Friction Loss Formulas and Calculations

\[ FL = (C \times Q^2)(L) \]
Friction Loss Formula

- $FL = (C \times Q^2)(L)$
- $C =$ Coefficient for hose diameter
- $Q =$ Quantity
- $L =$ Length
FL Coefficients

- C factors refer to the third principle of friction loss
  - The base of the friction loss equation
  - Assigned based on the diameter of the hose
    - FL decreases as diameter increases
- Reflects a worst-case scenario
  - Results are probably slightly higher
Standard (Coefficients)

1" = 150
1½" = 24
1¾" = 10
2½" = 2
3" = 0.8
4" = 0.2
4½" = 0.1
5" = 0.08
<table>
<thead>
<tr>
<th>Test Run #</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
<th>Column 7</th>
<th>Column 8</th>
<th>Column 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pump Discharge Pressure psi</td>
<td>Pressure @ Gauge 1 psi</td>
<td>Pressure @ Gauge 2 psi</td>
<td>Nozzle Pressure* psi</td>
<td>Flow from Flow meter or by Equation**</td>
<td>Friction Loss per 100 feet or</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>40</td>
<td>30</td>
<td>15</td>
<td>8</td>
<td>n/a</td>
<td>$\left(\frac{106}{100}\right)^2$</td>
<td>7.5</td>
<td>6.29</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>150</td>
<td>50</td>
<td>30</td>
<td>n/a</td>
<td>$\left(\frac{205}{100}\right)^2$</td>
<td>50</td>
<td>11.90</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>115</td>
<td>100</td>
<td>35</td>
<td>20</td>
<td>n/a</td>
<td>$\left(\frac{168}{100}\right)^2$</td>
<td>32.5</td>
<td>11.52</td>
<td></td>
</tr>
</tbody>
</table>

*Not necessary if flow meter is used

**gpm = 29.7 d\(^2\) \sqrt{NP}

<table>
<thead>
<tr>
<th>Total of all Column 9 answers</th>
<th>Average C = 29.71</th>
</tr>
</thead>
<tbody>
<tr>
<td># of tests conducted</td>
<td>Average C = 9.90</td>
</tr>
</tbody>
</table>

Driver/Operator 1B
September 2003    Slide 3-8-5
Calculating "Q"

- Second step of formula
- Must be calculated, then applied
- If gpm is 200, what is Q?
  \[ Q = \frac{200 \text{ (gpm)}}{100} = 2 \]
- If gpm is 400, what is Q?
  \[ Q = \frac{400 \text{ (gpm)}}{100} = 4 \]
Calculating FL

- FL = (2 \times 2^2)(1)
- FL = (2 \times 4)(1)
- FL = (8)(1)
- FL = 8 psi
Calculating Single Hose FL

- \( FL = (2 \times 1^2)(3) \)
- \( FL = (2 \times 1)(3) \)
- \( FL = 6 \text{ psi} \)

- \( FL = 1(3) \)
- \( FL = 6 \text{ psi} \)
- Multiple Hoselines -
Equal Size and Length

Calculate FL for one hoseline only if other hoselines will have the same pressure and gpm
Calculate Q

- gpm = (29.7)(d^2 \times \sqrt{NP})
- gpm = (29.7)(1^2 \times \sqrt{50})
- gpm = (29.7)(1 \times 7.0711)
- gpm = (29.7)(7.0711)
- gpm = 210 psi = 200 psi
- Q = 200/100 = 2
- FL = (C x Q^2)(L)
- FL = (2 x 2^2)(4)
- FL = (2 x 4)(4)
- FL = (8)(4)
- FL = 32 psi
Wyed Hoselines - Equal Lengths

- One hoseline supplies two others
  - Two 1½" or 1¾" attack lines wyed from a 2½" supply line is common
- Calculate FL for supply line and one wyed hoseline, then add together
- Only one needs to be computed since they carry equal amounts of water
Calculate $Q$

- **2½" Line**
  \[ Q = \frac{300}{100} = 3 \]

- **Wye Line**
  \[ Q = \frac{150}{100} = 1.5 \]
Calculate FL

\textbf{Wye Line}
- \( FL = (C \times Q^2)(L) \)
- \( FL = (10 \times 1.5^2)(1.5) \)
- \( FL = (10 \times 2.25)(1.5) \)
- \( FL = (22.5)(1.5) \)
- \( FL = 34 \text{ psi} \)

\textbf{2\{\frac{1}{2}\}" Line}
- \( FL = (C \times Q^2)(L) \)
- \( FL = (2 \times 3^2)(2) \)
- \( FL = (2 \times 9)(2) \)
- \( FL = (18)(2) \)
- \( FL = 36 \text{ psi} \)
Siamese Hoselines - Equal Length

- Two or more parallel hoselines
- Divide gpm by total number of hoselines
  - Then calculate FL for one line
- Take \( \frac{1}{2} \) of the gpm flow and figure the FL for one line
- Coefficients are used in calculating FL
Calculate Q

- Siamese
  - $Q = \frac{150}{100} = 1.5$

- 2½" Line
  - $Q = \frac{300}{100} = 3$
**Calculate FL**

- **Siamese**
  - FL = (C x Q^2)(L)
  - FL = (.8 x 1.5^2)(10)
  - FL = (.8 x 2.25)(10)
  - FL = (1.8)(10)
  - FL = **18 psi**

- **2½" Line**
  - FL = (C x Q^2)(L)
  - FL = (2 x 3^2)(3)
  - FL = (2 x 9)(3)
  - FL = (18)(3)
  - FL = **54 psi**
Calculate FL

Add FL together

54 psi
18 psi
72 psi
- Multiple Hoselines -
Unequal Length

- Calculate FL for each line
- Pump for highest pressure needed
- Gate down discharge of line(s) needing less pressure
- Calculating Q

\[ Q = \frac{250}{100} = 2.5 \]
Line 1:
- FL = (C x Q^2)(L)
- FL = (2 x 2.5^2)(3)
- FL = (2 x 6.25)(3)
- FL = (12.5)(3)
- FL = 38 psi

Line 2:
- FL = (C x Q^2)(L)
- FL = (2 x 2.5^2)(5)
- FL = (2 x 6.25)(5)
- FL = (12.5)(5)
- FL = 63 psi
Wyed Hoselines - Unequal Length

- Addition of hose lengths to an existing wyed hoseline assembly may result in unequal length attack lines
- Calculate FL for supply line and both wyed hoselines
- Pump to the highest wyed line and gate-down the other wyed line
Calculate Q

- **2½'' Line**
  \[ Q = \frac{200}{100} = 2 \]

- **Wye Line**
  \[ Q = \frac{100}{100} = 1 \]
Calculate FL

- **2½" Line**
  - FL = (C x Q²)(L)
  - FL = (2 x 2²)(2)
  - FL = (2 x 4)(2)
  - FL = (8)(2)
  - FL = **16 psi**

- **150' Wye Line**
  - FL = (C x Q²)(L)
  - FL = (24 x 1²)(1.5)
  - FL = (24 x 1)(1.5)
  - FL = (24)(1.5)
  - FL = **36 psi**

- **200' Wye Line**
  - FL = (C x Q²)(L)
  - FL = (24 x 1²)(2)
  - FL = (24 x 1)(2)
  - FL = (24)(2)
  - FL = **48 psi**
- Siamese Hoselines – Unequal Length

- Add the lengths of each line together, then divide by total number of lines
Calculate $Q$

- **Siamese**
  \[ Q = \frac{125}{100} = 1.25 \]

- **2½” Line**
  \[ Q = \frac{250}{100} = 2.5 \]
Calculate FL

- Determine L
  - 900
  - 1,000
  - 1,950
  - 1,950 ÷ 2 = 950
  - 950 ÷ 100 = 9.5

- Siamese
  - FL = (C x Q^2)(L)
  - FL = (.8 x 1.25^2)(9.5)
  - FL = (.8 x 1.56)(9.5)
  - FL = (1.25)(9.5)
  - FL = 12 psi
Calculate FL

- 2½" Line

\[ FL = (C \times Q^2)(L) \]
\[ FL = (2 \times 2.5^2)(1) \]
\[ FL = (2 \times 6.25)(1) \]
\[ FL = (12.5)(1) \]
\[ FL = 13 \text{ psi} \]

- 3" Line

\[ FL = (C \times Q)(L) \]
\[ FL = (2 \times 2.5)(1) \]
\[ FL = (6.25)(1) \]
\[ FL = 12 \text{ psi} \]