Research of Gas Water Heater Cycling System The laboratory Immersion Corrosion Test of Metal

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Abstract**—** *This study is based on the experimental method to investigate the gas water heater cycling piping system, In this experiment, the accelerated corrosion rate of laboratory immersion corrosion test of metal and electrochemical methods, three kinds of water quality to pure water, tap water, groundwater as a corrosion observed. Flow field experiments rectangular boxes, copper tube and acrylic sheet components, In order to visualize the flow, the shadowgraph technique is used. In order to understand the structure of the flow field and flow field of temperature and concentration measurement analysis and mass transfer rates.*

Keywords— Flow Field, Electrochemical, Immersion Corrosion Test, temperature, concentration.

I. INTRODUCTION

The existing water heaters are actually a type of energy conversion device, which converts electric energy, the chemical energy of fuel, or solar energy into heat energy, and uses the high heat capacity of water to contact the heat source indirectly to carry the heat away. In addition, this type of heat absorber (sink) requires an additional container for storing water by the host, the contour design of this container shall have sufficient heat absorption (sinking) capability to increase or reduce the water temperature, and this design using medium with high heat capacity to absorb (eliminate) heat usually causes heat flow fouling on the contact surface of any two objects. This contact thermal resistance has been discussed in depth in literature. For example, Kenneth W. B. et al. [1], Miroslav Colic et al. [2], R. L. D. Caneet al. and [3]. Li et al. [4] collected 679 water quality samples, and analyzed the LSI value to judge the trend of scale or corrosion. This study discusses the causes of corrosion in the water heater circulation system, the factors influencing pitting corrosion, and the countermeasures against corrosion, and the scale formation in the circulating water tower system and the work flow of the descaling device are evaluated and analyzed.

[5]Corrosion potential would be predicted correctly by chosen exact indicator. LSI is used generally for the indicator of corrosion potential. Database of this study were collected from the city water website. Including temperature, hardness, alkalinity, pH, the sulfate etc. The saturation indices can be predicted by using the MINEQL+ model for the reference city water. The result of this study indicted that, Taipei city water has a negative LSI value and corrosive tendency. Hsinchu city water has a positive LSI value and precipitating tendency.

II. EXPERIMENTAL DESIGN AND METHOD

this study proposes flow path analysis of anticorrosion systems for the copper tubes of thermal circulation systems. the research method, procedure, and progress are described, as follows:

the laboratory immersion corrosion test of metal is closest to the true environment, which is combined with the estimation of weight loss and test period, the electrochemical method is used for accelerating corrosion, the corrosion rate is calculated, and the period is usually 3-7 days. the test criteria include ASTM g31-72[6] and cns 13753[7]. in this immersion test, one head of an acrylic pipe is sealed, a length of copper tube is cut in half, the cut copper tubes are locked to both sides with screws, and corrosion by tap water is observed by using the electrochemical method.

(1) The voltage is fixed to observe when tap water generates a reactant.

(2) The voltage and time are fixed to measure the lost weight, and the corrosion rate is calculated.

(3) The surface area is magnified by optical microscope, and while the corrosion rate cannot be accurately measured to judge the type and degree of corrosion, it is recorded for reference as evidential data for judging the type and condition of corrosion in the future.

III. EXPERIMENTAL RESULTS AND DISCUSSION

This immersion test uses the electrochemical method to accelerate the rate of corrosion, and corrosion is discussed using tap water quality.

1. **Copper tube corrosion**

The voltage is fixed at 1.5 V, the current is conducted, there is chemical change nearby the left and right copper tubes, and the tap water quality has response in 20 minutes.

(1) The tap water quality corrodes the copper tube surface. Figure1 shows the initial copper tube surface condition. When the current is conducted for 20 minutes, the copper tube is taken out, there is no scale on the copper tube surface of the cathode; the corrosion of the anode is apparent, and there is scale, as shown in Figure 2

(2) For the copper tube corroded by tap water, the water corrosion surface is magnified 50 times and 100 times by metalloscope for comparison.

(a) The original surface condition of the copper tube before immersion is as shown in Figure 3. The surface has sandpaper abrasion marks.

(b) The corrosion surface condition of the copper tube soaked in tap water is as shown in Figure4, and the pitting corrosion is small and deep.

2. **Distribution pattern of the flow field in a copper tube**

(1) The concentration gradients at 25℃, 45℃, and 65℃ are as shown in Figures 5~ 7. It is observed that there is no obvious change in the concentration inside the copper tube at the three temperatures, thus, the concentration gradient in the small round tube does not significantly vary with temperature.

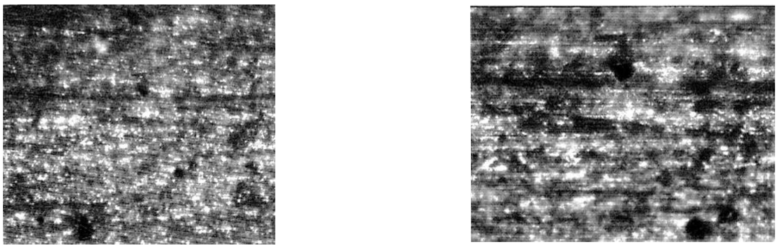
(2) The flow field at 65℃ is observed by using shadowgraphy, and the observations at 0 min, 30 min, 90 min, and 180 min are recorded, as shown in Figures 8~ 11.

FIGURE1. COPPER TUBE SURFACE CONDITION BEFORE IMMERSION ELECTROCHEMICAL REACTION

FIGURE2. SURFACE CONDITION 7 DAYS AFTER ELECTROCHEMICAL REACTION OF TAP WATER IMMERSED COPPER TU

(A) MAGNIFIED 50 TIMES (B) MAGNIFIED 100 TIMES

FIGURE3. SURFACE CONDITION BEFORE IMMERSION



(A) MAGNIFIED 50 TIMES (B) MAGNIFIED 100 TIMES

FIGURE4. SURFACE CONDITION 12 HOURS AFTER ELECTROCHEMICAL PROCESS OF TAP WATER IMMERSION

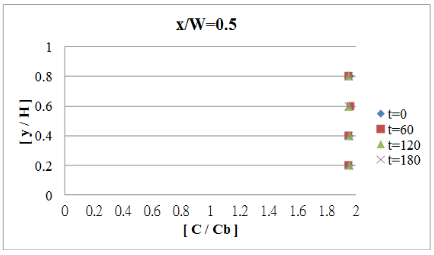


FIGURE 5. 2 CONCENTRATION PROFILE

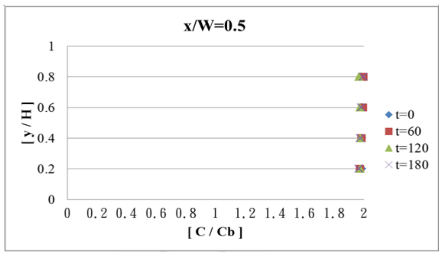


FIGURE 6. 45 CONCENTRATION PROFILE

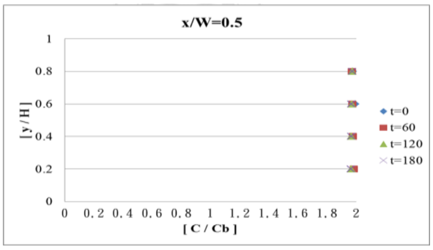


FIGURE 7. 65 CONCENTRATION PROFILE

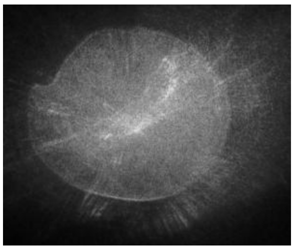


FIGURE8. 0 MIN REACTION AT 65

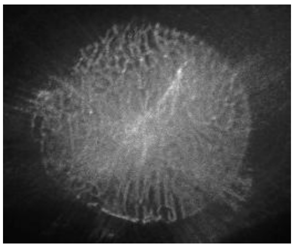


FIGURE 10. 90 MINS REACTION AT 65

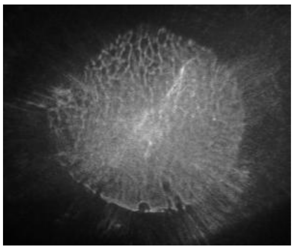


FIGURE 9. 30 MINS REACTION AT 65

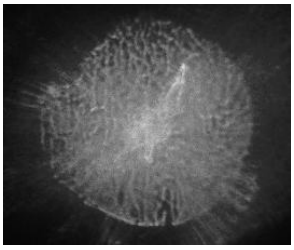


FIGURE 11. 180 MINS REACTION AT 65

IV. CONCLUSION

1. The design of the pipeline exhaust at high temperature can remove the water vapor pressure inside the thermal circulation pipeline, clear the flow path, and is corrosion resistant.
2. According to the experimental observations of the flow field, the metal pitting corrosion potential decreases as the medium temperature rises, the pitting corrosion is accelerated, and according to the concentration distribution and flow pattern, there shall be uniform corrosion in the copper tube.

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