meng 262– Fluids & Heat Transfer

Lab 2 – Parallel Pipe Flow October 2016

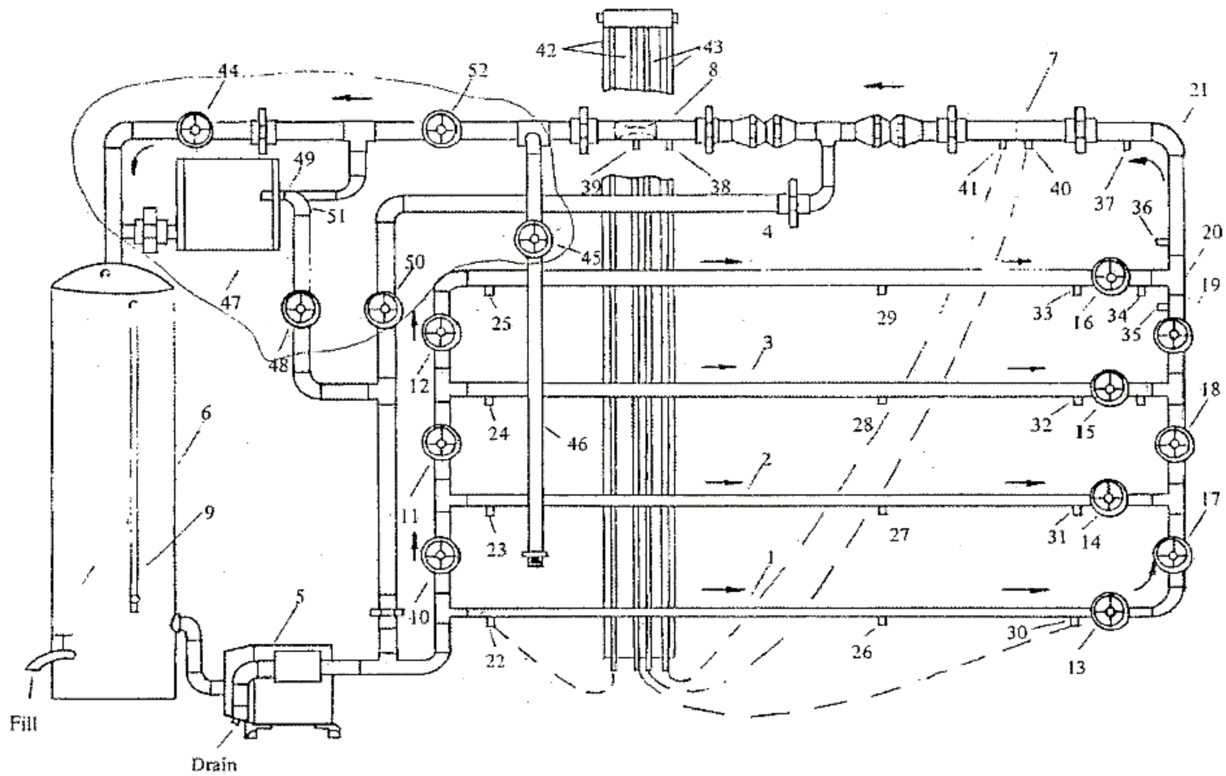
Purpose

Examine two-pipe parallel flow in the Scott Apparatus

Apparatus

The 'Scott Apparatus' located in TEC 106.

Procedure



Part 1: Create a flowmeter from a length of pipe

- Adjust the valves so that flow only travels through the 1" pipe (from port 25 to 33).
- Run through three different flowrates. Each time take manometer reading from all 4 manometers. Acquire data about $h_{40/41}$ and $h_{25/33}$.
- From the following equations find the average value of $K_{25/33}$.

  $h_{40/41} = K\left[\frac{v^2}{2g}\right]$; where $K = 14.85$

  $h_{25/33} = K_{25/33}\left[\frac{v^2}{2g}\right]$; combine these equations and solve for $K_{25/33}$.

  (note that the flow only travels through a 1", type k, copper pipe. Thus the inner diameter is the same between ports 25 and 33 as it is in the flow section associated with the ports 40 and 41. This makes the determination of $K_{25/33}$ fairly easy.)
- You have now created a flowmeter out of a pipe. Yipee!

Part 2: Determine the flow in a two-pipe parallel flow system

Measurements & Experimental Calculations

- Fully open the primary flow control valve so that the Scott Apparatus is operating at full flow.
- Fully open the valve at the end of the ¾" pipe (just after port 32).
- Check that the valve at the end of the 1" pipe (just after port 33) is fully open.
- Note you now have two-pipe parallel flow.
- Measure and note the level of the manometers.
- Using the given $K_{40/41}$ value and your newly created average $K_{25/33}$ value, and their associated equations, determine the flowrates going through the orifice flowmeter and the flowrate going through the 1", type k, copper pipe section (from port 25 to 33).
- Using: $Q_{total} = Q_{1''} + Q_{0.75''}$, determine the flowrate going through the ¾", type k, copper pipe section.

Theoretical Analysis

Your task here is duplicate the experimental analytical results by theoretically determining the flowrate of water through each of the two parallel pipes. Use your knowledge of the actual <u>total</u> flowrate and assume, for this calculation that f = 0.02. Don't bother iterating.

Mott describes the calculation procedure as follows:

1. Equate the total flow rate to the sum of the flow rates in the two branches, as stated in Eq. (12–1). Then express the branch flows as the product of the flow area and the average velocity; that is,

   Continuity Equation for Parallel Systems

   $$Q_1 = Q_2 = Q_a + Q_b \qquad (12\text{–}1)$$

   $$Q_a = A_a v_a \quad \text{and} \quad Q_b = A_b v_b$$

2. Express the head loss in each branch in terms of the velocity of flow in that branch and the friction factor. Include all significant losses due to friction and minor losses.
3. Compute the relative roughness D/ε for each branch, estimate the value of the friction factor for each branch, and complete the calculation of head loss in each branch in terms of the unknown velocities.
4. Equate the expression for the head losses in the two branches to each other as stated in Eq. (12–2).

   Head Loss Equation for Parallel Systems

   $$h_{L_{1-2}} = h_a = h_b \qquad (12\text{–}2)$$

5. Solve for one velocity in terms of the other from the equation in Step 4.
6. Substitute the result from Step 5 into the flow rate equation developed in Step 1 and solve for one of the unknown velocities.
7. Solve for the second unknown velocity from the relationship developed in Step 5.

Report

Present your work in a short but complete report that clearly lays out:

- What you did (procedure)
- What raw results you obtained (no calculations or interpretation here)
- What calculated results you obtained
- What comments you have (discussion)
- (No conclusion necessary)