tion and R-13 insulation, the best overall performance is achieved in terms of total energy required and minimum heat loss. An investigation of methods to enhance stratification in a single tank with a single heating element located in the upper portion was demonstrated with the use of a special inlet tube (Fanney et al. 1982). The tube, shown in figure 7.11, has alternate, equally spaced holes down the inner and outer tubes. It was experimentally shown that a stratified tank with this tube produced system fractional energy savings 8.7% higher than a tank with a plain tube to the same tank depth. The slower temperature decay rate in the upper portion of the tank results in lower auxiliary energy usage for the system when the tank is stratified.

Figures 7.12a and 7.12b illustrate the excellent thermal stratification obtained in a closed-loop indirect heating residential SDHW system using silicone as the heat transfer fluid (Jackson 1979). The 120-gallon preheat storage tank was equipped with a finned tube heat exchanger and operated at a flow rate of 5 gallons/minute (19 l/min).

7.2.2 Gas Backup Heater Development

Achieving stratification in a conventional single tank heated by gas or oil auxiliary is not normally possible because these tanks are constructed with the heat input at the tank bottom; free convection results in circulation of the heated water and a fully mixed tank. An analytical and experimental study of methods to obtain an efficient backup gas-fired heater was conducted by Morrison (1980). A schematic of an engineering prototype design comprising two storage tanks, a gravity return water heat pipe, and a unique side-flue type combustion chamber assembled into a thermally insulated container is shown in figure 7.13.

Stratification in the tanks was enhanced by using an offset "split-tube" connecting pipe and by the natural heat input into the demand tank by the heat pipe. Temperature differences as high as 32°C (90°F) were obtained between the bottom and the top of the tank. Burner efficiencies of about 80% were measured under typical DHW loads and operating conditions.

7.2.3 Controller Strategies

The primary function of the controller in a SDHW system is the efficient collection of solar energy by the controlling pump or blower settings. Other functions involve operation of components for freeze protection, high temperature protection, and special functions such as auxiliary en-

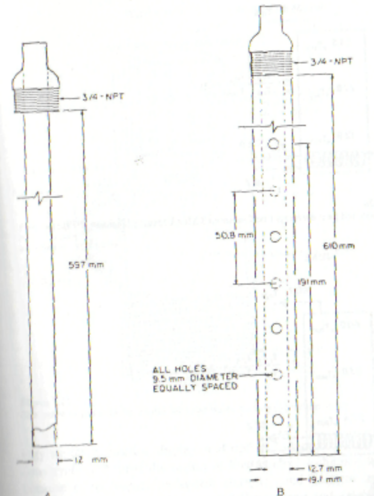

Figure 7.11
Comparison of standard hot water tank return tube (A) with modified tube (B) used to enhance temperature stratification (Fanney, Thomas, Scarborough, Terlizzi 1982).