CircuitSolver®
A ThermOmegaTech® product

Circuit Solver 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.

Calculating Pressure Loss Across the Valve

To calculate the pressure loss across the Circuit Solver, use the "Design Cv" shown in the chart below. This Cv is typical for a Circuit Solver 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 Circuit Solver

Circuit Solver size, NPT	Cv fully open	Cv "closed"	Design Cv
½"	1.3	0.1	0.6
¾"	1.8	0.1	0.85
1"	3.3	0.1	1.57
1¼"	5.1	0.15	2.48
1½"	7.6	0.15	3.72
2"	14.2	0.15	7.02

Flow rate calculation using C_v factor shown.

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

$\Delta P =$ 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 Circuit Solvers 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 ΔT = 10F. 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 **ΔT = 10F**, the above equation simplifies to: **GPM = BTUh/5000**

If the designer prefers a **ΔT = 5F** the above equation simplifies to: **GPM = BTUh/2500**

BTUH heat loss will vary based on pipe size, type and insulation. Heat loss tables and charts are available from a wide variety of industry standard reference sources. For example, this chart shows typical numbers for heat loss:

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

Pipe or Tube Size	Insulated Copper Tube or Steel Pipe	Non-Insulated Steel Pipe	Non-Insulated Copper Pipe
½"	1600	4,000	2,300
¾"	1800	5,000	3,000
1"	2000	6,000	4,000
1 ¼"	2400	7,500	4,500
1 ½"	2600	8,500	5,500
2"	3000	11,000	6,500
2 ½"	3400	12,000	8,000
3"	4000	15,000	9,500
4"	4800	19,000	12,000
5"	5700	22,500	
6"	6600	26,000	

Example 1:

Calculate the recirculation flow rate required for 100 feet of ¾" non-insulated copper pipe and the pressure drop across the Circuit Solver at that flow rate.

Use the chart above for heat loss of 3000 BTU/h per 100 feet and the equation above for temperature drop ΔT = 10F.

Flow rate = 3000 / 5000 = 0.6 GPM flow required in that circuit.

Using a ½" Circuit Solver with Design Cv = 0.7: pressure drop = $(0.6 / 0.7)^2 = 0.73$

Conclusion: Pressure drop across a ½" Circuit Solver with design Cv of 0.7 and branch flow of 0.6 GPM is 0.73 psi.

Example 2:

Calculate the recirculation flow rate required for 100 feet of ½" non-insulated copper pipe and the pressure drop across the Circuit Solver at that flow rate.

Use the chart above for heat loss of 2300 BTU/h per 100 feet and the equation above for temperature drop of ΔT = 10F.

Flow rate = 2300 / 5000 = 0.46 GPM flow required in that circuit.

Using a ½" Circuit Solver with Design Cv = 0.7: pressure drop = $(0.46 / 0.7)^2 = 0.43$

Conclusion: Pressure drop across a ½" Circuit Solver with design Cv = 0.7 and branch flow of 0.46 GPM is 0.43 psi.

Example 3:

Calculate the recirculation flow rate required for 100 feet of ½" non-insulated copper pipe and the pressure drop across a ¾" Circuit Solver at that flow rate, but allow only a ΔT = 5F between supply and return water temperature.

Use the chart above for heat loss of 2300 BTU/h per 100 feet and the equation above for temperature drop of ΔT = 5F.

Flow rate = 2300 / 2500 = 0.92 GPM flow required in that circuit.

Using a ¾" Circuit Solver with Design Cv = 0.95: pressure drop = $(0.92 / 0.95)^2 = 0.94$

Conclusion: Pressure drop across a ¾" Circuit Solver with design Cv = 0.95 and branch flow of 0.92 GPM is 0.94 psi.