Abstract

Effective control of cooling water systems requires sufficient control of fouling, scaling and corrosion. Fouling is generally defined as the formation of deposits on heat transfer surfaces, which interferes with heat transfer and/or fluid flow.

Depletion and degradation of water sources and environmental concerns have resulted in industries reducing their freshwater consumption and wastewater discharge, forcing their reliance on poorer water quality in cooling water systems. This results in the water containing large amounts of dissolved inorganic salts, suspended solids and organic compounds. As water contacts a hot heat transfer surface, the water may become supersaturated and precipitation of the contaminants will occur on the heat transfer surface resulting in fouling. This increases the resistance to heat transfer and reduces overall effectiveness of the heat exchanger. Cooling water thus has to be subjected to treatment in order to reduce the tendency to foul.

The object of this investigation was to develop techniques to evaluate the fouling potential of different streams. The techniques developed were then used to test the Sasol 2 process cooling water. Chemical speciation was used to examine the water chemistry effects, indicating the possible solids that may precipitate from the cooling water under different operating conditions. The computer program used for the chemical speciation was MINTEQA2, a geochemical equilibrium speciation program for dilute aqueous systems. There are, however, limitations in using computer simulated chemical speciation of cooling water, so along with chemical speciation, an investigation was done into assessing the applicability of laboratory scale tests for the simulation of the fouling in heat exchangers.

Initially, laboratory-scale precipitation experiments were performed to obtain an understanding of the precipitants in the water. These results, however, were inconclusive indicating that this method was inadequate for understanding the precipitation of solids onto heat exchanger surfaces. The precipitants formed using vacuum evaporation were not similar to samples of scale previously removed from a heat exchanger tube in the Sasol cooling water circuit.

To obtain more realistic data a fouling probe was designed and constructed, which simulates the same conditions of surface temperature and shear stress in the heat exchanger. The characterisation of the probe, using normal Durban potable water, allowed the development of the fouling resistance layer to be monitored, by subtracting the contribution of the boundary layer and the internal resistance. The probe was initially tested using a saturated solution of calcium sulphate. Thereafter fouling tests were performed on the Sasol 2 cooling water. This then allows for the effect of operating conditions to be monitored, or for treatment programs to be optimised. The probe can be modified for on-line operation.