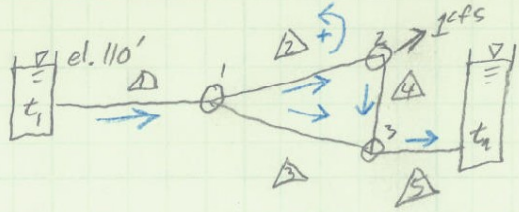

$t = 2$
$\ell = 1$
$e = t - 1 = 1$
$j = 3$ el. of all $j = 10'$
$N_p = 5$

} contistancy equ. $N_p = \ell + e + j$
$5 = 1 + 1 + 3 = 5$ OKAY

Continuity equ: $Q_{in} - Q_{out} = \emptyset$ Energy equ. (loop): $h_{L_3} - h_{L_4} - h_{L_2} = \emptyset \left\{ \Sigma h_L = \emptyset \right\}$ Based on ↻

Energy equ. (path): $\Sigma h_L = E_{drop} = W.L._{1}^{(t_1)} - W.L._{2}^{(t_2)}$
(E_{drop}: energy drop; $W.L.$: water level)

Put Both Energy equ. into terms of Q

$h_{L_p} = k_p Q_p^2 = k_p Q_p |Q_p|$

Loop: $\Sigma k_p Q_p |Q_p| = \emptyset$
Path: $\Sigma k_p Q_p |Q_p| = E_d$

① ASSUME a Q_{p_i} $\Sigma Q_{p_i} = \emptyset$ @ $j = 1, 2, 3$

Assume $Q_1 = 3$, $(j_1 : Q_2 = 2,\ Q_3 = 1)$, $(j_2 : Q_4 = 1)$, $(j_3 : Q_5 = 2)$

② Q_{p_i} loop $\Sigma h_{L_p} = 0 \rightarrow \Sigma k_p Q_p |Q_p| = \emptyset$

Accounts for error

$\rightarrow \Sigma (h_{L_{p_i}} + \Delta h_{L_{p_i}}) = \emptyset = \Sigma (k_p Q_{p_i} |Q_{p_i}| + \Delta h_{L_{p_i}}) = \emptyset$

$h_L = k_p Q_p^2$
$d(h_L) = 2 k_p |Q_p| \Delta Q$
$\Delta h_{L_{p_i}} = 2 k_p |Q_{p_i}| \Delta Q$

→ sub. in: $\Sigma (k_p Q_{p_i} |Q_{p_i}| + 2 k_p |Q_{p_i}| \Delta Q) = \emptyset$

$\rightarrow \Delta Q = \dfrac{-\Sigma k_p Q_{p_i} |Q_{p_i}|}{\Sigma 2 k_p |Q_{p_i}|}$

Given: $k_{p_1} = k_{p_5} = 2$, $k_{p_2} = k_{p_3} = k_{p_4} = 1$

$E_{1,op} = W_{L_1} - W_{L_2} = 110' - 60' = 50'$

Path $\Delta Q_{PATH} = \dfrac{-(\Sigma K_p Q_{pi} |Q_{pi}|) + E_{drop}}{\Sigma\, 2 K_p |Q_{pi}|}$

APPROX. CORRECTION

$$\Delta Q_{PATH} = \frac{-((2\cdot 3\cdot 3) + (1\cdot 1\cdot 1) + (2\cdot 2\cdot 2)) + 50}{(2\cdot 2\cdot 3) + (2\cdot 1\cdot 1) + (2\cdot 2\cdot 2)} = \frac{23}{22} \sim 1$$

(K_{p_3} Q_3 $|Q_3|$; K_{p_5} Q_5 $|Q_5|$; 2 K_{p_1} $|Q_1|$; 2 K_{p_3} $|Q_3|$; 2 K_{p_5} $|Q_5|$)

ADD ΔQ_{PATH} to Assumed Path Flows

$Q_1 = 3 + 1 = \underline{4}$; $Q_3 = 1 + 1 = \underline{2}$; $Q_5 = 2 + 1 = \underline{3}$

Loop $\Delta - \Delta - \Delta$ ↻ $\Delta Q_{loop} = \dfrac{-(\Sigma K_p Q_{pi} |Q_{pi}|)}{\Sigma\, 2 K_p |Q_{pi}|}$

Use new values from path if applicable

$$\Delta Q_{loop} = \frac{-((1\cdot 2\cdot 2) - (1\cdot 1\cdot 1) - (1\cdot 2\cdot 2))}{(2\cdot 1\cdot 2) + (2\cdot 1\cdot 1) + (2\cdot 1\cdot 2)} = \frac{1}{10} = 0.1$$

(K_{p_3} NEW Q_3, Q_3; K_{p_4} Q_4; K_{p_2} Q_2; 2 K_{p_3} Q_3; 2 K_{p_4} Q_4; 2 K_{p_2} Q_2)

ADD ΔQ_{loop} to Assumed Loop Flows

$Q_3 = 2 + 0.1 = 2.1$; $Q_4 = 1 - 0.1 = 0.9$ (subtracted b/c of assumed ↻)

$Q_2 = 2 - 0.1 = 1.9$ (ditto)

MAKE Tollerence = 1% of given Q_{out} (0.01)

Need to reiterate ∴ ΔQ approaches ∅ USE NEW VALUES

$$\Delta Q_{path} = \frac{-((2\cdot 4\cdot 4) + (1\cdot 2.1\cdot 2.1) + (2\cdot 3\cdot 3)) + 50}{(2\cdot 2\cdot 4) + (2\cdot 1\cdot 2.1) + (2\cdot 2\cdot 3)} = (-0.137)$$

New: $Q_1 = 3.86$; $Q_3 = 1.963$; $Q_5 = 2.863$

$$\Delta Q_{loop} = \frac{-((1\cdot 1.963\cdot 1.963) - (1\cdot 0.9\cdot 0.9) - (1\cdot 1.9\cdot 1.9))}{(2\cdot 1\cdot 1.963) + (2\cdot 1\cdot 0.9) + (2\cdot 1\cdot 1.9)} = 0.06$$

New: $Q_3 = 2.02$; $Q_4 = 0.84$; $Q_2 = 1.84$

$Q_1 = 3.86$, $Q_2 = 1.84$, $Q_3 = 2.02$, $Q_4 = 0.84$, $Q_5 = 2.863$