6.2.3 Flow regime maps

Despite the issues and reservations discussed in the preceding section it is useful to provide some examples of flow regime maps along with the definitions that help distinguish the various regimes. Perhaps the most widely studied multiphase flow is that of a gas/liquid mixture in a horizontal conduit and here some progress has been made in understanding the scaling of the boundaries in a flow regime map (see, for example, Hubbard and Dukler 1966, Weisman 1983, Mandhane *et al.* 1974, Brennen 2005). However, the focus in nuclear power generation is more frequently on vertical gas/liquid flow and the typical definitions of these flow regimes are as displayed graphically in figures 1 (see, for example, Hewitt and Hall Taylor 1970, Butterworth and Hewitt 1977, Hewitt 1982, Whalley 1987). An example of a vertical flow regime map is shown in figure 2, this one using momentum flux axes rather than volumetric or mass fluxes. Note the wide range of flow rates in this flow regime map by Hewitt and Roberts (1969) and the fact that they correlated both air/water data at atmospheric pressure and steam/water flow at high pressure.

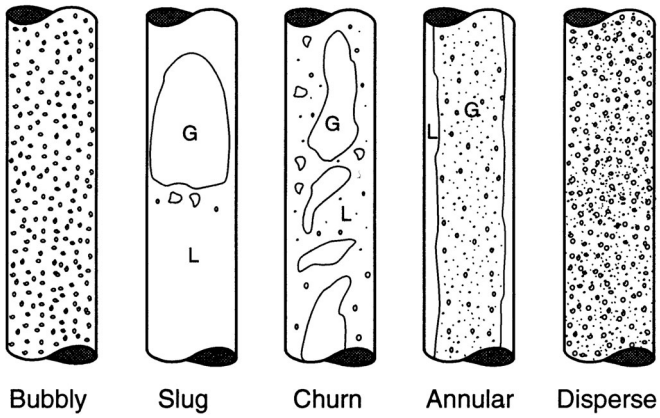

Figure 1: Sketches of flow regimes for two-phase flow in a vertical pipe. Adapted from Weisman (1983).

It should be added that flow regime information such as that presented in figure 2 appears to be valid both for flows that are not evolving with axial distance along the pipe and for flows, such as those in a reactor, in which the volume fraction is increasing with axial position. Figure 3 provides a sketch of the kind of evolution one might expect in a vertical fluid passage within a reactor core based on the flow regime maps given above.

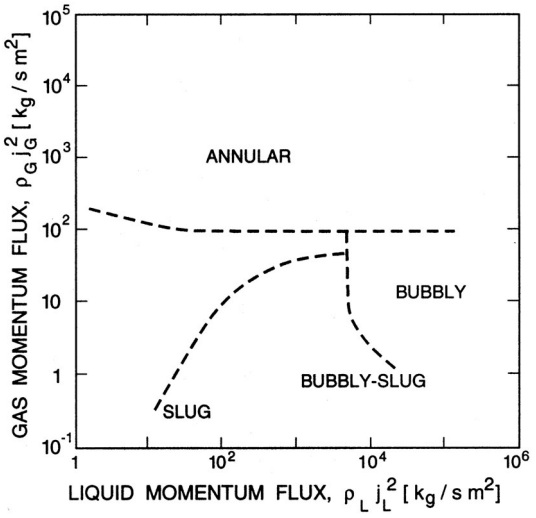

Figure 2: The vertical flow regime map of Hewitt and Roberts (1969) for flow in a 3.2 *cm* diameter tube, validated for both air/water flow at atmospheric pressure and steam/water flow at high pressure.

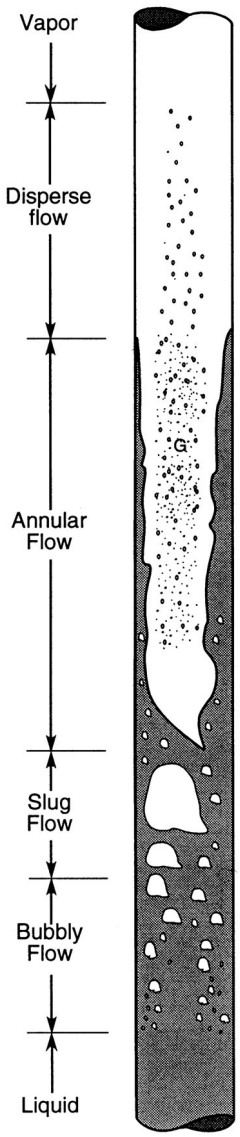

Figure 3: The evolution of the steam/water flow in a boiling vertical conduit.