Abstract

The concept of operating circulation loops exploiting the buoyancy force instead of any prime movers is not new. Over the years the use of buoyancy operated circulation loops are increasing. Researchers are continuously modifying the design of such loops and extending their applicability in newer fields of technology. Though, there could be different variations of Buoyancy Induced Circulation Loops (BICLs) they can mainly be grouped into two categories. One can exploit the change of density variation due to differential heating and cooling of the loop. These loops are known as Natural Circulation Loops (NCLs). On the other hand, circulation can be generated due to concentration change and loops can be operated adiabatically. Air-Lift Loops (ALLs) are examples of the second type of loops. In the present work, investigations on NCLs as well as on ALLs have been made.

Though, different configurations of NCLs have been studied, indirect heat exchangers coupled by NCLs have not been analysed in details by the earlier researchers. Such systems are convenient for waste heat recovery. The steady state performance of such loops has been analysed in details in the present work. It has also been discussed that for a given initial cost of the heat exchangers, how they are to be sized to get the maximum benefit out of the loop. Optimum design of NCLs with the constraint of specified loop volume has been determined for operating conditions of both single phase and two phase flow through the loop.

The steady state performance of a multi path loop having a number of risers and a single downcomer simulating the operation of a natural circulation boiler has been analysed. The effect of design variation of one of the risers on the loop performance has also been studied.

Transient performance and stability of NCLs are challenging issues to the researchers. The transient performance of a rectangular NCL with end heat exchangers has been studied in details. A simulation algorithm based on Finite Element Method (FEM) has been

developed for this purpose. The simulation predicts the response of the cold end h exchangers for given excitation to the hot end heat exchanger. The performance of above system has also been compared with dynamic behaviour of other conventional h exchange systems. Using the same Finite Element simulation the stability of the ab system has also been investigated. Stability of the loop has been investigated by analy its response due to a finite perturbation. Based on the results of the above analys stability map for the loop has also been prepared.

Finally, a thorough investigation has been made on the performance of an ALL thro an in depth scheme of experimentation. Performance of the ALL has been studied for b normal liquid level and for low liquid inventory. A simplified one-dimensional model loop hydrodynamics has been constructed. The model gives close prediction of experimental results. In limited liquid inventory, air is entrained in the downcomer due different mechanisms. This induces periodic oscillatory flow through the loop. If the flow rate is increased beyond a certain value, the periodic flow behaviour changes t random or chaotic flow.