THE HAZELETT STRIP-CASTING PROCESS FOR ALUMINIUM PACKAGING APPLICATIONS (FOIL, BEVERAGE CANS, AND EXTRUSION SLUGS)

David N. Hazelett
Wojciech S. Szczypiorski
Hazelett Strip-Casting Corporation
135 West Lakeshore Drive
Colchester, Vermont USA 05446

OVERVIEW

Several processes are currently used for the production of aluminium alloy strip for packaging applications. The direct chill (DC) caster, with conventional hot mill, is the most widely used and it produces high-quality strip of almost any alloy. This process has evolved over many years and has progressed to a technically sophisticated and relatively efficient process.

However, the capital and operating costs of DC casting are high. Lower cost continuous casting (CC) processes are increasingly used to produce aluminium strip for packaging applications. As continuous casting technologies evolve, they are claiming more and more of the packaging market from DC casting.

Several CC processes are utilized for the manufacture of aluminium packaging alloys. They include twin-roll, twin-belt, block, and wheel belt configurations. None of them are currently producing commercial strip for all packaging applications. The twin-belt caster comes the closest, as you can see in Table 1.

Product / Process Matrix

Product	**Process**		
Foil	DC	Twin-Belt (Hazelett, Alcan)	Twin Roll
Can Body	DC	Twin-Belt (Hazelett) (test series)	Twin Roll (test series) Block Caster (test series)
Can Lids/Tabs	DC	Twin-Belt (Hazelett)	Block Caster
Slugs	DC	Twin-Belt (Hazelett)	Wheel-Belt

Table 1

Foil is widely produced on twin-roll casters around the world. Their comparatively low production rate is not a disadvantage in the smaller foil markets. Twin-belt casters are important sources of foil stock in North America and Europe.

DC casting firmly dominates the can body market. However, even in this market, some technological progress has been made by CC technologies. The Hazelett twin-belt casting process has produced tab stock in commercial application and a promising can body stock in several test trials.

The extrusion slug market is mostly served by CC-supplied aluminium strip. Both wheel-belt and Hazelett twin-belt technologies play major roles.

HAZELETT® TWIN-BELT CASTER

The operating principle of the Hazelett twin-belt caster is shown below (Fig. 1). The caster uses a fully moving mold, consisting of parallel carbon-steel belts held in tension to form the top and bottom surfaces. Chains of rectangular steel blocks moving with the belts and spaced according to the desired cast width form the sides. The cooling of the belts is accomplished by an efficient fast-film, water application.

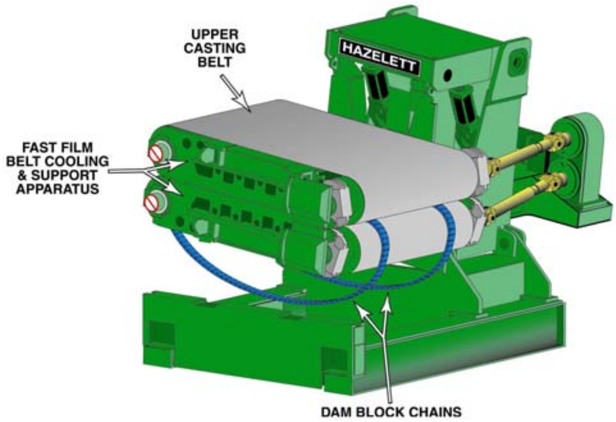

Fig. 1 Hazelett Twin-Belt Caster

A very important feature of the twin-belt mold is that it is flexible, enabling it maintain contact with the strip during solidification. This is particularly important in casting alloys.

Molten metal is introduced into the mold by the closed pool method (Fig. 2), whereby a Strip-Stream™ ceramic nozzle is positioned directly between the belts, allowing for low-turbulence feeding. Mixtures of gases are injected into the mold through the nosepiece, both to control oxidation and to enhance heat transfer from the solidifying slab.

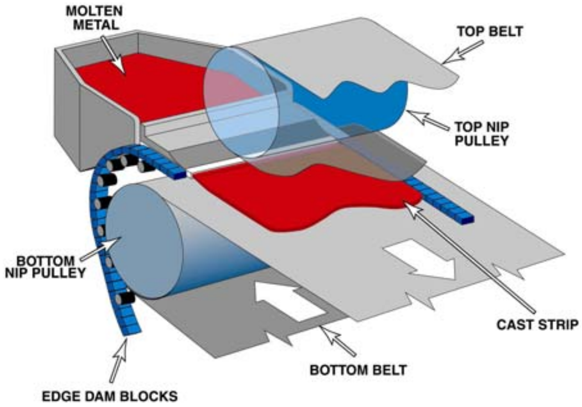

Fig. 2 Closed Pool Feeding System

The Hazelett twin-belt process has produced the highest quality strip for extrusion slugs for decades. In recent years, Hazelett has concentrated on developing its process to produce high quality sheet for demanding applications, including thin foil and beverage can body stock. Surface quality had to be improved, and this required attention to the uniformity of the heat transfer from the solidifying strip through the belts. Thermal distortion of the belts lead to local variations in heat transfer, which allowed reheating of the strip surface, resulting in surface liquation. It also negatively affected the internal structure of the as-cast strip, particularly when casting alloys with a long freezing range, such as AA5182.

In the past few years, Hazelett has developed two means to control belt distortion. Powerful electric induction heating units are employed to preheat and dry the belts prior to their entering the casting mold (Fig. 3), thus avoiding the distortion associated with the rapid heating of the belt in the mold ~~itself~~. Also, powerfully magnetic, finned support rolls are used in the mold ~~itself~~ to support and restrain the belts.

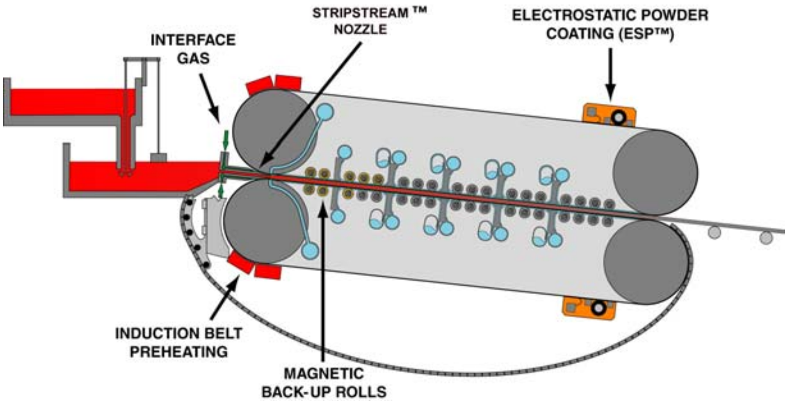

Fig. 3 Caster Developments

Several configurations of neodymium, high-strength, magnetic back-up rolls were tested, and the belt behavior was monitored with proximity sensors over a full range of cooling rates. A design was quickly put into practice. The result was dramatic, allowing high magnesium alloys to be cast without any distortion of the belts.

Once the belts were stabilized, Hazelett turned its attention to the interface between the belt and the solidifying strip. One of the technologies developed to adjust and control heat transfer across the interface is the ESP™ (electrostatic powder) coating system. This is a technique in which particles of fine powders, including fumed silica, are electrostatically charged so that they are attracted by the steel casting belt. The result is a very fine and uniform layer of powder being applied at a rate that can be adjusted for alloy and plant atmospheric conditions.

These and other significant developments have made it possible for the Hazelett twin-belt caster to commercially produce a full range of alloys containing up to 4.5% magnesium. The quality of the sheet produced is suitable for many packaging applications.

PACKAGING ALLOYS AND PRODUCTS

Table 2 sets out the range of alloys and products now produced by Hazelett casters.

Hazelett Twin-Belt Process
Alloy / Product Matrix

	Foil	Can Body	Tabs	Lids	Slugs			
Alloys	1170 8011 1200 8014 8079	3004 (test series)	5042 5082 5454	5182 (test series)	1050 1060 1070 1100	2011 2017	3003	6061/ 6063

Table 2

Foil markets differ around the world. The U.S. uses mostly 1XXX series, whereas Europe prefers 8XXX. Converter and cigarette foils in the U.S. are made from 1100, 1145, and 1200 alloys in the range of 6 – 7 microns.

Commercial foil stock has been produced by Hazelett casters for decades. Two Hazelett® twin-belt casters installed within the last three years in the U.S. and Europe concentrate on foil stock production.

Several can body tests have been conducted in the past yielding promising results. Earring, galling, and mechanical properties were acceptable for <u>can bodies</u>. These were relatively small test series, but proved the metallurgical viability of the twin-belt process for can bodies. Commercial use of the Hazelett process for can body sheet has been delayed by the downturn in the market and excess hot mill capacity.

Tab stock has been commercially produced by the Hazelett process. Lid stock has been cast successfully in test series.

Extrusion slug production on the Hazelett twin-belt caster has a long history. It is a well-established and understood technology. Slug stock is produced on four Hazelett twin-belt casters in Japan and North America in 1XXX, 3XXX, and 6XXX series. A majority of the Japanese slug market is served by two Hazelett casters. Two additional Hazelett casters primarily producing slug stock are located in Toronto and Sherbrooke, Canada.

Table 3 lists foil alloys, gauges, and applications produced on Hazelett casters. Both 1xxx and 8xxx series alloys are regularly cast. The thinnest foil produced is 6.35 microns and has an acceptable number of pinhole counts.

Hazelett Twin-Belt Process
Foil Alloy / Gauge Matrix

Alloy	Gauge	Application
1200	6.35 - 9.0 microns	converter, cigarette
8011	7.0 - 9.0 microns	converter, cigarette
8014	14 microns	household
8079	7 microns	converter, cigarette

Table 3

Table 4 lists slug alloys and gauges cast on Hazelett casters and, along with Figure 4, demonstrates stamped slug shapes and diameters.

Hazelett Twin-Belt Process
Slug Alloys / Gauge Matrix

Alloy	Slug Gauge	Diameter
1050	10.2 mm – 33.0 mm	12.7 mm – 114.3 mm
1060	8.9 mm – 33.0 mm	12.7 mm – 114.3 mm
1070	8.9 mm – 33.0 mm	12.7 mm – 114.3 mm
1100	2.5 mm – 33.0 mm	12.7 mm – 114.3 mm
2011	6.4 mm	
2017	8.9 mm	
3003	12.7 mm – 25.4 mm	38.1 mm – 107.9 mm
6061	12.7 mm – 31.7 mm	38.1 mm – 114.3 mm
6063	20.3 mm	

Table 4

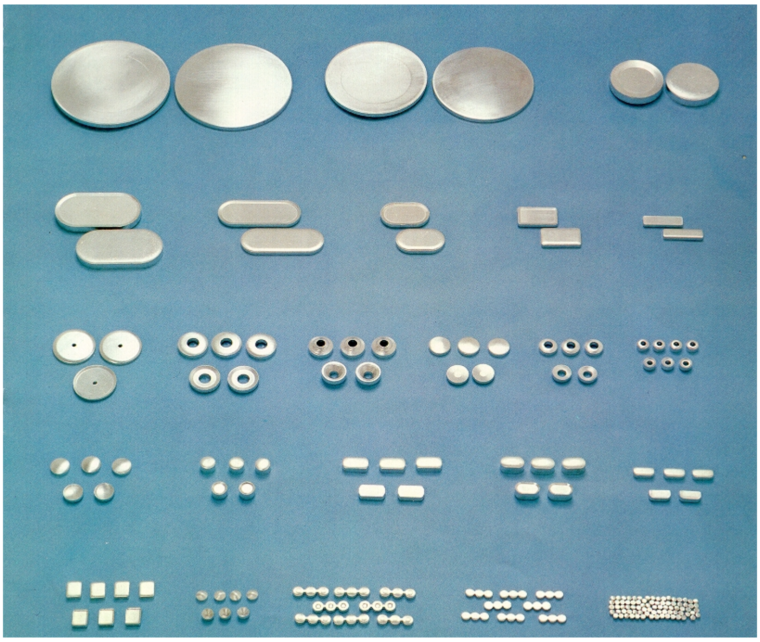

Fig. 4 Extrusion Slugs

Fig. 5 Extrusion Slug Products

In addition to "traditional" items such as aerosol cans, fire extinguishers, bottles, and collapsible tubes (Fig. 5), new products are gaining market acceptance. The latest growth in the market for Hazelett-cast slug stock is tied to the automotive industry, where lighter materials are gaining ground. The information contained in Table 5 reflects this growth. The 6XXX series are especially attractive for this application because of the combination of strength and corrosion resistance. A wide variety of alloys, thicknesses, and diameters are produced. End products include air dryers, air bag containers, Freon bottles, and steering parts.

Hazelett Twin-Belt Process
Slug Alloy/Application Matrix

Alloy	**Application**
1050 1060 1070 1100	Packaging (aerosol cans, aluminium bottles, collapsible tubes) and fire extinguishers
3003	Automotive (air dryers), utility, packaging
6061	Automotive (air dryers, air bags, Freon bottles, steering yokes)

Table 5

CONCLUSION

The Hazelett twin-belt process capability and versatility offers a possibility of casting a wide variety of alloys suitable for demanding packaging applications.

REFERENCES

Nihon Atsuen: "Aluminum Slugs for Impact Extrusion." Tokyo, 1982.
von Gal, R.: "The Aluminum Sheet Mill for the New Millennium." Vermont, 2000.