Waterside Fouling Performance of Brazed-Plate Type Condensers in Cooling Tower Applications

The worldwide market for brazed-plate heat exchangers (BPHEs) is in excess of $350M, and the North American market for these products is estimated to be in excess of $30M, in which the majority of them are used in HVAC&R applications. Many BPHEs are used as condensers in cooling tower applications. The waterside fouling is a significant concern in such applications. The deposition of unwanted materials inside the BPHEs reduces the performance of the BPHEs. To date, ARI Guideline E, a primary source of fouling information used by industry, does not include the case of fouling inside BPHEs because a comprehensive study has not been documented in the open literature. The users of this type of equipment have typically applied the fouling information for tube-type heat exchangers in ARI Guideline E. However, this may not be suitable for BPHE condensers. Overestimated fouling information results in over-sized condensers which increases first-costs and refrigerant volumes; inappropriate selection of the maintenance programs due to underestimated fouling information can increase the operational cost, and reduce system efficiencies and operational life for time being. Therefore, the objectives of this research are to determine the impact of water-side fouling on the performance of BPHEs and to develop the correlations of fouling data for BPHEs.

The proposed experimental setup consists of a refrigerant loop and a simulated cooling tower water loop. The two loops exchange heat to each other using several brand-new BPHEs being tested. The BPHEs are installed in parallel to ensure same inlet conditions. A variable speed pump and an electrical heater are installed in the refrigerant loop to condition the refrigerant to meet specific test requirements. Tap water and certain amount of additives that are well mixed will be used to simulate the cooling tower water. The water will be circulated by a water pump in the water loop. The essential instruments including mass flow rate meters, pressure transducers and thermocouples are installed along the loops. The system is operated continuously until the fouling has reached an asymptotic level. The experimental results are used to develop the correlations of fouling for BPHEs.

The expected outcome from this research is to provide design guidelines with fouling information for BPHEs. It has immediate benefits to HVAC&R industry. The guidelines can make the systems using BPHEs as condensers have the opportunity to be operated at peak efficiencies with maximized system life and minimized refrigerant charges and operational cost. It can provide supplementary information to ARI Guideline-E.