General Strategy in Solving Fluids Problems

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(1) First determine whether the problem involves viscous or inviscid flow.

(2) Be prepared to give criteria that justify whether you can treat the problem as viscous or inviscid. This will typically be done using the Reynolds number, thus reducing the equations of motion to either the Euler equations or the Stokes equations.

(3) Determine whether the problem is steady or unsteady. If it is not stated, be prepared to justify why you can consider the problem to be steady. Especially in cases of viscous fluid flow, this can be done by looking at the time scales associated with the type of flow considered (for instance, the viscous diffusion time, $t \sim \delta^2/\nu$).

(4) Define a volume or domain of interest. It is typically most conveniently defined so that the direction of the flow is perpendicular to the boundaries.

(5) Consider the conservation of mass/continuity equation, either in integral form or in differential form or some combination thereof. In differential form, continuity can be used to reduce the Stokes equation to a more tractable form. Most generally, continuity expresses the fact that "what goes in must come out" of the control volume so-defined.

(6) If the flow is inviscid, anticipate using either the Bernoulli equation or the Reynolds transport theorem for momentum conservation.

(7) If the flow is viscous, the (Navier-)Stokes equations are likely to be most useful, since incorporating viscous forces into the Reynolds transport theorem for momentum conservation will require knowing the flow profile *a priori*.

(8) If the (Navier-)Stokes equations are used, give your boundary conditions. These will be one of the following: no slip, or equal shear.