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Low-antimony–lead alloy strip production

P. S. Kolisnyk
Cominco Ltd., Toronto, Ont., (Canada)

A. M. Vincze*
Cominco Product Technology Centre, Mississauga, Ont., (Canada)

Abstract

Cominco is developing a new casting process for the continuous production of low-antimony–lead alloy strip that is expanded to make positive plates for hybrid-design, maintenance-free batteries. The stages of development from initial trials to pilot production plant are reviewed. The advantages of the process and the product are also discussed.

Background

The battery industry has an on-going mandate to improve product performance, to reduce production costs, and to provide reduced hazards of lead exposure to plant personnel. Government regulatory bodies are watching lead users very closely, and looking for ways to make the lead industry responsible for environmental concerns.

The replacement battery buyer wants a lower cost, higher capacity battery requiring little or no maintenance. By contrast, the OEM battery buyer demands these benefits and also batteries of lower weight for the new, more fuel-efficient vehicles of today. These requirements are taxing the limits of present manufacturing methods. New technologies are required by batterymakers to meet the demands of the marketplace.

Cominco has recognized that the above pressures will cause the lead/acid battery industry to adopt new manufacturing technologies. These methods must be environmentally sound for production, they must be safe to operate, and they must be able to use recycled materials. In response to these pressures, Cominco previously developed a high speed, continuous cast and expanded-metal plate manufacturing process; this was based on calcium–lead alloys. Major batterymakers around the world now use the Cominco technology.

The automotive battery industry is moving from the all-calcium–lead alloy grid system to a hybrid configuration. Hybrid batteries have negative grids made from a calcium–lead alloy and antimony–lead alloy positive grids. Until now, no commercial process has been widely adopted for the continuous production of positive plates.

A major drawback has been the wider solidification ranges of antimony–lead alloys. This metallurgical characteristic prevented the development of antimony–lead alloy strip or mesh for use as grid metal. Almost without exception, the low-antimony–lead alloy grids produced at present are made in conventional gravity-casting equipment. This production process is non-continuous, labour intensive, and gives low productivity.

*Author to whom correspondence should be addressed.

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The need for continuous manufacturing methods for positive plates has been recognized, but previous attempts by Cominco and others have failed. Cominco is now developing, however, a method for continuous casting of low-antimony–lead alloy strip that is suitable for positive grids in hybrid batteries.

Process development

About two and a half years ago, Cominco identified an experimental continuous-casting process for strip. The technology was in use for metals other than lead. After trials with antimony–lead alloy, the caster was modified at the Cominco Product Technology Centre (PTC) in Mississauga, Ontario. Soon after, the feasibility of continuously casting low-antimony–lead alloy strip was confirmed.

An experimental caster at the PTC was used to refine the casting process and to produce trial quantities of coiled strip. Material is being tested and evaluated both at the PTC and by selected battery manufacturers. The results have been very encouraging but final qualification of the material requires additional testing.

Cominco is bringing a semi-production caster into operation at the PTC in early 1992. The caster will be used for process refinement and for production of test coils of antimony–lead alloy strip for sale to interested battery manufacturers.

Potential advantages of the Cominco technology

Negative plates made from continuously cast calcium–lead strip have shown advantages over conventional grids cast in book moulds. This new method for making positive plates from low-antimony–lead alloy strip should offer similar opportunities to reduce production costs and improve battery performance.

Cominco antimony–lead alloy strip is an as-cast product and is free of porosity. These features will improve corrosion resistance and lower grid growth.

The as-cast strip has been used to make grids that are 0.5 to 1.0 mm thick. This gauge satisfies the needs of the automotive battery industry to make batteries that have greater capacity, but are lighter in weight. In this thickness range, the tolerance has been about $\pm 5\%$.

The process has made positive grids using low-antimony–lead alloy with antimony contents in the range 1 to 3 wt.%. In general, arsenic and tin have been added to enhance battery performance. Unlike other methods of producing grids from antimony–lead alloys, grain refiners such as selenium and copper have not been necessary for producing continuously cast strip via the Cominco casting technology.

At present, the process has a productivity of about 2100 kg h^{-1} of strip, using a three-strand casting system. Cast strip has been coiled at speeds up to 18 m min^{-1} (i.e., 60 feet min^{-1}).

The equipment is compact. The machine requires about the same floor space as the Cominco casting equipment used for making calcium–lead alloy strip. In addition, the caster can be adapted to make strip for negative plates.

The Cominco process should have favourable economics compared with other systems because there is no need for costly rolling equipment. The estimated conversion cost from alloy ingot to finished strip is in the range 2 to 4.5 c US per kg of lead alloy strip.

The pilot plant operation has processed alloys made from primary and secondary lead, and has not required the addition of grain refiners. The low-antimony–lead alloy

can be made using 100% recycled lead. The production of secondary antimony–lead alloys can be cheaper than that of alloyed calcium–lead.

Performance

Coils of strip have been made at the PTC and several battery companies have converted the strip to battery grids using in-house production expander lines. These grids have been incorporated into full-size batteries that are now being evaluated. The latter involves accelerated and high-temperature cycling tests. The results to-date have been encouraging. The battery companies are showing strong interest in the material and are encouraging Cominco to continue this development programme.

Cominco is also evaluating the continuously-cast product. A team of electrochemists and metallurgists at the PTC is critically evaluating the corrosion and growth characteristics of the strip. The objective of these studies is to maximize battery performance and life.

Development work in 1992 will focus on the performance of strip in production batteries. The process will be further refined before commissioning the semi-production caster in 1992. It is planned to use the semi-production caster for training and demonstrating equipment to support future equipment sales.

Conclusions

Cominco is aggressively developing a casting technology for low-antimony–lead alloy strip. The process will provide battery manufacturers with a new material for reducing the production costs and improving the performance of automotive batteries.