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## Trench Talk

A series of live webinars to serve the geothermal community

# Pump Selection

Tuesday April 12, 2022, 4 PM EDT

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## Agenda

- The Basics (10 min)
- The Why (5-10 min)
- The Mechanics (20-25 min)
- Q&A

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Poll

# Are you familiar with Cv & know how to use it?

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## The Basics

- Pressure Drop
- Pump Curves

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## Pressure Drop

- Reflects the energy required to overcome fluid friction
- All friction ends up as heat
- If you have a flow rate & a pressure drop you can calculate the pressure drop at a different flow rate:

$$\text{Pressure Drop} = \text{Ref Pressure Drop} \times \left( \frac{\text{New gpm}}{\text{Ref gpm}} \right)^2$$

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## Pressure Drop

What's the pressure drop at 15 gpm?

Model	gpm	30°F	50°F	70°F	90°F	110°F
054	3.8	0.5	3.3	3.0	2.8	
104	6.5	1.0	6.6	6.2	4.9	
204	12.7	4.1	16.5	16.0	12.4	

gpm	psi
0	0
8	1.8
12	3.8
16	6.5
20	9.7

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### Pressure Drop – for Example

$$\text{Pressure Drop} = \text{Ref Pressure Drop} \times \left( \frac{\text{New gpm}}{\text{Ref gpm}} \right)^2$$



$$\text{Pressure Drop} = 9.7 \times \left( \frac{15}{20} \right)^2$$

$$\text{Pressure Drop} = 9.7 \times (0.75)^2$$

$$\text{Pressure Drop} = 9.7 \times 0.5625$$

$$\text{Pressure Drop} = 5.46$$

To convert to Feet of Head multiply by 2.31, therefore Pressure Drop = 12.6 FOH

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### Understanding



# C<sub>v</sub>




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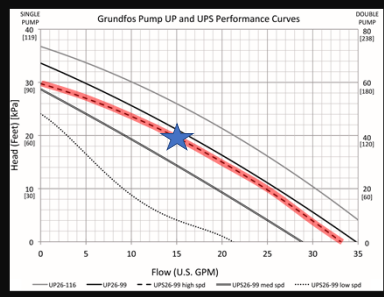


### C<sub>v</sub>

- The Flow Rate at which Pressure Drop = 1 psi
- Knowing Flow Rate & Pressure Drop allows you to calculate Pressure Drop at any Flow Rate
- As a general guide, use a valve in applications where flow equals ½ the C<sub>v</sub> (this will result in Pressure Drop = ¼ psi)
  - For example, a valve with a C<sub>v</sub> of 10 should be used where flow is 5 gpm +/- 1, which makes it suitable for a 2 Ton heat pump
  - A C<sub>v</sub> of 30 would be good for a 5 Ton heat pump
- Understanding C<sub>v</sub> is a vital tool to avoid “scar tissue”


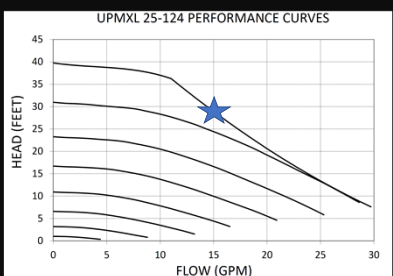


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### Pump Curves


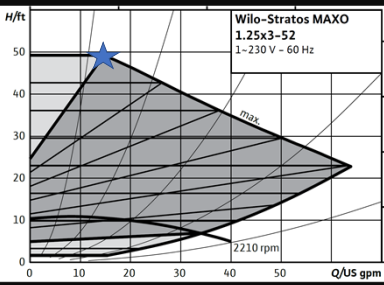


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### Pump Curves

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### Pump Curves

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### The Why

- Efficiency is Sacrificed
  - “4 ft/100” is no longer acceptable
- Energy Audit of GSHP System in PA
- “Penny Wise & Pound Foolish”



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### Example – 5 Ton Aston



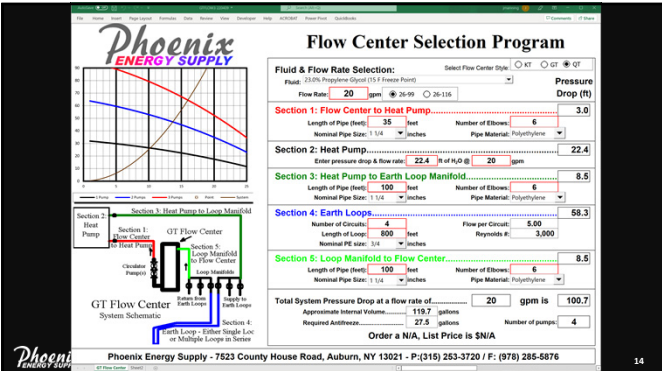
Dual Capacity		Pressure Drop (ft)				
Model	gpm	30°F	50°F	60°F	80°F	100°F
604	8	1.8	1.7	1.6	1.4	1.3
604	12	3.8	3.5	3.3	3.0	2.8
604	20	6.2	6.0	5.8	5.5	5.3
604	20	6.7	6.1	6.0	6.0	5.4

**Choices**

- Flow Rate
  - 2 1/4 to 4 gpm/Ton
  - Let's start with 20 gpm (More is better, Right?)
- Antifreeze
  - Propylene Glycol, Ethanol or Methanol
  - Let's start with 23% Propylene Glycol
- Loop Field Configuration
  - Horizontal or Vertical
  - Number of Circuits
  - Loop Pipe Size
  - Let's start with (4) 3/4" x 800' Horizontal Circuits w/ a buried manifold ~100' from house
- Supply & Return Pipe Size
  - 1", 1-1/2" or 2"
  - Let's start with 1 1/4" x 100 ft (one way)



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**Fluid & Flow Rate Selection:** 20% Propylene Glycol (15 F Freeze Point)  
 Flow Rate: 20 gpm  
 Pressure Drop (ft): 100.7

**Section 1: Flow Center to Heat Pump**  
 Length of Pipe (feet): 35  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.0

**Section 2: Heat Pump**  
 Enter pressure drop & flow rate: 22.4 ft of H<sub>2</sub>O @ 20 gpm  
 Pressure Drop (ft): 22.4


**Section 3: Heat Pump to Earth Loop Manifold**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 8.5

**Section 4: Earth Loops**  
 Number of Circuits: 4  
 Flow per Circuit: 5.00  
 Length of Loop: 800 feet  
 Nominal PE size: 1/4 inches  
 Reynolds #: 3,000  
 Pressure Drop (ft): 58.3

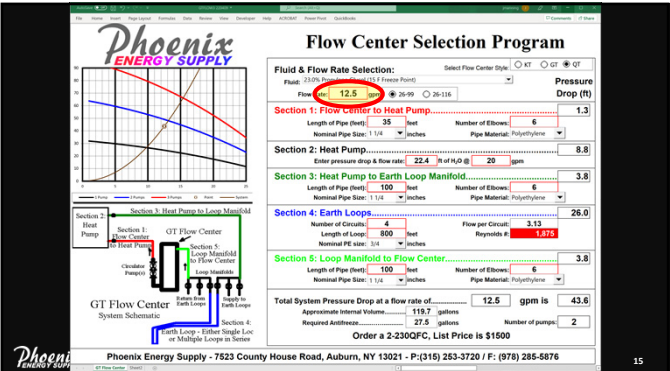
**Section 5: Loop Manifold to Flow Center**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 8.5

**Total System Pressure Drop** at a flow rate of 20 gpm is 100.7 ft.  
 Approximate Internal Volume: 119.7 gallons  
 Required Antifreeze: 27.5 gallons  
 Number of pumps: 4

Order a N/A, List Price is \$N/A



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**Fluid & Flow Rate Selection:** 20% Propylene Glycol (15 F Freeze Point)  
 Flow Rate: 12.5 gpm  
 Pressure Drop (ft): 43.6

**Section 1: Flow Center to Heat Pump**  
 Length of Pipe (feet): 35  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 1.3

**Section 2: Heat Pump**  
 Enter pressure drop & flow rate: 22.4 ft of H<sub>2</sub>O @ 20 gpm  
 Pressure Drop (ft): 8.8


**Section 3: Heat Pump to Earth Loop Manifold**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.8

**Section 4: Earth Loops**  
 Number of Circuits: 4  
 Flow per Circuit: 3.13  
 Length of Loop: 800 feet  
 Nominal PE size: 1/4 inches  
 Reynolds #: 1,875  
 Pressure Drop (ft): 26.0

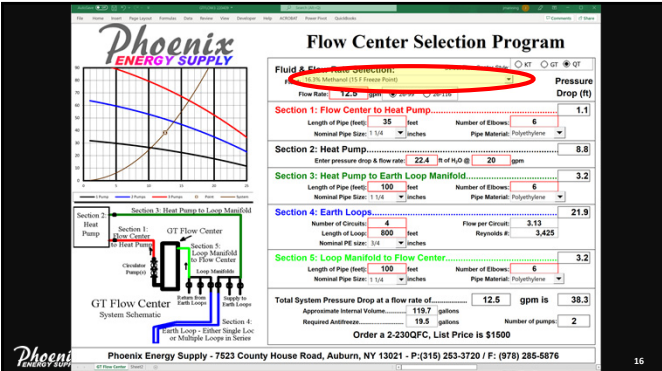
**Section 5: Loop Manifold to Flow Center**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.8

**Total System Pressure Drop** at a flow rate of 12.5 gpm is 43.6 ft.  
 Approximate Internal Volume: 119.7 gallons  
 Required Antifreeze: 15.0 gallons  
 Number of pumps: 2

Order a 2-230QFC, List Price is \$1500



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**Fluid & Flow Rate Selection:** 18.3% Methanol (15 F Freeze Point)  
 Flow Rate: 12.5 gpm  
 Pressure Drop (ft): 38.3

**Section 1: Flow Center to Heat Pump**  
 Length of Pipe (feet): 35  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 1.1

**Section 2: Heat Pump**  
 Enter pressure drop & flow rate: 22.4 ft of H<sub>2</sub>O @ 20 gpm  
 Pressure Drop (ft): 8.8


**Section 3: Heat Pump to Earth Loop Manifold**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.2

**Section 4: Earth Loops**  
 Number of Circuits: 4  
 Flow per Circuit: 3.13  
 Length of Loop: 800 feet  
 Nominal PE size: 1/4 inches  
 Reynolds #: 3,425  
 Pressure Drop (ft): 21.9

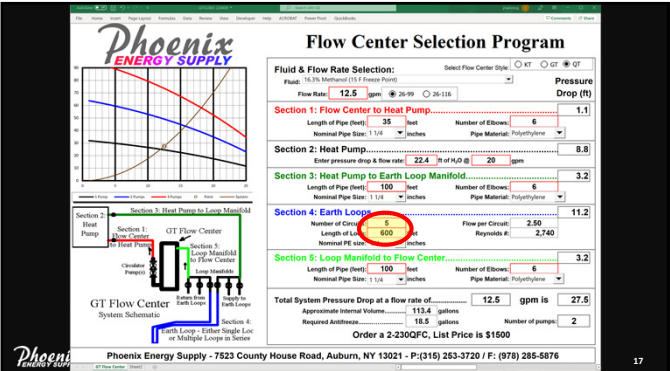
**Section 5: Loop Manifold to Flow Center**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.2

**Total System Pressure Drop** at a flow rate of 12.5 gpm is 38.3 ft.  
 Approximate Internal Volume: 119.7 gallons  
 Required Antifreeze: 19.5 gallons  
 Number of pumps: 2

Order a 2-230QFC, List Price is \$1500



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**Fluid & Flow Rate Selection:** 18.3% Methanol (15 F Freeze Point)  
 Flow Rate: 6 gpm  
 Pressure Drop (ft): 27.5

**Section 1: Flow Center to Heat Pump**  
 Length of Pipe (feet): 35  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 1.1

**Section 2: Heat Pump**  
 Enter pressure drop & flow rate: 22.4 ft of H<sub>2</sub>O @ 20 gpm  
 Pressure Drop (ft): 8.8


**Section 3: Heat Pump to Earth Loop Manifold**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.2

**Section 4: Earth Loops**  
 Number of Circuits: 6  
 Flow per Circuit: 2.50  
 Length of Loop: 600 feet  
 Nominal PE size: 1/4 inches  
 Reynolds #: 2,740  
 Pressure Drop (ft): 11.2

**Section 5: Loop Manifold to Flow Center**  
 Length of Pipe (feet): 100  
 Number of Elbows: 6  
 Nominal Pipe Size: 1 1/4 inches  
 Pipe Material: Polyethylene  
 Pressure Drop (ft): 3.2

**Total System Pressure Drop** at a flow rate of 6 gpm is 27.5 ft.  
 Approximate Internal Volume: 113.4 gallons  
 Required Antifreeze: 18.5 gallons  
 Number of pumps: 2

Order a 2-230QFC, List Price is \$1500



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**Flow Center Selection Program**

Fluid & Flow Rate Selection: Fluid: 15.00 Minimum 15.00 Flow Rate: 12.5 gpm Pressure Drop (ft): 1.1

Section 1: Flow Center to Heat Pump  
Length of Pipe (feet): 35 Number of Elbows: 6  
Normal Pipe Size: 1 1/4 inches Pipe Material: Polyethylene

Section 2: Heat Pump  
Enter pressure drop & flow rate: 22.4 ft of H<sub>2</sub>O @ 25 gpm Pressure Drop (ft): 8.8

Section 3: Heat Pump to Earth Loop Manifold  
Length of Pipe (feet): 100 Number of Elbows: 6  
Normal Pipe Size: 1 1/2 inches Pipe Material: Polyethylene

Section 4: Earth Loop  
Length of Loop: 600 feet Flow per Circuit: 2.50 Reynolds #: 2,740

Section 5: Loop Manifold to Flow Center  
Length of Pipe (feet): 100 Number of Elbows: 6  
Normal Pipe Size: 1 1/2 inches Pipe Material: Polyethylene

Total System Pressure Drop at a flow rate of 12.5 gpm is 22.0  
Approximate Internal Volume: 133.6 gallons Number of pumps: 1  
Order a 1-2300FC, List Price is \$1218

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The Moral to That Story

- Every detail of system design can & does influence pump selection
- To own your design decisions, you need to understand these dynamics
- Design tools to quickly evaluate your choices will help avoid “scar tissue”

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Multiple Heat Pump Systems

Each Heat Pump Circuit Must be Evaluated – BUT the Basics Still Apply

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**System Characteristics**  
Normal Tonnage: 21.0 tons  
Type: Multi-zone  
Number of Heat Pump Flow Circuits: 6  
Pumping Strategy: Parallel  
Interior Piping Material: Minimum EWT @ 32.2

**Loop Field Description**  
Number of Groups: 2  
Length: 600 feet  
Manifold Length: 4 feet  
Support/Return Piping for Average Group: 100 feet  
Main Pipe (at Common Pipe that will handle Full System Flow to and from Loop Field): 20 feet

**Heat Pump Distribution Manifolds**  
Dist Manifold A: 197.1 gal  
Dist Manifold B: 142.2 gal

**Pressure Drop Summary**  
System Volume: 1.36  
Primary DP: 19.9  
Secondary DP: 64.0  
Total: 83.9

Heat Pump Flow Circuits	Model	Flow	Pipe Diam	Length	SD	ZV CV	RV CV	Model	Flow	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
1	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

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2	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

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2	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	10404	20.0	2.0	100	1.0	1.0	1.0	A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

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Acknowledgement & Gratitude to:

- Geo-Flo
- Grundfos
- WILO
- GeoStar

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# Q&A

Please complete our short evaluation Poll

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