6.5.1 Pool Boiling

Attention will now be shifted to the heat transfer phenomena associated with heterogeneous vaporization and begin with the most common version of this namely, pool boiling, in which the vapor bubbles form and grow as a result of the conduction of heat through a bounding solid surface (in a nuclear reactor the surface of the fuel rods). The most obvious application of this information is the boiling that occurs in a BWR. The heat flux per unit area through the solid surface is denoted by $\dot{q}$; the wall temperature is denoted by T_w and the bulk liquid temperature by T_b (or T_L). The temperature difference $\Delta T = T_w - T_b$ is a ubiquitous feature of all these problems. Moreover, in almost all cases the pressure differences within the flow are sufficiently small that the saturated liquid/vapor temperature, T_e, can be assumed uniform. Then, to a first approximation, boiling at the wall occurs when $T_w > T_e$ and $T_b \leq T_e$. The label *sub-cooled boiling* refers to the circumstances when $T_b < T_e$ and the liquid must be heated to T_e before bubbles occur. On the other hand vapor condensation at the wall occurs when $T_w < T_e$ and $T_b \geq T_e$. The label *super-heated condensation* refers to the circumstances in which $T_b > T_e$ and the vapor must be cooled to T_e before liquid appears at the wall.

The solid surface may be a plane vertical or horizontal containing surface or it may be the interior or exterior of a conduit. Another factor influencing the phenomena is whether there is a substantial fluid flow (convection) parallel to the solid surface. For some of the differences between these various geometries and imposed flow conditions the reader is referred to texts such as Collier and Thome (1994), Hsu and Graham (1976) or Whalley (1987). The next section includes a review of the phenomena associated with a plane horizontal boundary with no convection. Later sections deal with vertical surfaces.