Ledinegg Instability

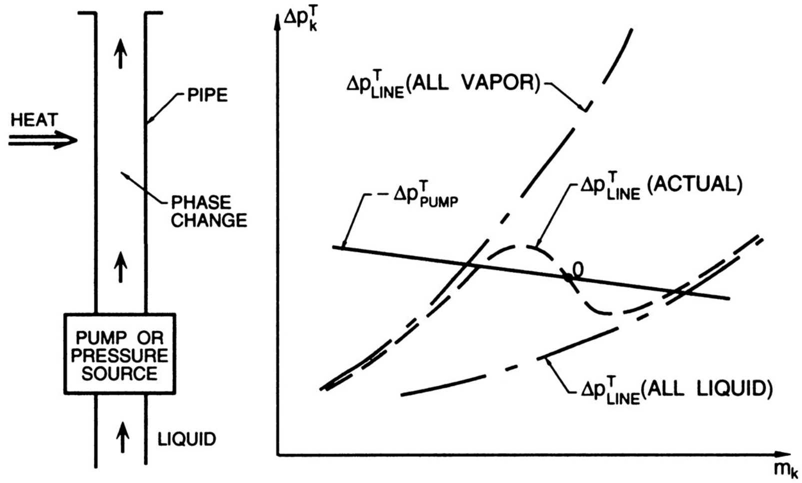

Figure 1: Sketch illustrating the Ledinegg instability.

Two-phase flows can exhibit a range of similar instabilities. Usually, however, the instability is the result of a non-monotonic *pipeline* characteristic rather than a complex *pump* characteristic. Perhaps the best known example is the Ledinegg instability (Ledinegg 1983) which is depicted in figure 1. This occurs in boiler tubes through which the flow is forced either by an imposed pressure difference or by a normally stable pump as sketched in figure 1. If the heat supplied to the boiler tube is roughly independent of the flow rate, then, at high flow rates, the flow will remain mostly liquid since, as discussed in section (Nkg), $d\mathcal{X}/ds$ is inversely proportional to the flow rate (see equation (Nkg6)). Therefore $\mathcal{X}$ remains small. On the other hand, at low flow rates, the flow may become mostly vapor since $d\mathcal{X}/ds$ is large. In order to construct the $\Delta p_k^T(\dot{m}_k)$ characteristic for such a flow it is instructive to begin with the two hypothetical characteristics for all-vapor flow and for all-liquid flow. The rough form of these are shown in figure 1; since the frictional losses at high Reynolds numbers are proportional to $\rho u^2 = \dot{m}_k^2/\rho$, the all-vapor characteristic lies above the all-liquid line because of the different density. However, as the flow rate, $\dot{m}_k$, increases, the actual characteristic must make a transition from the all-vapor line to the all-liquid line, and may therefore have the non-monotonic form sketched in figure 1. This may lead to unstable operating points such the point O. This is the Ledinegg instability and is familiar to most as the phenomenon that occurs in a coffee percolator.