Contents

Appendix B - Sizing and Calculation Methods

Revit MEP automatically calculates sizing information and selects ductwork, piping and wire sizes for the systems created in a project. The following topics provide tables and methods used for calculating size requirements and selecting wire, ducts, and pipe for systems.

Hydronic Pipe Sizing

In Revit MEP, you use the Pipe Sizing dialog to automatically specify the sizing for sections of hydronic pipe using friction and/or velocity sizing methods.

Hydronic Piping System Properties

Number of Elements	The number of piping components in the system.
System Equipment	Mechanical equipment assigned to the system.
System Type	The type of system (Hydronic Return, Hydronic Supply, Other).
System Name	String that uniquely identifies the system.
Volume	The volume of liquid contained in the system.
Static Pressure	Pressure with no fluid flowing in the system.
Fluid Type	Fluid type.
Fluid Temperature	Fluid temperature - units are determined by Project Units setting.

Hydronic Piping Instance Properties

Parameter	Description
Flow	Cumulative flow for the system, based on the flow for individual components in the system.
Reynolds Number	**Calculation formula** $Re = DV\rho/\mu$ *where* Re = Reynolds number, dimensionless ε = absolute roughness of pipe wall, ft μ = dynamic viscosity of fluid, $lb_m/ft \cdot s$
Relative Roughness	$\frac{D}{\varepsilon}$ D = Inside Diameter of pipe (feet) ε = Average Pipe Wall Roughness (feet)
Flow State	The Flow State is determined by the value of the Reynolds Number. A Reynolds Number less than 2,000 is considered laminar flow. A Reynolds Number greater than 4000 is considered turbulent flow. Numbers between 2,000 and 4,000 are unpredictable and no loss calculation is made. Two types of turbulent flow: transition and complete turbulence.
Friction Factor	Friction factor used in Darcys equation is calculated based on the flow state **Laminar Flow** $f = \frac{64}{Nr}$ f = friction factor Nr = Reynolds Number **Turbulent Flow** $\frac{1}{\sqrt{f}} = 2\text{Log}_{10}\left(\frac{3.7\,D}{\varepsilon}\right)$ $\frac{D}{\varepsilon}$ Relative Roughness of the pipe f = friction factor

Parameter	Description
Velocity	$V = \frac{\text{Flow Rate (feet}^3\text{/Second)}}{\text{Flow Area (feet}^2\text{)}}$
Friction	The pressure loss for a specific length unit of pipe.
Pressure Drop	The total pressure drop for the entire length of pipe.

Hydronic Pipe Sizing Methods

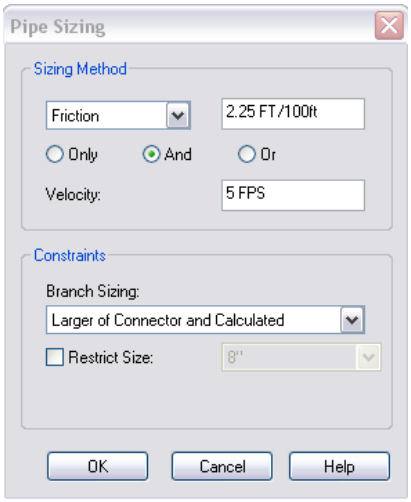
Revit MEP provides 2 standard sizing methods for sizing pipe:

- Friction
- Velocity

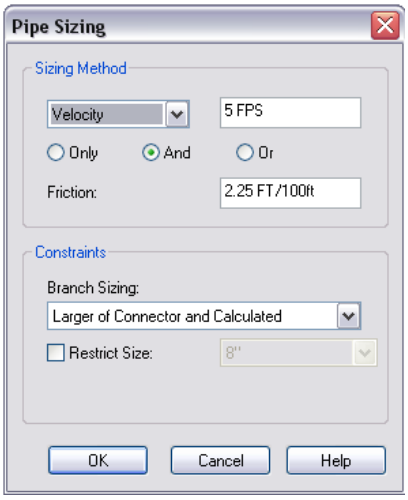
Friction and Velocity Methods

When the friction or velocity sizing method is selected, sizing can be based on Only the selected method, or a logical combination of friction and/or velocity methods.

Sizing Method - Friction

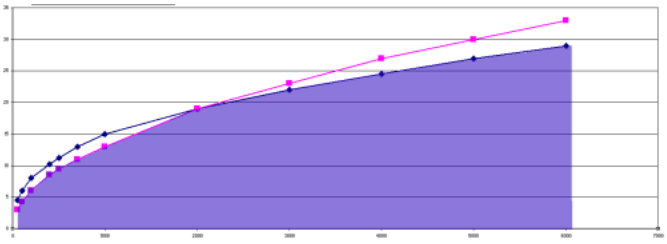


Sizing Method - Velocity

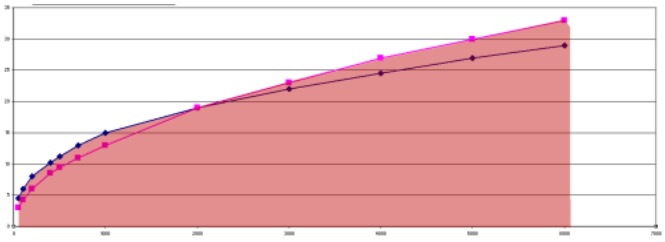


When And is selected, the size of the pipe must comply with both the friction and velocity values. When Or is selected, the size of the pipe is allowed to break either the friction or velocity rule, but must pass one rule. The following curves (based on 1000 FPM and 0.08") show the difference between Or and And sizing methods:

Friction ( ) And Velocity ( ) Pipe Sizing Method



Friction ( ) Or Velocity ( ) Pipe Sizing Method



How Velocity Affects Noise and Erosion

Velocity can be increased if the hours of operation are reduced and the erosion criteria will remain based on the following table.

Hours (per year)	Velocity (fps)
1500	1
2000	14
3000	13

Hours (per year)	Velocity (fps)
4000	10
6000	Junction

Pressure Drop Calculation

Revit MEP computes pressure losses in piping based on the geometry and roughness of piping, fluid density, and fluid viscosity. Values for Density and Viscosity are specified as Mechanical Settings. Roughness is specified in the type properties for pipe/pipe fitting component families.

The following example shows how CEV_ProdName_CEV calculates the pressure drop for a 100 foot segment of 4" carbon steel pipe, containing water at a temperature of 60 degrees F, with a flow rate of 100 GPM.

- Fluid Viscosity - u = 0.0007533333 lb/ft-s.
- Fluid Density - p = 62.36 lb/ft3.
- Roughness - e = 0.00015 ft (inside diameter, D = 0.3355 ft). Relative roughness (e) is calculated as D/e = 0.3355 / 0.00015 = 2236.67.

Pressure drop is defined as:

$$\Delta p = f\left(\frac{L}{D}\right)\left(\frac{\rho}{g_c}\right)\left(\frac{V^2}{2}\right)$$

where

Δp = pressure drop, lb_f/ft^2
f = friction factor, dimensionless
L = length of pipe, ft
D = internal diameter of pipe, ft
ρ = fluid density at mean temperature, lb_m/ft^3
V = average velocity, fps
g_c = units conversion factor, 32.2 $ft \cdot lb_m/lb_f \cdot s^2$

Average fluid velocity is defined as:

- V = 2.520241077 FPS.

The Reynolds number is defined as:

- Re = V * D * p / u = 2.520241077 * 0.3355 * 62.36 / 0.0007533333 = 69992.82.

The friction factor is defined as:

- Re > 4000, so friction factor “(f) is: f = (1 / (2 * log10 (3.7*e)) ^ 2 = 0.0162875.

Revit MEP calculates the Darcy-Weisbach equation as follows:

dpf=f*L*p*V*V/(D*gc*2)=0.0162875*100*62.36*2.520241077*2.520241077/(0.3355*2*32.2*144)=0.207 psi.

Hydronic Pipe Sizing Elements

Applied example to be determined.