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Wiping Effect of CGL on Appearance of Hot-Dip Coated Steel Sheet

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Abstract:

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measuring 10 points in the longitudinal direction of the respective areas. The measurement range of one measurement was ϕ2 mm with the position of the probe as the center. The coating thickness of the linear marks was 4–5 μm thicker than that in the normal area. Thus,

between the coating thickness of the linear mark and the normal area. Here, “Normal” means the condition without a block. The coating thickness tends to increase as L_l increases. Compared with Fig. 7, it can be understood that the linear mark becomes increasingly visible as the difference in the coating thickness increases. Moreover, because the linear mark is clearly visible at $L_l \geqq 0.125$ mm, the visibility threshold of the coating thickness is considered to be approximately 2 μm.

Fig. 8(b) shows the coating thickness under the condition in Fig. 5(b) “Front edge of nozzle”, and Fig. 8(c) shows the coating thickness under the condition in Fig. 5(c) “Upper part of nozzle”. Although a linear mark was not visible under either of these conditions, this is thought to be because the difference in the coating thicknesses of the linear mark and the normal area was less than 2 μm.

The results presented above revealed that adhesion of foreign material to the front edge or upper part of the wiping nozzle has an insignificant influence on surface quality, but blocking of the slit gap has a serious effect on the generation of linear mark.

4. CFD Analysis and Wiping Theory

Quantification of linear mark generated by blocking of the slit gap was attempted based on a CFD analysis and wiping theory.

First, the wiping theory will be explained. As a wiping theory, a model like that in **Fig. 9** is known, and it is possible to calculate the coating thickness[4–6]. Here, is the coating thickness, is acceleration of gravity, τ is shear stress, is impingement pressure, ρ_L is the density of a liquid, μ_L is the viscosity of the liquid and V is the strip transfer speed.

Next, the CFD analysis will be explained. **Figure 10** shows the numerical analysis model. The commercial software, Fluent 15.0, was used in the numerical analysis, and 3-dimensional compressible Navier-Stokes equations were solved. A standard k-ε model was used in the turbulence model, and a standard wall was used in the wall function. The other analytical conditions were the same as those in Tables 1 and 2, but molten zinc was not simulated. The geometry of the wiping nozzle was the same as in Fig. 4. The number of mesh elements was approximately 2.5 million, with some differences depending on the size of the block.

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