Reducing Glass Corrosion During Bottlewashing

The following article which appeared in Technical Quarterly Volume 36, Number 4, 1999 is being reprinted due to the omission of co-author Mike Howell’s name, which inadvertently was omitted from the article. MBAA apologizes for this error.

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ABSTRACT

Scuffing of refillable glass bottles reduces packaging appeal and increases packaging replacement costs. This paper discusses a method of reducing scuffing by 50% on refillable glass bottles, that is achieved by reducing chemical etching in the bottlewasher. In addition, this method is also effective in protecting the color and gloss of applied ceramic labeling. This discovery makes it possible to double the number of trips before unacceptable scuffing and loss of label gloss occurs, thus maintaining brand image and package appearance longer. It also functions as a complete bottlewashing detergent to provide effective detergency and to control foam and scale in the bottlewasher. This technology is especially suited to the brewing industry where package appearance, brand image and costs are considerations. Because this new technology is a bottlewash detergent, it is easy to implement and requires no additional equipment or capital investment.

Keywords: bottles, bottlerwashing, glass corrosion, scuffing, detergents, glass etching

INTRODUCTION

Returnable glass bottles are a predominant package for many markets in the brewing industry, and must be washed to ensure product quality and to provide a clean appealing package. Sodium hydroxide-based solutions are used for washing because of their efficacy in cleaning and for their ability to effect sterility under specified conditions. However, caustic bottlewash solutions are corrosive to glass and chemical corrosion combined with physical abrasion, that occurs during handling and production, leads to poor package appearance and increased rejects [1,3,4]. By reducing the chemical corrosion, this technology can significantly reduce scuffing and keep bottles looking newer longer.

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ETCHING

Sodium hydroxide attacks and destroys soda lime glass by a process known as etching, which is actually dissolution of the glass structure. For soda lime glass, silica, sodium, calcium, and aluminum along with any other possible constituents of the glass will be drawn into the bottlewashing solution. Insoluble complexes based on calcium, magnesium and other polyvalent cations are formed as by-products of the reaction and can redeposit back onto the glass surface and the bottlewasher. Etching results in a loss of clarity and release of glass components into the wash solution, which can lead to operational inefficiencies [5].

SCUFFING

Physical abrasion that occurs when bottles rub together on the production line damages the glass at these contact points. Subsequent chemical etching accentuates the physical damage, causing visible wear rings to appear sooner. The combined effect of the repeated chemical and physical damage to the bottle on the production line is called scuffing. The result over time and trips through the production process is a much less appealing package, which affects consumer perception of brand image; increases reject rates and float replacement costs.
CURRENTLY

THE APPROACH

chemical

physical

FIGURE 1

Relationship between scuffing and etching.

Since a relationship exists between etching and scuffing, this work was done to determine if scuffing could be reduced by reducing chemical corrosion (etching) in the bottlewasher (Figure 1). A recent study showed that a 20-50% improvement in overall bottle appearance could be achieved by proper detergent selection[2].

LABORATORY STUDIES

Thorough screening of chemicals used in the bottlwashing process revealed that certain materials accelerate caustic corrosion, while others actually inhibit corrosion. Chemicals present in many traditional bottlewash detergents, such as EDTA and phosphates, accelerate caustic corrosion of glass. Caustic concentration, residence time of the glass in the washer, temperature of the wash solutions and contaminants in the wash solution (e.g. carbonate) also influence etching. Laboratory tests using glass slides as the substrate showed that eliminating the accelerators and incorporating suitable corrosion inhibiting agents could significantly reduce chemical damage under typical bottlewash conditions. This was visually apparent, and was measured by weight loss after extended contact of glass in the wash solutions. These findings were used to formulate a bottlewash additive that inhibits etching called Divobrite Integra. The etching characteristics of the new additive were compared to a traditional additive and to caustic alone. The laboratory test confirmed that etching could be dramatically reduced by proper chemical selection. (Figure 2).

FIELD STUDIES

Extensive field studies were conducted to determine the ability of the technology (Divobrite Integra) to reduce scuffing. New bottles were cycled through a bottlewasher and production line 30 times along with soiled trade bottles. Bottles were conveyed from the depalletizer into and through the washer, then filled before they were removed from the line at the labeler. This was repeated a total of 30 times. The wash conditions were 2% NaOH at 80°C in tap water with 240 ppm naturally occurring hardness and 1% sodium carbonate. The scuffing appearance was observed and measured, and the weight loss of the bottles was recorded. In addition, the edge of the scuff band was examined using electron microscopy to observe the degree of surface damage. All of these results were compared to those obtained from a control trial using a traditional bottlewash additive.

The photograph shows that the scuff band width and intensity is much lower on the bottles washed 30 times with the scuff reducing technology (Divobrite Integra) compared to the bottle washed with the traditional additive (Figure 3).

A 50% improvement in visible scuffing was achieved when...
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The Divobrite Integra was used (Figure 4). The weight loss of the bottle was also reduced, indicating that surface integrity was maintained longer and less glass components were dissolved in the bollweh solution (Figure 5). Microscopic examination of the exterior scuff marks reveals in more detail the reduced degree of surface damage on the bottle washed with the new technology when compared to traditional additives (Figures 6A & 6B: Electron micrograph of bottle surface at edge of scuff band at 200X.)

![Figure 4: Field validation of reduced scuffing on bottles.](image1)

![Figure 6A: Bottle washed 30 times using Divobrite Integra in caustic.](image2)

![Figure 6B: Bottle washed 30 times using traditional additive in caustic.](image3)

The bottle washed in Divobrite Integra shows large scratches and gouges, damage that is clearly caused by physical abrasion. More extensive damage is evident on the bottle washed in the traditional additive, visible as uneven degradation leaving a coarse and rugged surface. This is caused by a combination of physical and chemical damage and manifests itself macroscopically as white scuff rings.
The reduced scuffing results with the new technology (Divobrite Integra) were also validated through further rigorous testing in the Dutch and German brewing markets. In addition, Divobrite Integra has been proven to be an effective bottlewash detergent under a variety of conditions. Over 100 million bottles have been washed in many different geographic locations, with excellent cleaning results.

**Causticity:** 1 - 3.5% NaOH  
**Sodium carbonate:** levels up to 1%  
**Wash temperature:** 60 - 80°C  
**Labels:** ACL, paper and 7 layer metallized  
**Machine:** Several designs, from new to 30 years old  
**Environment:** Rural and urban  
**Bottle type:** 0.3 to 0.75 liter

Clean bottles protect product integrity. Brewing customers in the German and Dutch markets have evaluated Divobrite Integra and have not found any adverse effects on beer foam or taste. Analyses of bottles washed in Divobrite Integra have shown no detectable chemical residues.

**CONCLUSIONS**

- Reduced chemical etching lead to reduced scuffing (up to 50% less scuffing).  
- Divobrite Integra has the potential to reduce packaging cost by extending bottle life.  
- Divobrite Integra is an effective bottlewash detergent.  
- There is no capital investment required to implement this technology  
- This technology is not a coating or maskant.  
- This technology has no affect on beer characteristics.

**BENEFITS FROM REDUCED GLASS CORROSION**

No packaging says *quality* and *freshness* like a sparkling, clean glass bottle. Whether you are bottling with a distinctive glass bottle, dominate a common float, or competing with imported one-trip glass bottles, the benefits of reduced glass corrosion are the same.

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Brand Image Protection</td>
<td>Reduces scuffing</td>
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<tr>
<td>Product Integrity</td>
<td>Effective detergency</td>
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<tr>
<td>Cost Control</td>
<td>No impact on beer taste or foam</td>
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<td></td>
<td>Extends bottle life</td>
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<td>Reduces float replacement</td>
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<td>No capital investment required</td>
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<td></td>
<td>Preventative protection of float</td>
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<tr>
<td>Ease of Implementation</td>
<td>No alterations to bottling line required</td>
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<td></td>
<td>No additional products to purchase</td>
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This technology has the ability to keep refillable glass an attractive and competitive choice for packaging beverages. While it cannot reverse existing damage on bottles, it will function to prevent further damage, so it is useful for new and used glass bottles. It effectively doubles the trips before unacceptable scuffing occurs, thereby reducing the bottle replacement cost due to scuffing rejects. Because the scuff reducing agents are incorporated into a bottlewashing detergent, this technology is easy to implement and requires no additional equipment or capital investment.

**REFERENCES**