composition, can bodies and lids are recycled together. This uses 95% of the energy needed to smelt and refine aluminum from natural ores. Adding magnesium or manganese brings the melt up to spec for either the body or lid material. The material is cast into ingots and rolled down to 0.011 in. Two months after the cans are recycled, the aluminum alloy reappears in another can — the epitome of sustainability. — *Howard A. Kuhn*

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