JFE TECHNICAL REPORT
No. 23 (Mar. 2018)

Introduction of Practical Use Technology for All-Laminated 18-Liter Cans†

1. Introduction

Laminated steel sheets are products in which a thermoplastic resin is coated on the surface of a tin-free steel (TFS) or other substrate. The thermoplastic resins used in laminated steel sheets include polyester resins, beginning with polyethylene terephthalate (PET), which is a general-purpose material used in food containers, polyolefin resins such as polypropylene, etc. Laminated steel sheets have a variety of outstanding features. In addition to the fact that the lacquer coating process can be omitted, and the material is free of bisphenol A (suspected of being an environmental endocrine disrupter) and also has excellent corrosion resistance and scratch resistance, etc. As a result, use has expanded to a wide range of container applications, including beverage cans, food cans, 18 L cans, etc. JFE Steel offers a full lineup of laminated steel sheets to respond to customer needs[1)].

18 L cans are large cans that are widely used in industry, food applications, etc. Conventionally, lacquer-coated tinplate or TFS materials have been used in 18 L cans. However, due to the heavy weight of the filled cans, scratching occurs easily due contact between the cans and handling during transportation, and the cans are frequently used in severe outdoor environments in coastal areas, etc. For these reasons, rusting of the can outside surface during use is a serious concern. In particular, since the risk of scratching of the top and bottom can-end plates is higher than in the can body use of laminated steel sheets is desirable in these parts, as laminated materials provide excellent scratch resistance. However, until now, laminated steel sheets were mainly used only in the can body, and there were many calls from the market for laminated top and bottom end plates. Against the background of these requests from customers, JFE Steel developed practical all-laminated cans with excellent scratch resistance in the entire can by using laminated steel sheets in the top and bottom end plates. This report introduces the development of the all-laminated cans, which were developed jointly with Dainichi Can Co., Ltd. and Toyokinzoku Co., Ltd.

† Originally published in *JFE GIHO* No. 39 (Feb. 2017), p. 29−30

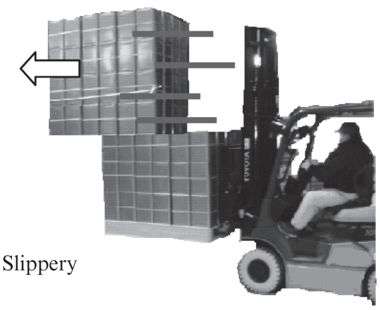


Fig. 1 The problem in 18 litter cans transportation

2. Issue for Practical Application of All–Laminated Cans

As shown in **Fig. 1**, bundles of stacked 18 L cans are commonly moved by using a forklift. The cans are light before filling with the contents, and even under favorable conditions, the load can easily collapse as a result of wind, vibration, etc. during transportation. One obstacle to adoption of laminated top and bottom end plates was the problem that all-laminated cans with film-coated end plates tend to slide more easily than lacquered cans during transportation of stacked empty cans.

3. Mechanism of Sliding

The difference in the ease of sliding of lacquered cans and laminated cans is mainly due to the difference in the coefficient of dynamic friction of the two types of material. As shown in **Fig. 2**, there is substantially no difference in the coefficient of static friction of lac-

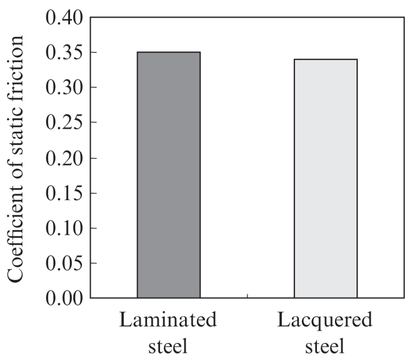
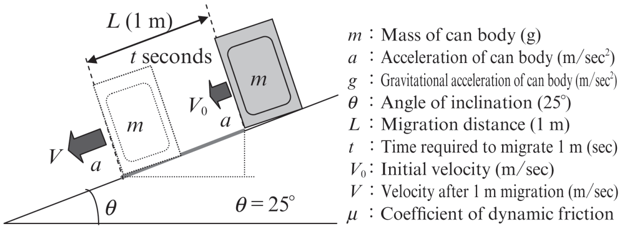


Fig. 2 Comparison of static coefficient



μ(coefficient of dynamic friction) $= \tan\theta - 2/(t^2 \cdot g \cdot \cos\theta)$

Coefficient of dynamic friction is derived using the following energy balance equation by the measurement of time (t sec) of the can body to slip on the inclined surface.

$$m \cdot g \cdot L \cdot \sin\theta = (1/2) \cdot m \cdot V^2 + L \cdot \mu \cdot m \cdot g \cdot \cos\theta$$

Potential energy	Kinetic energy	Frictional work

Fig. 3 Method for measuring the dynamic friction coefficient

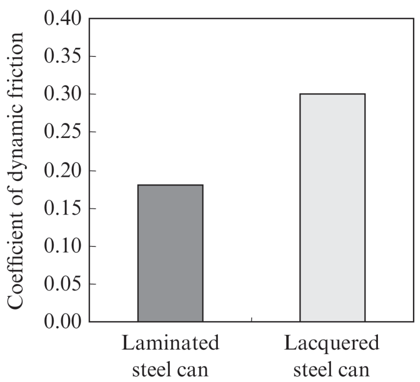


Fig. 4 The dynamic friction coefficient of laminated can and lacquered can

quered steel sheets and laminated steel sheets (film: PET).

When 18 L cans made of the respective steel sheets were placed on a smooth platform, and their sliding behavior when the angle of inclination of the platform was changed was compared, the angle at which the cans began to slide was the same. However, after sliding started, the sliding speed of the laminated can accelerated, whereas the sliding speed of the lacquered can did not increase, and the lacquered can sometimes stopped sliding before the end of the experiment.

Actually, when the time required to slide a certain distance on an inclined surface was measured and the coefficient of dynamic friction was calculated by an energy balance equation, as shown in **Fig. 3**, the coefficient of dynamic friction of the laminated can was lower than that of the lacquered can, as shown in **Fig. 4**.

4. Improvement of Sliding Property

To realize practical application of all-laminated

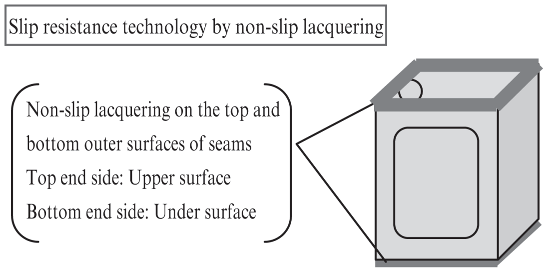


Fig. 5 Improvement of sliding property in the laminated can

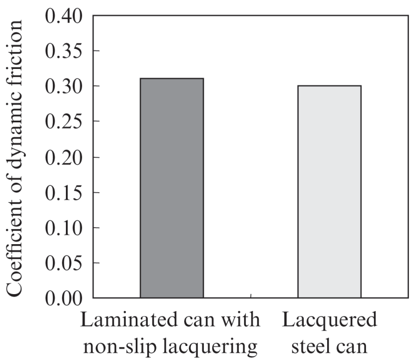


Fig. 6 The dynamic friction of non-slip lacquered all laminated can

cans, it is necessary to increase the coefficient of dynamic friction of the top and bottom end plates. Various approaches to increasing the coefficient of dynamic friction exist, for example, modification of the film surface morphology, changing the lubricant used during film manufacturing and so on. However, in the present case, it is not necessary to increase the coefficient of dynamic friction of the entire film surface because the stacked cans are only in contact at the outer edges of the end plates. Therefore, the method of applying non-slip lacquering to the seams at the outer edges of the top and bottom end plates (**Fig. 5**) was adopted, and the film itself was not changed.

The key point in the development of the slip-resistant lacquer was the slip-resistant component which is added to the base resin. Pine resin (turpentine) was the optimum additive for increasing the coefficient of dynamic friction.

As shown in **Fig. 6**, use of the optimum slip-resistant lacquer has made it possible to control the coefficient of dynamic friction of cans to the same level as that of lacquered cans.

All-laminated cans with improved slip resistance can be transported by the customer in the same manner as lacquered cans, and the problem of cargo collapse specific to laminated cans was also solved.

5. Conclusion

As this example shows, JFE Steel does not simply sell laminated steel sheet products, but strives to provide the optimum proposal and support, extending to the manufacturing process of the final product (in this report, 18 L cans), by thinking together with the customer.

Laminated steel sheets have the outstanding features of scratch resistance and rust resistance. Because 18 L all-laminated cans with improved slip resistance allow the customer to take even greater advantage of these features than in the past, wider adoption laminated steel sheets is expected in the 18 L can industry.

Reference

1) JFE Steel Catalog. JFE UNIVERSAL BRITE, Laminated Steel Sheet for Containers. Cat. no. B1E-009-01.

For Further Information, Please Contact:

Tin Mill Products Sec., Products Design & Quality Control for Sheet & Strip Dept., Fukuyama Works, JFE Steel
Phone: (81) 84-945-4041 Fax: (81) 84-945-4050