

## Introduction to Unsteady Internal Flows

This section is devoted to a description of the methods available for the analysis of unsteady flows in pumps and their associated hydraulic systems. There are two basic approaches to the solution of unsteady internal flows: solution in the time domain or in the frequency domain. The traditional time domain methods for hydraulic systems are treated in depth elsewhere (for example, Streeter and Wylie 1967, 1974), and will only be touched upon here. They have the great advantage that they can incorporate the nonlinear convective inertial terms in the equations of fluid flow, and are best suited to evaluating the transient response of flows in long pipes in which the equations of the flow and the structure are fairly well established. However, they encounter great difficulties when either the geometry is complex (for example inside a pump), or the fluid is complex (for example in the presence of cavitation). Under these circumstances, frequency domain methods have distinct advantages, both analytically and experimentally. On the other hand, the nonlinear convective inertial terms cannot readily be included in the frequency-domain methodology and, consequently, these methods are only accurate for small perturbations from the mean flow. This does permit evaluation of stability limits, but not the evaluation of the amplitude of large unstable motions.