UNENE Graduate Course
Reactor Thermal-Hydraulics Design and Analysis
McMaster University
Whitby
March 19-21, April 23-25, May 2, 2004

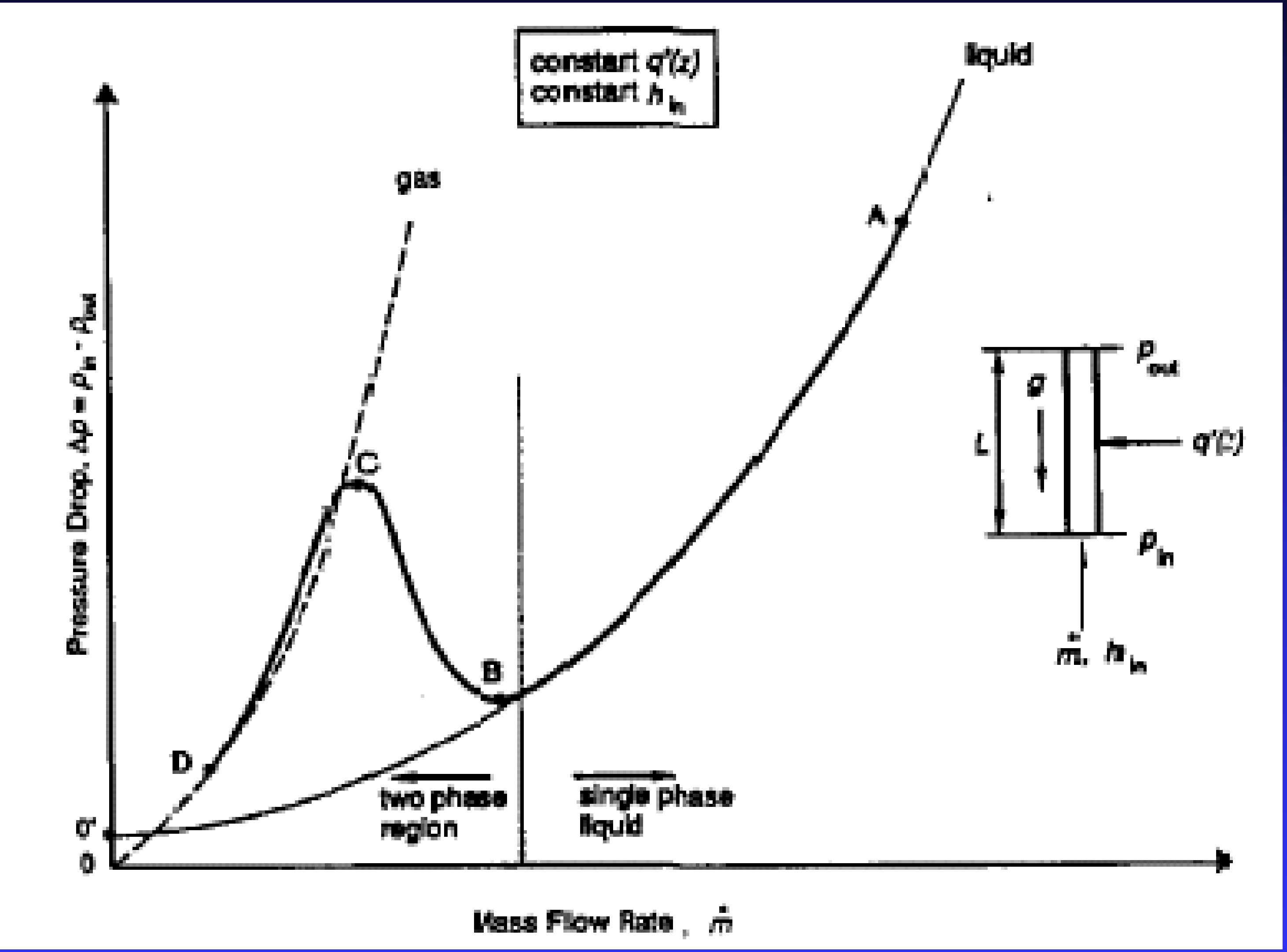
Flow Instabilities

Dr Nik Popov

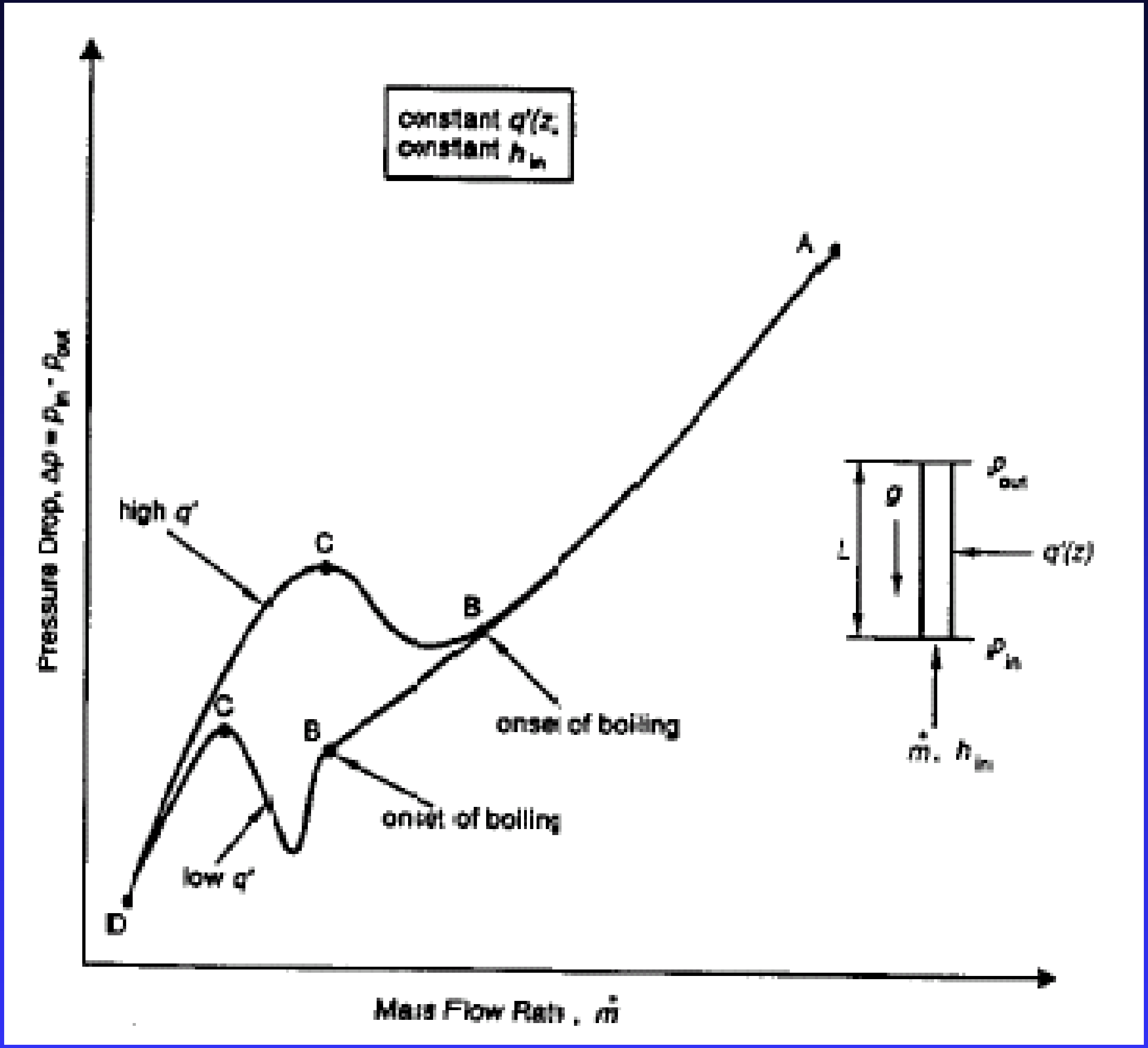
Flow Instabilities

- Understanding flow instabilities is instrumental to ensuring good understanding of thermal-hydraulics system behavior
- Scale-based grouping
  - Microscopic instabilities (occur locally)
  - Macroscopic instabilities (involve entire system)
- Process-based grouping
  - Static instabilities (unstable equilibrium states)
    - Flow excursions (Ledinegg instability)
    - Relaxation instabilities (flow pattern transitions, nucleation instabilities, bumping, chugging, and geysering)
  - Dynamic instabilities
    - Density wave oscillations
    - Pressure wave oscillations
    - Acoustic oscillations

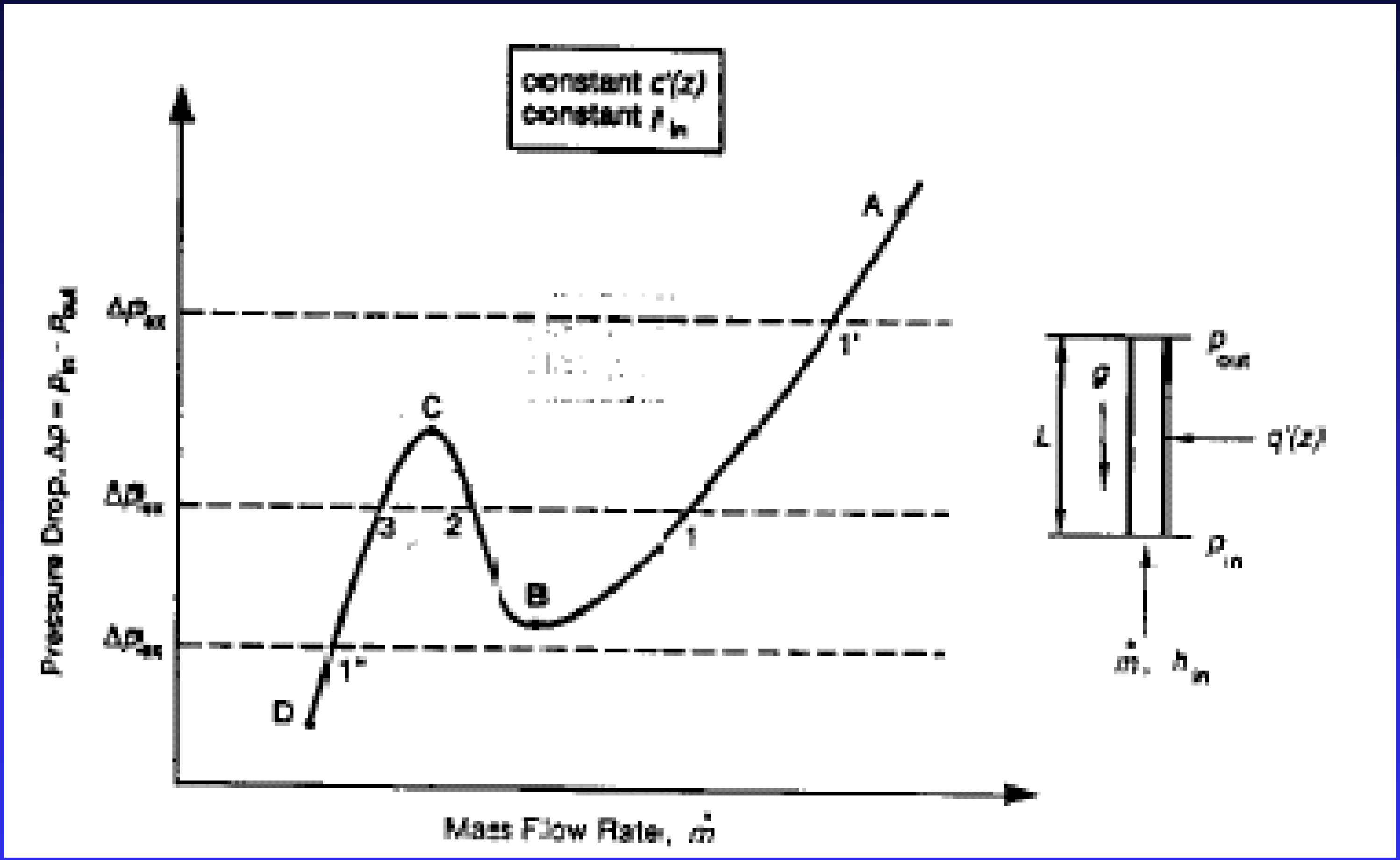
Flow Instabilities - Background



Flow Instabilities - Background



Flow Instabilities - Background



Flow Excursion Instability

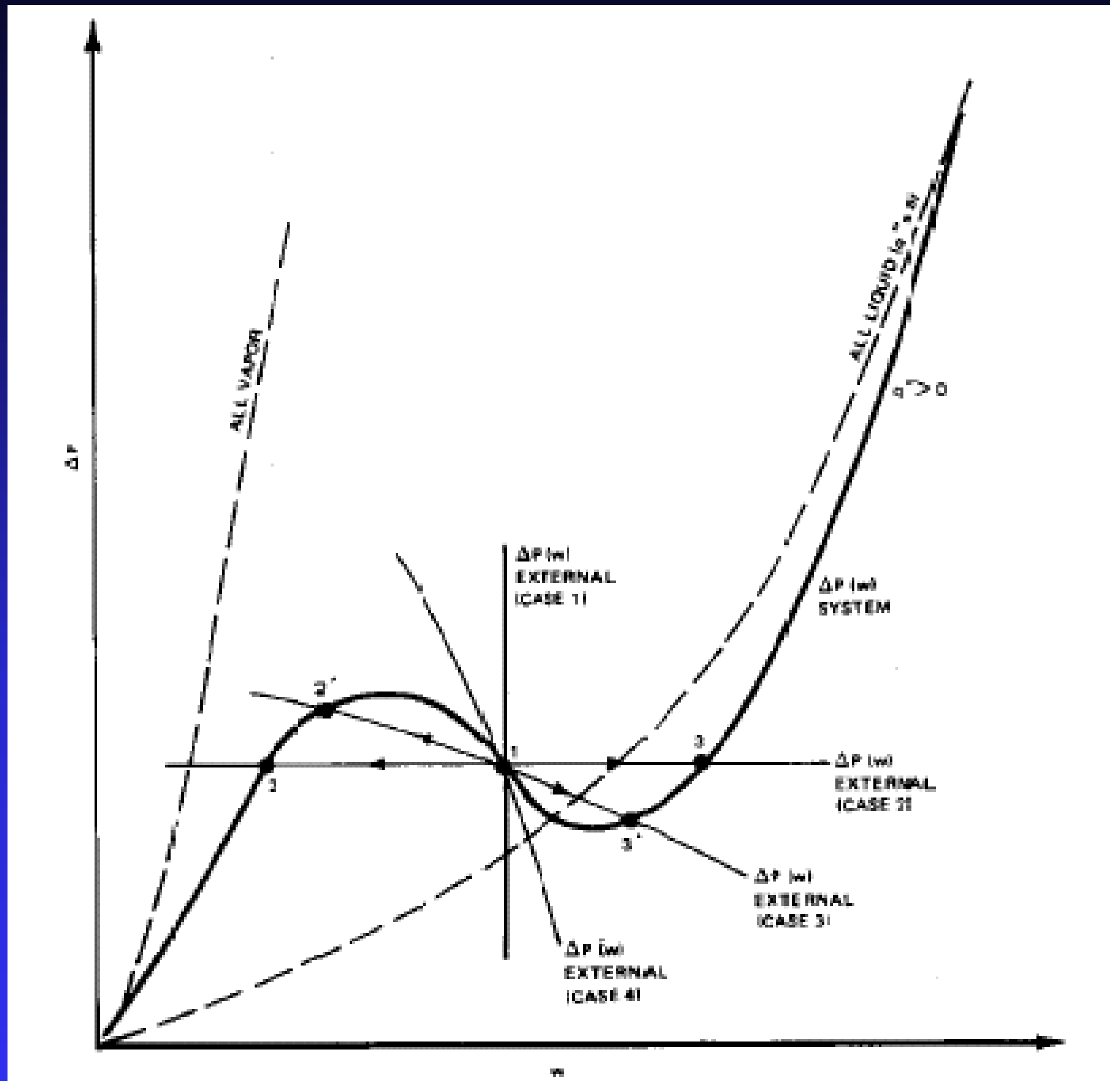


Fig. 7-1. Excursive instability.

$$\frac{\partial(\Delta p_{system})}{\partial w} > \frac{\partial(\Delta p_{ext})}{\partial w}.$$

Case 1 – positive displacement pump

Case 2 – parallel channel situation

Case 3 – centrifugal or jet pump situation