CHAPTER 3

OBJECTIVES AND METHODOLOGY

In any conventional simple solar still, solar energy heats a mass of water at the basin, which acts as an evaporating zone, and evaporates its surface layer. By means of natural convection, the water vapour reaches the inclined transparent glass inner surface, which is at a relatively lower temperature than the water vapour, and so condenses on it. The condensed drops of water slide on the inner glass surface and are collected in the collecting channel, which is already discussed in the Chapter 1. These stills suffer from some drawbacks which make them uneconomical for domestic purposes. Some of these drawbacks can be listed as follows:

1. The productivity of the basin still is limited by the large mass of water presence at the basin. For a fixed amount of heat entering the unit, the temperature of the water and hence, the rate of evaporation, is inversely proportional to the mass of the water at the basin.

2. The temperature of the inner glass surface, which acts as a condenser, is interrelated to the evaporating zone and is marginally lower than the temperature of the vapour produced. Since the rate of condensation greatly depends on the difference between these two temperatures, only a small portion of the vapour produced will condense on the inner glass surface.
3. The water droplets, which condense on the inner glass surface, reduce the glass transparency by diffusing some of the solar radiation, thereby not allowing all the solar radiation entering the cell to reach the water surface.

4. Since the system relies on natural convection, not all the water vapour produced reaches the glass cover inner surface.

5. Not all the water drops condensed on the glass reach the collecting channel, some fall back into the evaporator.

6. Due to relatively higher temperature of the collecting channel, which is integrated into the evaporating zone, some of the fresh water which reaches the channel will re-evaporate back into the system.

7. Inner wall surfaces have considerable surface area and stores certain amount of heat, which increase the vapour and glass temperature inside the still, hence the temperature difference between water and glass falls to a lower value, resulting in lower output.

The ultimate aim of most of the research work done in the field of solar distillation is to increase the distillate output from the solar still. This is achieved either by increasing the water temperature or decreasing the condensing cover temperature. Thus, any new approach to be employed should attain either one of the two objectives efficiently or both.

3.1 OBJECTIVES

The main objective of this study is to enhance the performance of a simple solar still. To achieve the objective, certain modification is done on the simple solar distillation system, and experimental and theoretical parametric studies are performed.
Also the study aims:

- To enhance the productivity of a solar still by increasing temperature difference between water and glass, using sponge liners at the inner wall surfaces and reducing the heat losses by using energy storage materials inside the basin and by studying the effect of various parameters like water depth, sponge liner thickness and colours, etc.

- To develop a thermal model using simple linear regression analysis for evaluating the convection heat transfer coefficient correlations $C$ and $n$, and to find the convective and evaporative heat transfer coefficients using the new modified $C$ and $n$ values, for various parameters like water depth, sponge liner thickness, energy storage materials etc.

- To develop a mathematical model to predict the performance of solar distillation system using the new calculated value of convective and evaporative heat transfer coefficients, which are obtained in thermal model.

### 3.2 METHODOLOGY

To achieve the above objectives, the following methodologies are used in the experimental and theoretical investigations.

1. The conventional solar still was modified to accommodate sponge liner and energy storage medium.

2. Detail experimental investigation was carried out to access the performance of the solar still for the following cases, the effect of (i) water depth, (ii) sponge liner thicknesses, (iii)
sponge liner colour, (iv) energy storage medium and (v) black granite gravels and black coloured sponge liner combination.

3. Detailed heat transfer analysis was carried out to study the internal and external energy flow like convective heat transfer from glass to ambient, conductive heat transfer from inner surface to outer surface, radiation heat transfer from glass to ambient etc.

4. An extensive experimentation has been carried out to analyse the convective and evaporative heat transfer coefficients to obtain the values of C and n through a thermal model using the experimental values of water and glass temperature and distilled output. The thermal model used in this methodology is based on the method of regression analysis. Mathematical formulation (macro) has been developed in EXCEL to evaluate C and n value for thermal model.

5. A mathematical model was developed by writing the energy balance equation of water mass, glass and basin liner, to predict theoretical temperature of glass, basin water, basin liner and the yield of distilled water, using the convective and evaporative heat transfer coefficients values which are obtained in thermal model. The C program is used for the mathematical model to predict the theoretical temperature of water, glass, basin liner and distilled output.

In the next Chapter – 4, the fabrication of experimental setups including materials, specifications, measurement techniques of various parameters and observation has been discussed in detail.