Chapter I

INTRODUCTION

1.1 Double Pipe Heat Exchanger

Heat transfer is the transfer of energy occuring as a result of a driving force called temperature difference. There are three mechanisms by which heat transfer can occur; conduction, convection and radiation. In this work, convection is an important factor. The heat exchanger used in the experiment is a double pipe heat exchanger, which is the simplest type of heat exchangers.

The double pipe heat exchanger is essentially two concentric pipes with one fluid flowing through the center pipe while the other fluid moves cocurrently or countercurrently in the annular space. The length of each section is usually limited to standard pipe lengths, so that, if an appreciable heat transfer surface is required, banks of sections are frequently used. The use of a double pipe heat exchanger is not limited to liquid-liquid heat exchanger but may also be used for gas-liquid exchange and for gas-gas exchange. Materials of construction may be varied, depending upon the fluids being handled. Either fluid may be moved through the tube or annulars at relatively high velocities, thereby aiding in the heat transfer processes.

1.2 Controlled Cycling Operation

The concept of controlled cycling was introduced by Cannon (1950). He defined controlled cycling as a cyclic process in which the time for each part of the cycle or amount of material moved in each part of the cycle, or both is controlled by automatic equipment. Although controlled cycling had been proved to be a very effective method of operation, it still has not been applied extensively to industrial plants.

All previous application of controlled cycling in the field of mass transfer have involved the flow of only one phase at a time. Some processes have a short pause with no flow between flow periods to permit phase separation. The directions of the flow during their respective periods are opposite. There are two important advantages of this alternate, one phase flow. First, it prevents the channelling of phases and therefore improves the contact between phases. Second, it increases greatly the average driving force, for sample the average concentration difference in the case of mass transfer. For these reasons, efficiency and capacity with controlled cycling should be higher than conventional operation.

In the present study the controlled cycling technique was applied to the process of heat transfer in a double pipe heat exchanger. There were four patterns of flowing in the heat exchanger: cocurrent and counter-current of either cold or hot fluid in either the center pipe or the annulus of the exchanger. This operation had one phase flowed continuously while the other flowed intermittently. It was done so that the driving force of heat transfer, ie. temperature difference would be increased. It was expected that the thickness of laminar sublayer would be reduced by the intermittent fluid flow, and this would result a lower resistance to heat transfer. Therefore, the amount of heat transfer in the controlled cycling operation would be higher than the conventional operation. The cycle time for each phase flowing was controlled by an electric timer.

1.3 Purpose of This Work

Many investigators have found that the efficiency and the capacity of mass transfer processes were higher by controlled cycling than by conventional operation. This method of operation is general and can be applied to many kinds of mass transfer reaction and heat transfer processes such as liquid-liquid extraction, sieve plate distillation column. It was the purpose of the present work to find out whether cyclic operation improved the efficiency of the double pipe heat exchanger.

1.4 Nature and Scope of the Research Work

A double pipe heat exchanger was operated both in the conventional manner and using cyclic operation. In the case of cyclic operation, experimental runs were performed at various combinations of the following operating conditions:

1. controlled cycling on either phase and on both phases

2. when both phases were subjected to controlled cycling

   2.1 cycle time

   2.2 lagging of the cyclic actions in both phases.

3. flow rates of hot and cold fluids

4. temperature of hot and cold fluids

The effects of these operating conditions on overall heat transfer coefficient were investigated, and the results were discussed and concluded. The fluid phases was hot and cold water. The temperatures at various points were measured using copper-copper constantan.