CircuitSolver®
A ThermOmegaTech® brand

CIRCUITSOLVER® DESIGN GUIDE

FOR FLOW, PRESSURE LOSS, AND RECIRCULATION PUMP SIZING

To determine pressure loss in the recirculation system, we recommend the use of traditional pipe sizing and head loss practices. Design guides published by ASPE and ASHRAE are widely accepted and recommended. The following guide is not intended as a design recommendation, only as a guide to allow the plumbing designer to use any values of their choice.

Calculating Pressure Loss Across the Valve

To calculate the pressure loss across the CircuitSolver®, use the "Design Cv" shown in the chart below. This Cv is typical for a CircuitSolver® valve under normal working conditions. Use the value that you calculate for the branch design GPM required to offset heat loss in the equation below the chart. Include that pressure drop in your head loss calculations for the circuit and pump sizing.

DESIGN CV for CircuitSolver®

CircuitSolver® size, NPT	Cv fully open	Cv "closed"	Design Cv
½"	1.3	0.2	0.6
¾"	1.8	0.2	0.85
1"	3.3	0.2	1.57
1¼"	5.1	0.2	2.48
1½"	7.6	0.2	3.72
2"	14.2	0.2	7.02

Flow rate calculation using Cv factor shown.

$$GPM = C_v\sqrt{\Delta P} \qquad C_v = \frac{GPM}{\sqrt{\Delta P}} \qquad \Delta P = \left[\frac{GPM}{C_v}\right]^2$$

ΔP = pressure difference between inlet and outlet (psi)

Recirculation Pump Sizing

In a recirculation system, the pump must be sized to provide sufficient flow to compensate for the total heat loss in all the supply branches to the furthest fixture in each circuit. Heat loss in the return lines downstream of the CircuitSolvers is not included in the flow rate calculations.

The required flow rate formula is: **GPM = BTUh/(ΔT X 500)**

A common design practice for domestic hot water recirculation systems is to use $\Delta T = 5F$. This is the temperature difference of the recirculating water between the heat source and the furthest fixture in each circuit.

If we assume this common value of a $\Delta T = 5F$, the above equation simplifies to: **GPM = BTUh/2500**

If the designer prefers a $\Delta T = 10F$ the above equation simplifies to: **GPM = BTUh/5000**

Note that if a less temperature drop is allowed, this requires higher flow rate. The BTUH heat loss will vary based on pipe type, size, length, and insulation. The BTUH heat loss table below is used only to demonstrate example calculations and should not be referenced for real world BTUH heat loss.

BTUH heat loss per 100ft for tubing and steel pipe:

Pipe or Tube Size	Insulated Copper Tube or Steel Pipe	Insulated PEX Pipe	Insulated CPVC Pipe
½"	1600	1,546	1,476
¾"	1800	1,739	1,660
1"	2000	1,932	1,845
1 ¼"	2400	2,319	2,214
1 ½"	2600	2,512	2,398
2"	3000	2,898	2,767
2 ½"	3400		
3"	4000		
4"	4800		
5"	5700		
6"	6600		

Example 1:
Calculate the recirculation flow rate required for $\Delta T = 5F$ with 100 feet of ¾" insulated copper pipe, and determine the pressure drop across the CircuitSolver® at that flow rate.
Use the chart above for heat loss of 1800 BTU/h per 100 feet and the equation above for temperature drop $\Delta T = 5F$.

Flow rate = 1800/2500 = 0.72 GPM flow required in that circuit.
Using a ¾" CircuitSolver® with Design Cv = 0.85: pressure drop = $(0.72 / 0.85)^2 = 0.72$ PSI

Conclusion: Pressure drop across a ¾" CircuitSolver® with design Cv = 0.85 and branch flow of 0.72 GPM is 0.72 PSI.

Example 2:
Calculate the recirculation flow rate required for $\Delta T = 5F$ for 200 feet of ½" insulated copper pipe, and determine the pressure drop across a ½" CircuitSolver® at that flow rate.
Use the chart above for heat loss of 1600 BTU/h per 100 feet (X2 for 200 ft.) and the equation above for temperature drop of $\Delta T = 5F$.

Flow rate = 3200/2500 = 1.28 GPM flow required in that circuit.
Using a ½" CircuitSolver® with Design Cv = 0.6: pressure drop = $(1.28 / 0.6)^2 = 4.5$ PSI

Conclusion: Pressure drop across a ½" CircuitSolver® with design Cv = 0.6 and branch flow of 1.28 GPM is 4.5 PSI.

Example 3:
Calculate the recirculation flow rate required for $\Delta T = 10F$ for 200 feet of ½" non-insulated copper pipe, and determine the pressure drop across a ½" CircuitSolver® at that flow rate.
Use the chart above for heat loss of 2300 BTU/h per 100 feet (X2 for 200 ft.) and the equation above for temperature drop of $\Delta T = 10F$.

Flow rate = 4600/5000 = 0.92 GPM flow required in that circuit.
Using a ½" CircuitSolver® with Design Cv = 0.6: pressure drop = $(0.92 / 0.6)^2 = 2.3$ PSI

Conclusion: Pressure drop across a ½" CircuitSolver® with design Cv = 0.6 and branch flow of 0.92 GPM is 2.3 PSI.

Because of continuous improvements, ThermOmegaTech®, Inc. reserves the right to change the design and specifications without notice