Nakajima Diagram 3D as a Diagnosis of Water Quality for Pitting Corrosion Risk of Cupper Used in Heat Exchanger of Air Conditioner

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The copper is widely used for the cooling tubes of the heat exchanger because it has a high thermal conductivity and workability [1, 2]. However, the copper heat exchanger causes the leakage accident due to water quality, which is mainly the pitting corrosion. Although the pitting corrosion of the copper is significantly influenced by water quality component [3], the occurrence conditions of pitting corrosion are not clarified yet. In this study, the relation between the parameters of the water quality and the pitting corrosion of the cupper was discussed.

The cooling water was sampled by the cupper heat exchanger of the air conditioner of all over the country in Japan to construct two-dimensional phase diagrams, which are used for the investigation of the cooling water quality flowing through the copper tube. As the result from two-dimensional phase diagrams, it was found that the pitting corrosion of copper almost occurred when the concentration of acid consumption was less than 200 ppm. It indicated that the acid consumption had a remarkable influence on the occurrence of pitting corrosion.

In this study, we focused on the Nakajima Diagram [4]. The Nakajima Diagram, which is proposed by Hiroshi Nakajima, is a two-dimensional phase diagram of the water quality to evaluate the risk of the occurrence of pitting corrosion. In this diagram, the horizontal axis is pH and the vertical axis is the percentage of equivalent concentration of sulfate and chloride ions against all anions. It is also including the diagonal line, which is the boundary line of the occurrence of the pitting corrosion. Water quality plots on the area above the diagonal line high risk possibility of pitting corrosion. Figure 1 shows the Nakajima Diagram including the cooling water quality data sampled from all over the country in Japan. The plots represented by circle symbol are water qualities in which pitting corrosion occurred actually, and are located above the diagonal line almost. However, since the vertical axis of the Nakajima Diagram is percentage of equivalent concentration of sulfate and chloride ions against all anions, water quality often cannot be distinguished. We developed three dimensional plot by adding the acid consumption as the z axis to Nakajima diagram for more precise diagnosis regarding pitting corrosion risk, and named it Nakajima diagram 3D. We plotted the same data as those in Fig. 1 on Nakajima diagram 3D shown in Fig. 2. The curved surface in Nakajima diagram 3D means the diagnostic surface which was calculated by pitting corrosion index theoretically. All data representing pitting corrosion accident cases were discriminated apparently in Nakajima diagram 3D.

Reference

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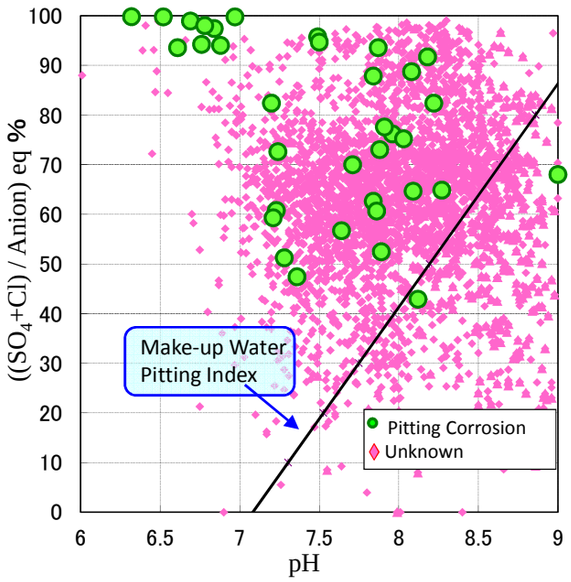

Fig. 1 Nakajima Diagram

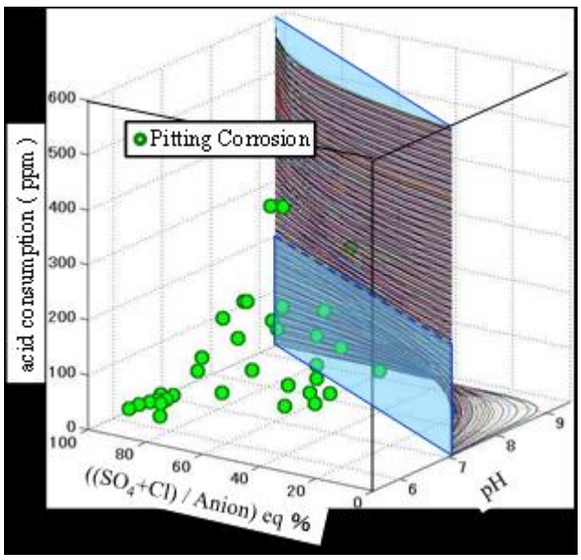

Fig. 2 NakajimaDiagram 3D