ABSTRACT

In thermal power generation and nuclear power generation, thermal efficiency remarkably decreases by precipitation of components in seawater on the wall within a heat exchanger (condenser), conduits and pumps\footnote{1}. The precipitated layer is called “scale”, which generally consists of calcium carbonate. The calcium carbonate is generated by a simple reaction between calcium ion and carbonate ion. This calcium ions are contained regardless of soft water, hard water and sea water. Thus, the calcium carbonate precipitates in various industrial products. However, in industry, the precipitated scale is frequently removed during maintenances in which much cost and time are required after growing problems as resistances for flow and heat transfer\footnote{2}. Thus, a novel technique is needed to suppress generation of the calcium carbonate scale.

Under these circumstances, a novel technique using the electrolysis water has been proposed for suppressing generation of the calcium carbonate scale within devices. The electrolysis water is a solution obtained by electrolyzing ionic solutions in both anode and cathode fluid regions separated by an ion exchange membrane. Therefore, acid and alkaline solutions can be produced from ionic solutions without using chemicals. It is known that the calcium carbonate is generated by a reaction between calcium ion and carbonate ion. This indicates possibility of suppression for the generation of the calcium carbonate scale, utilizing a forming reaction of bicarbonate ion from carbonate ion by addition of acid-electrolysis water into the fluid in a heat exchanger (condenser), conduits and pumps etc.

In this study, the effect of acid-electrolysis water on suppressing generation of the calcium carbonate scale has been experimentally investigated by a millimetre-sized channel in which the wall temperature can be controlled from 20 to 100°C. A series of accelerated tests using both aqueous sodium hydrogen carbonate solution and calcium chloride aqueous solution have been carried out under the different temperatures, flow rates and pH conditions in order to examine the validity of the proposed acid-electrolysis water injection method. It has been found that generation of the calcium carbonate scale is completely suppressed under the pH=7 or less. This indicates that generation of the calcium carbonate strongly depends on the concentration of carbonate ion. Moreover, the possibility that acid-electrolysis water affects the crystal structure of calcium carbonate has been found from the SEM images.

REFERENCES

\footnote{1} KH Teng, SN Kazi, Ahmad Amiri, Calcium carbonate fouling on double-pipe heat exchanger with different heat exchanging surfaces, Powder Technology 315 (2017) 216–226