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# Basics of Firewater Steady State Hydraulics

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**Abstract:** The Intent of this paper is to provide a overiew on basic requirements to perform an Fire water steady state hydraulics study.
**Keywords:** Fire Water, hydraulic, pressure, heat Etc

## I. INTRODUCTION

Active Fire Protection, which is detection and suppression of fire by automatic or manual means. Fire will continue until the combustible material is consumed or Oxygen agent concentration is lowered to below the concentration necessary to support combustion Sufficient heat is removed or restricted from reaching the combustible material to prevent further combustion. As the complete material consumption and oxygen concentration cannot be ensured at all times, the only thing which can be ensured to prevent the fire is availability of adequate Firewater system.

Firewater application to protect a particular equipment or location is guaranteed by the flow and pressure availability. To meet the pressure & flow required, performing steady firewater hydraulics is essential.

## II. BASIS OF FIREWATER STEADY STATE HYDRAULICS

The purpose of steady state hydraulic analysis in firewater network is:

- To determine the Pressure & Flow required for operation of Firefighting equipment (Hydrant / Monitor / Deluge / Sprinklers etc.
- To verify network pipe sizes are adequate for design flow.

Key considerations in hydraulics:

**a) Friction Loss:**

The hydraulic calculations are commonly based on the Hazen Williams equation. The Hazen Williams equation in S.I units is as follows.

$$Pm = 6.05\,(Q_m^{1.85}/C^{1.85}\ X\ d_m^{4.87})10^5$$

*Where: Pm = frictional resistance in barg per meter of pipe*
*Qm = flow in m3/hr.*
*C = friction loss coefficient (C Value)*
*Dm = actual internal diameter (mm)*

### b) C Value

As per section a, C- Factors are an important factor in hydraulics. Increase in C factor results in reduced pressure drop. various types of fire water pipes generally being used in Fire water network are to be considered as per NFPA 15 (listed below):

- *140 for cement lined pipe*
- *150 for Cu-Ni pipe*
- *120 for Galvanized steel*
- *100 for ductile Iron*

**c) Equivalent Pipe Length**

The fittings such as tees and elbows are considered in the hydraulic calculation as equivalent lengths. The equivalent pipe length represents the same pressure loss as the pressure loss through the fittings. Table 8.5.2.1 Equivalent Pipe Length Chart from NFPA 15 is to be considered for equivalent pipe lengths.

Extracts from NFPA-15

Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe

| Fittings and Valves | ¾ in. | | 1 in. | | 1¼ in. | | 1½ in. | | 2 in. | | 2½ in. | | 3 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft | m | ft | m | ft | m | m | ft | ft | m | ft | m | ft | m |
| 45° elbow | 1 | 0.3 | 1 | 0.3 | 1 | 0.3 | 2 | 0.6 | 2 | 0.6 | 3 | 0.9 | 3 | 0.9 |
| 90° standard elbow | 2 | 0.6 | 2 | 0.6 | 3 | 0.9 | 4 | 1.2 | 5 | 1.5 | 6 | 1.8 | 7 | 2.1 |
| 90° long turn elbow | 1 | 0.3 | 2 | 0.6 | 2 | 0.6 | 2 | 0.6 | 3 | 0.9 | 4 | 1.2 | 5 | 1.5 |
| Tee or cross (flow turned 90°) | 4 | 1.2 | 5 | 1.5 | 6 | 1.8 | 8 | 2.4 | 10 | 3.1 | 12 | 3.7 | 15 | 4.6 |
| Gate valve | — | — | — | — | — | — | — | — | 1 | 0.3 | 1 | 0.3 | 1 | 0.3 |
| Butterfly valve | — | — | — | — | — | — | — | — | 6 | 1.8 | 7 | 2.1 | 10 | 3.1 |
| Swing check* | 4 | 1.2 | 5 | 1.5 | 7 | 2.1 | 9 | 2.7 | 11 | 3.4 | 14 | 4.3 | 16 | 4.9 |

Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe

| Fittings and Valves | 3½ in. | | 4 in. | | 5 in. | | 6 in. | | 8 in. | | 10 in. | | 12 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft | m | ft | m | ft | m | ft | m | ft | m | ft | m | ft | m |
| 45° elbow | 3 | 0.9 | 4 | 1.2 | 5 | 1.5 | 7 | 2.1 | 9 | 2.7 | 11 | 3.4 | 13 | 4.0 |
| 90° standard elbow | 8 | 2.4 | 10 | 3.1 | 12 | 3.7 | 14 | 4.3 | 18 | 5.5 | 22 | 6.7 | 27 | 8.2 |
| 90° long turn elbow | 5 | 1.5 | 6 | 1.8 | 8 | 2.4 | 9 | 2.7 | 13 | 4.0 | 16 | 4.9 | 18 | 5.5 |
| Tee or cross (flow turned 90°) | 17 | 5.2 | 20 | 6.1 | 25 | 7.6 | 30 | 9.2 | 35 | 10.7 | 50 | 15.3 | 60 | 18.3 |
| Gate valve | 1 | 0.3 | 2 | 0.6 | 2 | 0.6 | 3 | 0.9 | 4 | 1.2 | 5 | 1.5 | 6 | 1.8 |
| Butterfly valve | — | — | 12 | 3.7 | 9 | 2.7 | 10 | 3.1 | 12 | 3.7 | 19 | 5.8 | 21 | 6.4 |
| Swing check* | 19 | 5.8 | 22 | 6.7 | 27 | 8.2 | 32 | 9.8 | 45 | 13.7 | 55 | 16.8 | 65 | 19.8 |

### d) Velocity

Each pipe category has certain velocity limitations. With increased flow, velocity tend to increase in firewater piping.Below are the generally used velocity criteria for Firewater piping sections.

- *Maximum velocity in main firewater rings and wet lines is 3 m/s.*
- *Maximum velocity in firewater dry line (downstream of deluge valve) is 5 m/s.*

### e) Pipe Schedule

The Internal Diameter & Outer diameter of piping shall be used in the fire water pipe network as per piping wall thickness calculation. Below table indicates a sample of wall thickness for Cement lined carbon steel and Cu-Ni piping

| Cement Line | OD (mm) | Wall Thickness (mm) | ID (mm) | Cement lining (mm) |
|---|---|---|---|---|
| 10” | 273.1 | 7.80 | 257.40 | 6 |
| 12" | 323.9 | 8.38 | 307.14 | 8 |
| 14" | 355.6 | 9.53 | 336.54 | 8 |
| 16" | 406.4 | 9.53 | 387.34 | 8 |
| 30" | 762 | 9.53 | 742.94 | 10 |

| Cu-Ni | OD (mm) | Wall Thickness (mm) | ID (mm) |
|---|---|---|---|
| 12" | 323.9 | 7 | 309.9 |
| 10” | 267 | 5.5 | 256 |
| 8” | 219.1 | 4.5 | 210.1 |
| 2” | 57 | 2.5 | 52 |

## III. SOFTWARE

Widely used and internationally acceptable software to perform fire water hydraulics is PIPENET – Spray / Sprinkler module. All the above inputs mentioned in section II shall be utilized and be available to perform hydraulics.

## IV. CONCLUSION

Upon finalizing the zone extents, apparatus subgroup & temperature class, all electrical and instrument equipment shall be selected & produced in line with the Hazardous area classification extents.

## REFERENCES

[1] NFPA15 – Standard for water spray fixed systems for fire protection
[2] NFPA 13 - Standard for the Installation of Sprinkler Systems