There are a number of instabilities that may occur in two-phase systems. These may be classified into static and dynamic instabilities [Lahey andPodowski (1989)]. Examples *of static instabilities* include: *flow excursion* (i.e., Ledinegg) *instabilities, flow regime relaxation instabilities, geysering* or *chugging instabilities* and the *terrain-induced instabilities* that may occur in off-shore oil well lines. Similarly, *dynamic instabilities* include: *density-wave oscillations, pressure drop oscillations, flow regime-induced instabilities* and *acoustic instabilities*.

Of these instability modes, the most important, and most widely studied, have been *Ledinegg instabilities* [Ledinegg (1938)] and *density-wave oscillations* (DWOs). While the subsequent discussion will be focused on boiling systems, it should be noted that similar instabilities may also occur in condensing systems [Lahey and Podowski (1989)].

A typical *boiling loop* includes a heated channel (or channels), an unheated riser, a condenser, a downcomer (in which a pump may be installed) and a lower plenum. A dynamic force balance on the boiling loop yields:

(1)

$$\Delta p_{ext} = \Delta p_{sys} + I \frac{dw}{dt}$$

where, Δp_{ext} is the impressed pressure rise in the system (e.g., due to a pump) and Δp_{sys} is the pressure drop of the system at flow rate w. The hydraulic inertia of the loop (I) is given by

(2)

$$I = \left(\frac{L}{g_c A_{x-s}} \right)$$

Linearizing Equation (1), we obtain

(3)

$$I = \frac{d(\delta w)}{dt} + \left[\frac{\partial(\Delta p_{sys})}{\partial w} - \frac{\partial(\Delta p_{ext})}{\partial w} \right] \delta w = 0$$

which has a solution given by

(4)

$$\delta w(t) = \delta w(0) \left[\exp\left\{ - \left[\frac{\partial(\Delta p_{sys})}{\partial w} - \frac{\partial(\Delta p_{ext})}{\partial w} \right] t / I \right\} \right]$$

We note that Equation (4) implies that a flow excursion will occur if

(5)

$$\frac{\partial(\Delta p_{sys})}{\partial w} - \frac{\partial(\Delta p_{ext})}{\partial w} > 0$$