7.   Pipe Systems

Most pipe flow problems can be classified as being of one of three types:

    Type I: The desired flow rate is specified and the required pressure drop must be determined.

    Type II: The desired pressure drop is specified and the required flow rate must be determined.

    Type III: The desired flow rate and pressure drop are specified and the required pipe diameter must be determined.

Type I pipe systems are the easiest to solve. Since the flow velocity and diameter are known, calculation of the major loss coefficient, the friction factor in particular, is straightforward. Type II and Type III problems are more challenging to solve since the friction factor is unknown. These types of pipe systems usually require iteration to solve.

Notes:
1. There is no unique iterative scheme that must be used to solve Type II and Type III pipe flow problems. Different people may propose different algorithms. In addition, there is no guarantee that a particular iterative scheme will converge to a solution.
2. When using an iterative scheme, choose an initial flow rate or diameter that is reasonable. Don't start with an exceedingly small or large value. For example, for a Type II pipe system, choose a starting flow rate that corresponds to the fully turbulent zone region.
3. It's often worthwhile to first assume that a Type II and Type III flow system is operating in the fully rough zone of the Moody plot. Using this assumption will generally avoid the need for iteration. However, one must verify at the end of the solution that the assumption of fully rough flow was correct. If not, then an iterative solution should be considered.

Serial Pipe Systems

Serial pipe systems have multiple pipes that have the same inlet conditions and the same outlet conditions. For these systems one simply applies the EBE separately for each pipe.
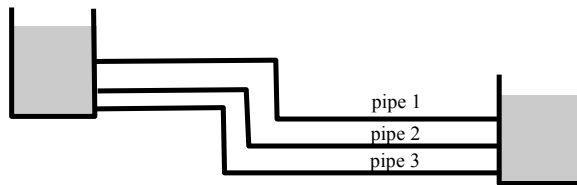
Parallel Pipe Systems

Parallel pipe systems involve pipes that have intersections (aka nodes). These pipe systems are more challenging to solve. The EBE can be used between nodes and between nodes and inlets and outlets. In addition, conservation of mass should be used at each node. The result will be a system of non-linear equations (due to velocity squared terms that appear in the EBE) that must be solved simultaneously. Often these systems of equations are solved computationally using iterative techniques. Interestingly, pipe networks have many similarities with electrical networks, with pipe resistances corresponding to electrical resistances, flow rates corresponding to current, and head differences (due to elevation differences or pumps) corresponding to voltage differences. There are other electrical analogies too. For example surge tanks have properties similar to capacitors, heavy paddle wheels have properties similar to inductors, and ball and check valves act as diodes.