NETWORK OF PIPES

Complex connections of pipes are used in city water supply as well as in industrial systems. Some of these are discussed in the para.

Pipes in Series—Electrical Analogy

Series flow problem can also be solved by use of resistance network. Consider equation For given pipe specification the equation can be simplified as

$hf = 8\ f\ L\ Q^2/\pi^2 g\ D^5 = R\ Q^2$

Note: The dimension for R is s^2/m^5. For flow in series Q is the same through all pipes. This leads to the relation

$$hf1 + hf2 + hf3 + \ldots\ldots\ldots\ hfn = hf = (R1 + R2 + R3 + \ldots. + Rn)\ Q^2$$

The R values for the pipe can be calculated. As the total head is also known Q can be evaluated. The length L should include minor losses in terms of equivalent lengths.

Pipes in Parallel

Case (i) The head drop between locations 1 and 2 are specified: The total flow can be determined using

$$hf = 8\ f1\ L1\ Q1^2 / g\ D^5 \pi^2 = 8\ f1\ L1\ Q1^2 / g\ D^5 \pi^2$$

As *hf* and all other details except flow rates Q1, Q2 and Q3 are specified, these flow rates can be determined.

Total flow Q = Q1 + Q2

The process can be extended to any number of connections.

Case (ii) Total flow and pipe details specified. One of the methods uses the following steps:

1. Assume by proper judgment the flow rate in pipe 1 as Q1.
2. Determine the frictional loss.
3. Using the value find Q2 and Q3.
4. Divide the total Q in the proportion Q1 : Q2 : Q3 to obtain the actual flow rates. Case (iii) Electrical analogy

Branching Pipes

The simplest case is a three reservoir system interconnected by three pipes The conditions to be satisfied are (*i*) The net flow at any junction should be zero due to continuity principle. (*ii*) The Darcy-Weisbach equation should be satisfied for each pipe. If flows are $Q1$, $Q2$, $Q3$, then the algebraic sum of $Q1 + Q2 + Q3 = 0$. **If one of the flow rate is specified the solution is direct. If none are specified, trial solution becomes necessary.**

The flow may be from the higher reservoir to the others or it may be from both high level reservoirs to the low level one. The hydraulic grade line controls the situation. If the head at the junction is above both the lower reservoirs, both of these will receive the flow. If the head at the junction is below the middle one, the total flow will be received by the lowest level reservoir.

The method of solution requires iteration.

(i) A value for the head at the junction is assumed and the flow rates are calculated from pipe details.

(ii) The sum of these (algebraic) should be zero. But at the first attempt, the sum may have a positive value or negative value.

(iii) If it is positive, inflow to the junction is more. So increase the value of head assumed at the junction.

(iv) If it is negative, the outflow is more. So reduce the value of head assumed. Such iteration can be also programmed for P.C.

Pipe Network

More complex network of pipes exist in practice. For analysis of the system the following conditions are used.

1. **The algebraic sum of the pressure drop around each circuit must be zero.**
2. **The flow into the junction should equal the flow out of the junction.**

3. **For each pipe the proper relation between head loss and discharge** should be **maintained.**

Analytical solution to such a problem is more involved. Methods of successive approximation are used. With the use of computers, it is now possible to solve any number of simultaneous equations rather easily. Use of the above conditions leads to a set of simultaneous equations. This set can be solved using computers.