

Turbomachine Surge

Perhaps the most widely studied quasistatic instabilities are the surge instabilities that occur in pumps, fans and compressors when the turbomachine has a characteristic of the type shown in figure 1(b). When

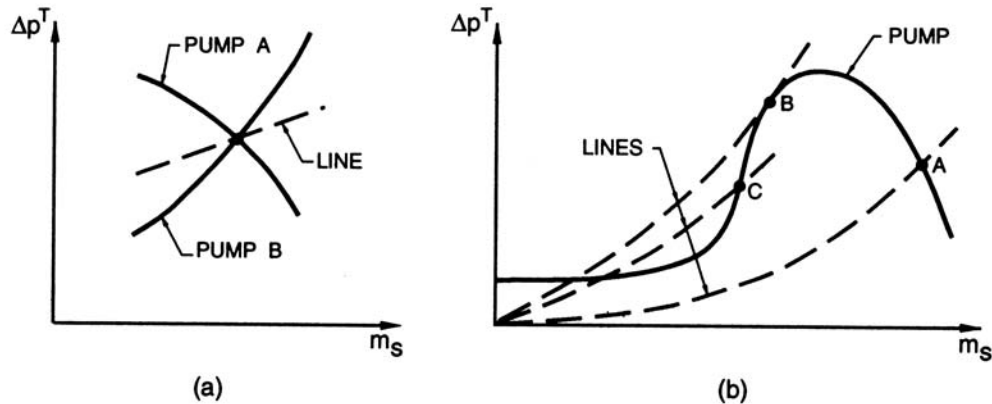


Figure 1: Quasistatically stable and unstable flow systems.

the machine is operated at points such as *A* the operation is stable. However, when the turbomachine is throttled (the resistance of the rest of the system is increased), the operating point will move to smaller flow rates and, eventually, reach the point *B* at which the system is neutrally stable. Further decrease in the flow rate will result in operating conditions such as the point *C* that are quasistatically unstable. In compressors and pumps, unstable operation results in large, limit-cycle oscillations that not only lead to noise, vibration and lack of controllability but may also threaten the structural integrity of the machine. The phenomenon is known as compressor, fan or pump surge and for further details the reader is referred to Emmons *et al.*(1955), Greitzer (1976, 1981) and Brennen (1994).