Distribution of Water

1. Distribution Systems

The system of conduits that conveys water to the points of use from the terminus of the supply conduit is known as the distribution system.

1.1. High and Low Services

Sections of the community that lie at too high an elevation to receive water at adequate pressure from the principal or low-service, works are generally incorporated in a separate distribution system possessing independent piping and service storage. This high-service system is normally fed by pumps that take suction from the main supply and boost its pressure by the requisite amount.

1.2. Fire Supply

The congested central portion or high-value district of a few large cities is protected by an independent system of pipes and hydrants that are capable of delivering large volumes of water under high pressure for fire-fighting purpose. This high-pressure fire-supply takes water from the public supply and raises its pressure by booster pumps whenever the alarm is given to do so.

<table>
<thead>
<tr>
<th>Table 1. Hydraulic Slope in Fire Hoses</th>
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<tbody>
<tr>
<td>Q</td>
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<tr>
<td>500</td>
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<tr>
<td>800</td>
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If there was no fire hazard, the hydraulic capacity of the distribution system would have to equal the max demand for domestic, industrial and other general uses. The general requirements of the İller Bankası Domestic Water Regulations the fire-fighting capacity of excess demand to add in distribution systems may be summarized as follows;

1. for communities of 10000 people or less
   - main pipeline 5 lt/sec
   - major distribution pipes 5 lt/sec
   - minor distribution pipes 2,5 lt/sec
2. for communities of 10000 and 50000 people
   - main pipeline 10 lt/sec
• major distribution pipes 5 lt/sec
• minor distribution pipes 2.5 lt/sec
3. for communities of 50,000 people or more
• main pipeline 20 lt/sec
• major distribution pipes 10 lt/sec
• minor distribution pipes 5 lt/sec

1.3. Pressures
For normal municipal uses, pressures of 4 to 5 atm is desirable.

1.4. Capacity
The capacity of distribution is dictated by domestic, industrial and other normal water uses and by the stand-by or ready-to-serve requirements for fire-fighting. Pipes should be sufficiently large to carry max draft (max hourly draft + fire demand) at velocity of 0.60 to 1.2 m/sec.

1.5. One and Two Directional Flow

According to type of flow we can distinguish the four systems illustrated in Figure 1. the hydraulic gradients of the systems and the residual pressures within the areas served, together with the volume of distribution storage, determine the sizes of pipe within the network. Selection of volume and location of distribution storage depend upon topography and water needs.
Example 1

The population of a city is 30000. Calculate the flowrate in AC pipe.

- $H_{k_{AB}} = 5$ m
- $H_{k_{AC}} = 8$ m
- $H_{k_{BC}} = 3$ m
- $f = 0.03$
- $D_{AC} = 300$ mm
- $L_{AC} = 1500$ m
- $Q_F = 5$ lt/sec

Solution:

$$h_k = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

$$h_{k_{AC}} = f \cdot \frac{L_{AC}}{D_{AC}} \cdot \frac{V_{AC}^2}{2g} \rightarrow 8 = 0.03 \cdot \frac{1500 \cdot V_{AC}^2}{0.3 \cdot 19.62}$$

$Q_{AC}$ is the equivalent flowrate

$$V_{AC} = 1.023 m / sec$$

$$Q_{AC} = V_{AC} \cdot A_{AC} = 1.023 \cdot \frac{\pi \cdot 0.3^2}{4} = 0.072 m^3 / sec = 72 lt / sec$$

inside the pipe.

There is a distribution discharge ($Q_D$) which will be distributed. We calculate $Q_D$;

$$Q_{AC} = 0.577 \cdot Q_D + Q_F$$

$$72 = 0.577 \cdot Q_D + 5$$

$$Q_D = 116.12 \text{ lt/sec}$$
Example 2

Distribution system serves 3000 people. If max daily draft is 200 lt/ca/day, determine the flowrates in each pipe.

Solution:

\[ MaxQ_{\text{hourly}} = \frac{3000 \times 200 \times 1,5}{86400} = 10,4 \text{ lt/sec} \]

We have to calculate equivalent pipe length;
\[ L_e = (1,3 \times 100) + (1,0 \times 200) = 330 \text{ m} \]

We need distributing flowrate in unit pipe length;
\[ q = \frac{MaxQ_{\text{hourly}}}{L_e} = \frac{10,4}{330} = 0,0315 \text{ lt/sec/m} \]

For the 1. pipe;
\[ Q_1 = q \times L_1 = 0,0315 \times (100 \times 1,3) = 4,1 \text{ lt/sec} \]

For the 2. pipe;
\[ Q_2 = q \times L_2 = 0,0315 \times (200 \times 1,0) = 6,3 \text{ lt/sec} \]

We know the total flowrate equation for the pipes;
\[ C = (0,577 \times Q) + Q_f \]

For the 1. pipe;
\[ C_1 = \left(0,577 \times Q_1\right) + Q_f = \left(0,577 \times 4,1\right) + 5 = 7,36 \text{ lt/sec} = 0,00736 \text{ m}^3/\text{sec} \]

For the 2. pipe;
\[ C_2 = \left(0,577 \times Q_2\right) + Q_f = \left(0,577 \times 6,3\right) + 5 = 8,63 \text{ lt/sec} = 0,00863 \text{ m}^3/\text{sec} \]

Checking velocities and head losses

For pipe 1;
\[ V_1 = \frac{C_1}{A_1} = \frac{0,00736}{\pi \times 0,1^2} = 0,937 \text{ m/sec} \]

\[ h_1 = f \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} = 0,03 \times \frac{100}{0,1} \times \frac{0,937^2}{19,62} = 1,34 \text{ m} \]
For pipe 2:
\[ V_2 = \frac{C_2}{A_2} = \frac{0.00863}{\pi \times 0.15^2} = 0.488 \text{ m/sec} \]
\[ h_2 = f \cdot \frac{L_2}{D_2} \cdot \frac{V_2^2}{2g} = 0.03 \times \frac{200}{0.15} \times \frac{0.488^2}{19.62} = 0.485 m \]
\[ \Delta h = h_1 - h_2 = 0.855 < 1.0 \]
It’s O.K.