Introduction

Sometimes, the experiment or testing that is needed requires a large facility outside the normal scope or financial resources of the experimenter. For example, a small automobile manufacturer may wish to examine the aerodynamics of his/her vehicle at full scale and may seek to find a wind tunnel in which to conduct such aerodynamic tests. In the sections that follow we describe a few of the features of large facilities. No effort is made to list all the facilities in the world; rather we attempt to introduce the reader to some of the typical features of large, fluid flow facilities. What follows are sections on wind tunnels, water tunnels, towing tanks, model basins and pump and turbine test facilities.

Of course there are many fluid machinery manufacturers for whom full-scale testing of their product is essential not only in order to improve and refine their product but also to demonstrate performance to their customers. Details of such facilities are beyond the scope of this text but several examples are worth mentioning. All the major international gas turbine manufacturers maintain their own test facilities for both aircraft engines and for power generation plants; these are impressive facilities that have led to large improvements in the performance and reliability of gas turbines. Large water turbine test facilities tend to be more disperse, with some commercial manufacturers using their own facilities while utilities who plan to utilize a large water turbine often using independent turbine test facilities such as are maintained at some independent research organizations or universities (for example, the cole Polytechnique Fdrale de Lausanne). Smaller fluid machines (and this includes the majority of pumps) also use a mix of internal test facilities and those maintained at independent organizations or universities. An example of the former are the extensive test facilities maintained by the US Navy for the testing of small-scale models of their ship propellers. It is not easy to find good written guidance on the deign and use of these facilities though Dicmas (1987) provides a useful chapter on the use of pump test facilities.

As described in section (Ka), testing in a large facility such as a wind tunnel or water tunnel requires careful attention to scaling problems and therefore to the relevant scaling parameters, most frequently the Reynolds Number, Re, and the Mach Number, M, as well as to other factors such as the effects of the tunnel walls and the effect of the natural level of turbulence in the tunnel flow. We comment first on the simpler circumstances in which the flow under consideration is sufficiently subsonic so that the effects of the fluid compressibility are small; usually this requires $M < 0.3$. Then the primary concern is for the effects of Reynolds Number, Re. Though it may not always be possible it is desirable to conduct model tests in the same range of Reynolds Numbers as that which pertains in the prototype in order to properly model the intricate effects of the Reynolds Number on flow features such as boundary layer separation and transition to turbulence. If the same fluid is to be used at the same temperature this means that the size times the speed must be the same for the model and prototype. Therefore a small scale model must be tested at speeds higher than in the prototype. Sometimes it is valuable to consider using a fluid (air or water) for the test that is different from the prototype. For example, testing in a wind tunnel is much simpler (and cheaper) than water tunnel tests and the model structure does not need to be as strong as in water. On the other hand, high Reynolds numbers can be achieved in water since its kinematic viscosity is more than ten times less than that of air. In summary, careful attention needs to be paid to the advantages and disadvantages of conducting tests at a different scale than the prototype and even then most experimenters would be very reluctant to rely on experiments which were more than an order of magnitude smaller (or larger) than the prototype.