Abstract:

“EC F N IE 1” -f f x h h h/ y EMI h f h , h h h

$$(\text{Conduction probability (\%)}) = ((\text{Number of occurrences of conduction})/10) \times 100 \quad \cdots\cdots (1)$$

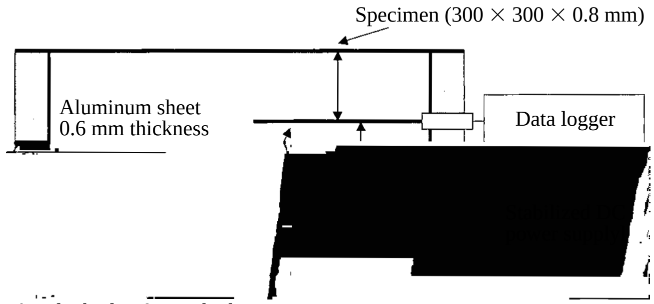
Considering the fact that the main applications of Z1 are electrical appliances and OA equipment, the target level for corrosion resistance was set at time to 5% white rust appearance in SST ≧ 120 h. To secure adequate weldability, groundability, and EMI shielding performance, conduction probability = 100% in the above-mentioned conduction evaluation is desirable. From this viewpoint, the film was designed to be able to satisfy simultaneously the target levels for corrosion resistance and conduction, as shown in Fig. 4. Because the Zn-Ni electroplated surface which is given anodic treatment to produce a black color is extremely active, adequate corrosion resistance cannot be obtained with the chromate-free film applied to ordinary Zn-coated sheets. The authors therefore adopted a composite of an inorganic component, which is used to passivate the surface, and an organic film, which dramatically increases the barrier property against penetration by corrosive substances by enhancing the degree of crosslinking, making it possible to secure the target level. Thus, with Z1, it is possible to satisfy both corrosion resis he dthy osible

Regardless of whether cleaning was performed with the above-mentioned alkali degreasing agent or the solvent-type degreasing agent, no film peeling was observed, and the difference in lightness before and after cleaning, ΔL^*, was no more than 0.1. Thus, no significant changes in appearance were observed, confirming excellent resistance to cleaning and degreasing agents.

3.4 Heat Absorption/Radiation Property

In recent years, the increasing amount of heat generated by electrical appliances, OA equipment, and other products accompanying higher performance has become a problem. Steel sheets with a heat radiation effect have attracted attention as one countermeasure against heat[3). The aim in this case is to reduce the internal temperature inside the equipment housing by promoting radiant heat transfer between the heat-generating source inside the equipment and the steel sheet housing by using a steel sheet with a high thermal emissivity film formed on its surface as the housing material. Formation of a paint film using a paint containing a pigment with high thermal emissivity, such as carbon black or various kinds of oxides, is considered effective for improving the thermal emissivity of the surface film. Furthermore, because the thermal emissivity of organic resins is generally high, increasing the thickness of the paint film is also effective. However, with these methods, increased surface resistance is necessarily unavoidable. On the other hand, the surface film of black-colored steel sheets has sufficient conductivity for use in parts of electrical appliances and OA equipment, as described above, and at the same time, also has a high heat absorption/radiation property.

Figure 7 is an example of an experiment which was conducted to confirm this fact. A heater was set inside a model housing made from acrylic plates 20 mm in thickness, and power was supplied by a DC stabilized power supply at a constant rate of 39 W. The internal dimensions of the model housing were 280 mm(L) × 280 mm( ) × 110 mm(H). The model housing was then set inside a thermostatic chamber in which the temperature was controlled to 23 ± 1°C, and the temperature inside the housing was measured with a thermocouple while the opening at the top of the housing was closed with either a 0.8 mm thick aluminum alloy sheet (JIS 1050), Zn electrogalvanized steel sheet, or Z1. The inner sides of the acrylic housing were covered with reflective aluminum sheets (thickness: 0.6 mm) so that exchanges of heat with the outside were mainly through



the specimen sheets placed over the opening at the top of the test apparatus. Although not shown in Fig. 7, aluminum foil was also placed directly under the thermocouple so the thermocouple would not receive radiation directly from the heater. **Figure 8** shows the change in the internal temperature of the test apparatus described above when current was supplied to the heater. The internal temperature differed remarkably depending on the type of specimen placed over the opening. As shown in Fig. 8, in comparison with aluminum alloy sheet and the EG sheet, a remarkable decrease in internal temperature was confirmed when Z1 was used.

Because the thermal conductivity of aluminum is approximately 4 times greater than that of carbon steel, there are cases where aluminum is used in the housings of personal computers and other devices where the heat radiation property is important. However, as shown by the results of this experiment, when the heat source and the equipment housing are not in direct contact, the difference in the surface film has a greater effect on the heat radiation property than that of the thermal conductivity of the metal sheet. The excellent heat absorption/radiation property of Z1 has been confirmed, and this sheet is now being used in car audio parts and others which are installed in sealed spaces and require a heat absorption/radiation property.

4. Conclusion

The properties of a chromate-free black-colored steel sheet, “ECO FRONTIER Z1,” which features an organic-inorganic composite film on an anodic-treated black-colored Zn-Ni electroplated steel sheet, were presented. ECO FRONTIER Z1 has appearance, corrosion resistance, electric conductivity, and resistance to cleaning and degreasing agents equal to those of conventional black-colored steel sheets, and also possesses an excellent heat absorption/radiation property. From the viewpoint that Z1 is capable of responding to the rising environmental needs of the future, while also offering an effective countermeasure for heat generation accompanying higher performance in electrical appliances, OA equipment, and car audios, expanded application is expected.

References

1) Official Journal of EU, L37/19. 2003-02-13.
2) Yamada, S.; Mitsunari, M.; Taguchi, N.; Kurosawa, M.; Ogawa, T.; Hatano, H. JFE Technical Report. no. 2, 2004, p.19.
3) Nishiyama, N.; Higai, K.; Ogata, H.; Umino, S.; Kato, C. Tetsu-to-Hagané, vol. 89, no. 1, 2003, p. 92.
4) Hirano, Y.; Watase, T.; Mitsuta, M. J. Surface Finishing Soc. Jpn. vol. 54, no. 5, 2003, p. 20.
5) Nakamaru, H.; Umino, S.; Kato, C., Proc.—Electrochemical Soc. 2003-25 (Surface Oxide Films). 2004, p. 335−340.
6) Mochizuki, K. Kawasaki Steel Giho. vol. 31, no. 1, 1999, p. 34.
7) Kikuchi, K.; Suzuki, S.; Tada, C.; Mochizuki, K. CAMP-ISIJ, vol. 9, 1996, p. 1424.