

6.6.2 Concentration wave oscillations

Often in multiphase flow processes, one encounters a circumstance in which one part of the flow loop contains a mixture with a concentration that is somewhat different from that in the rest of the system. Such an inhomogeneity may be created during start-up or during an excursion from the normal operating point. It is depicted in figure 1, in which the closed loop has been somewhat arbitrarily divided into a *pipeline* component and a *pump* component. As indicated, a portion of the flow has a mass quality that is larger by $\Delta\mathcal{X}$ than the mass quality in the rest of the system. Such a perturbation could be termed a concentration wave though it is also called a density wave or a continuity wave; more generally, it is known as a kinematic wave. Clearly, the perturbation will move round the circuit at a speed that is close to the mean mixture velocity though small departures can occur in vertical sections in which there is significant relative motion between the phases. The mixing processes that would tend to homogenize the fluid in the circuit are often quite slow so that the perturbation may persist for an extended period.

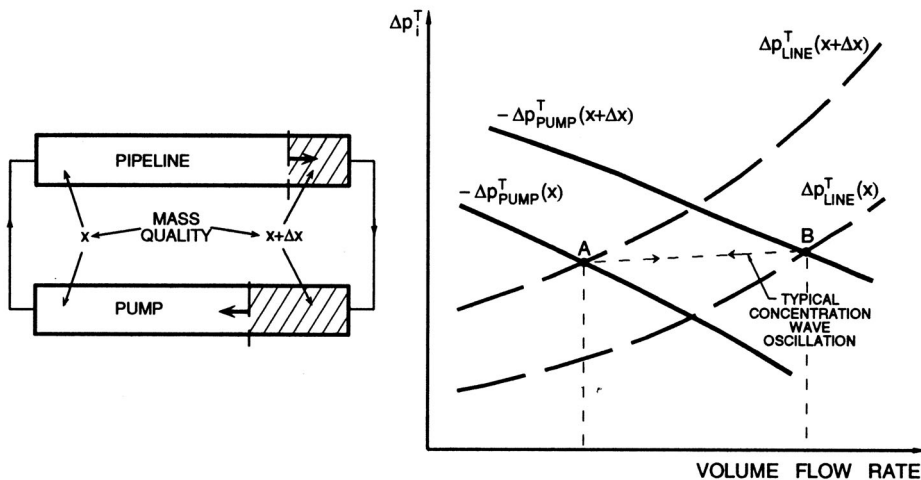


Figure 1: Sketch illustrating a concentration wave (density wave) oscillation.

It is also clear that the pressures and flow rates may vary depending on the location of the perturbation within the system. These fluctuations in the flow variables are termed concentration wave oscillations and they arise from the inhomogeneity of the fluid rather than from any instability in the flow. The characteristic frequency of the oscillations is simply related to the time taken for the flow to complete one circuit of the loop (or some multiple if the number of perturbed fluid pockets is greater than unity). This frequency is usually small and its calculation often allows identification of the phenomenon.