“Tanks” For The Memories…

Mod-Cons, Buffer Tanks, Expansion Tanks & You…

Modulating Boilers

- Variable firing rates
  - Adjust output to match load
  - Internal microprocessor adjust gas/air mix to burner
- Based on:
  - System Delta T – maintain
  - Outdoor reset
    - Maintain calculated temp
    - Can't? Fire it up!

Taco
Do your best work.

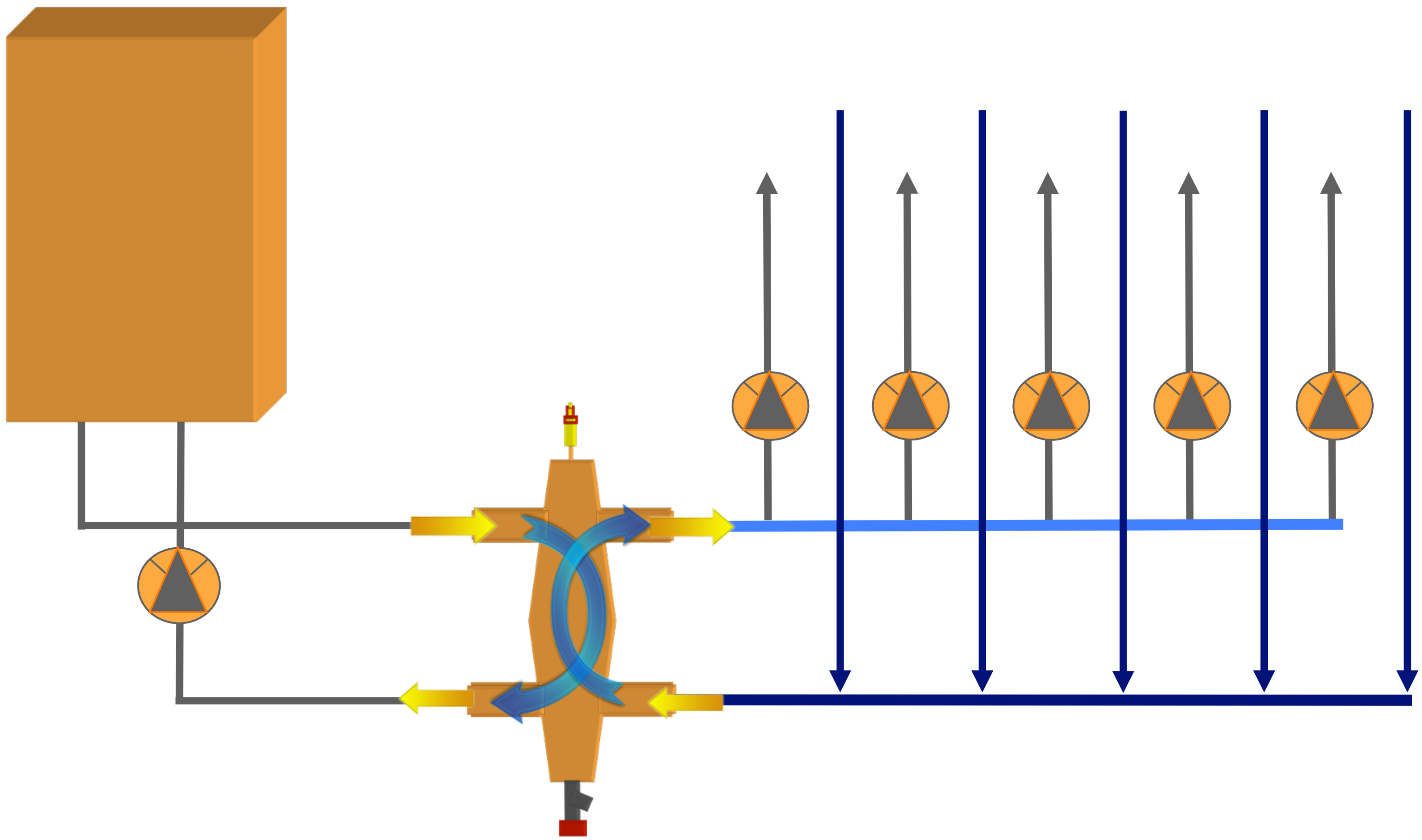
It's All About The BTU's

- ≈ 2% of heating season at/near ODT
  - 50% of heating season at ⅓ load or less
- Turn down ratio
  - Modulating gas valve, fan
  - 0-10V DC signal ramps burner up/down
  - 5:1 means boiler can fire @ 20% firing rate

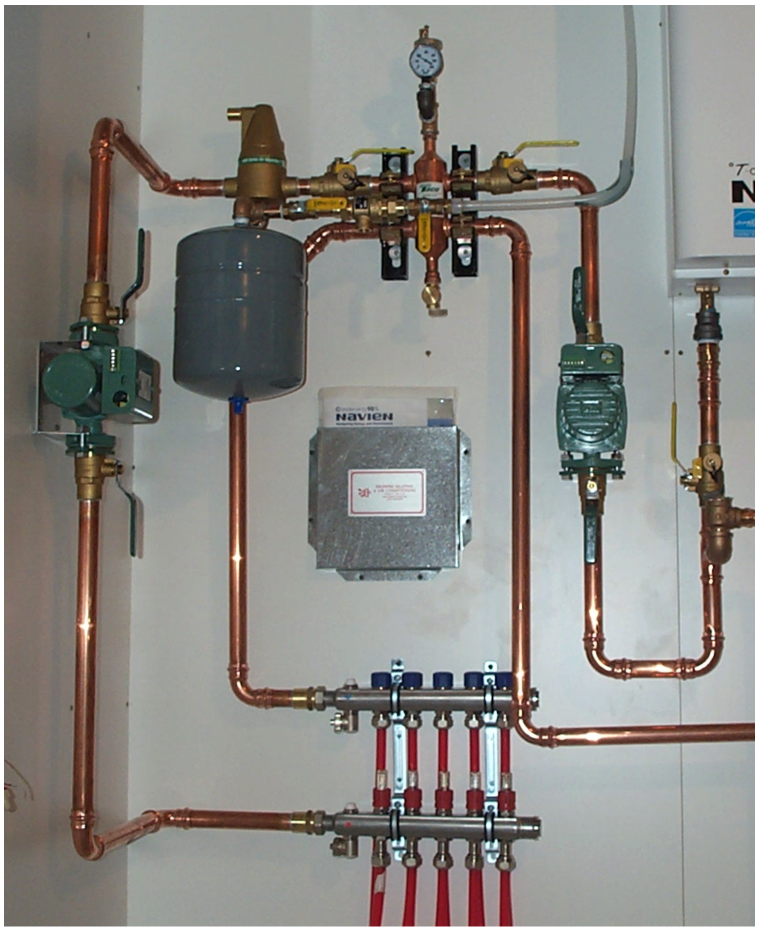
Still Possible Short Cycling

- 100k BTU boiler
  - 5:1 – lowest rate is 20k
  - Microzones – short-cycle like crazy
  - EVEN UNDER DESIGN CONDITIONS!!!!!!
- How can we minimize/prevent?

Option1 –
Hydraulic Separator



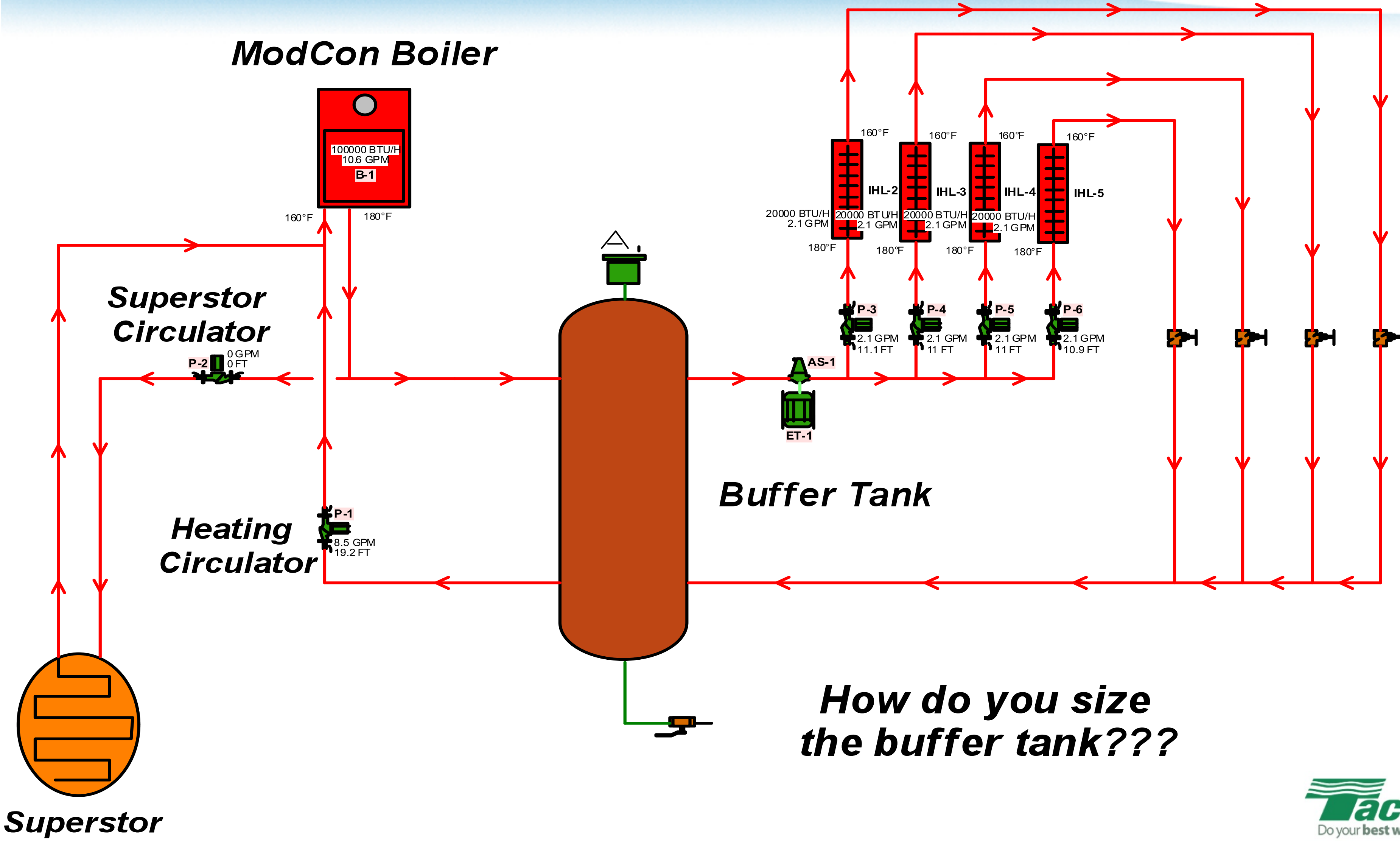
Some Examples…



Option 2 – Buffer Tank

- Adds mass to mod-con
- Reduces short-cycling
- Boiler piped to/ from buffer tank
- Zone S & R's piped to buffer tank

Piping Schematic

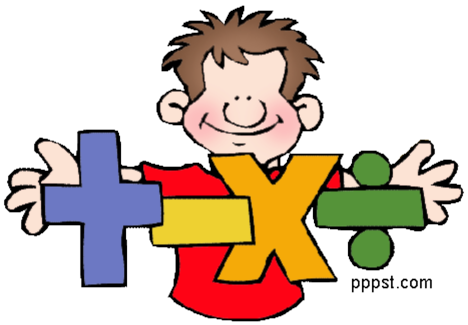


How do you size the buffer tank???

Taco
Do your best work.

How Big?

- Minimum boiler firing rate − Smallest zone = BTU surplus
- BTU surplus × Desired min. run time (usually 10 min.) = Cycle factor
- Cycle factor ÷ (ΔT × 500) = Tank capacity (gallons)



Taco Do your best work.

Example…

- 100,000 BTU Mod/con with 4-1 turndown ratio
  - Minimum firing rate?
- Smallest zone – 8,000 BTUH
- 25,000 – 8,000 = 17,000 BTUH
- 17,000 × 10 minute cycle = 170,000
- 170,000 ÷ 10,000 (Delivery ΔT of 20 × 500) = 17 gallon tank

Taco® Do your best work.

That's Some VOLUME!!!

- What about the expansion tank?

- $V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$

- Huh?

Taco
Do your best work.

Define The Terms…

- V = minimum required exp. tank volume
- V_{system} = total system volume, gallons
- D_{cold} = density of water at fill temp (60^{0}f)
- D_{hot} = density of water at operating temp
- $P_{relief\ valve}$ = boiler relief valve setting
- P_{charge} = exp. tank charge pressure

Taco
Do your best work.

Water Density (lbs/ft^3)

- 60^0f = 62.34
- 100^0f = 62.00
- 110^0f = 61.84
- 120^0f = 61.73
- 130^0f = 61.54
- 140^0f = 61.39
- 150^0f = 61.20
- 160^0f = 61.01
- 170^0f = 60.79
- 180^0f = 60.57
- 190^0f = 60.39

Boiler Water Content

- Look it up
- Some examples:
  - Triangle Tube Prestige ≈ 3.3 gallons
  - Buderus GB 142 ≈ 1.3 gallons
  - Viessmann Vitodens 100 ≈ .87 gallons
- Radiation
- Buffer tank

Taco® Do your best work.

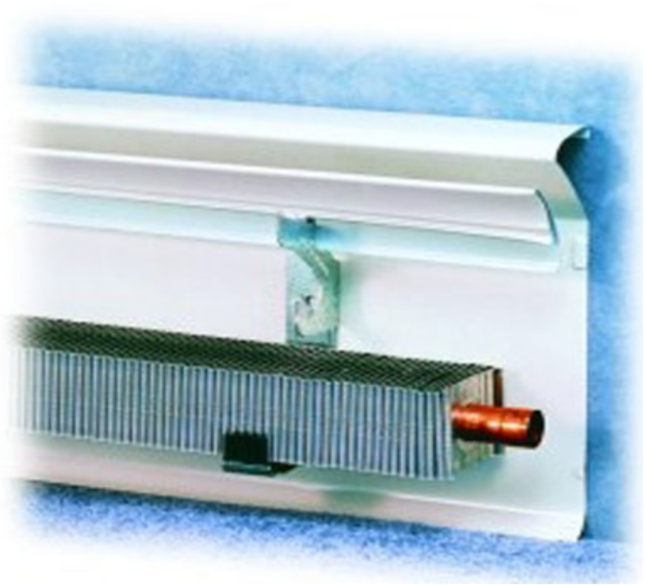
Piping Water Content

- Copper – gallons per foot:
  - ½" = 0.016
  - ¾" = 0.027
  - 1" = 0.046
  - 1¼" = 0.068
  - 1½" = 0.096
- PEX – gallons per 100':
  - ⅜" = 0.497
  - ½" = 0.917
  - ⅝" = 1.392
  - ¾" = 1.832
  - 1" = 3.067

Taco
Do your best work.

Radiation Water Content

- Baseboard – use water content of ¾" pipe
- Panel rads – look 'em up…



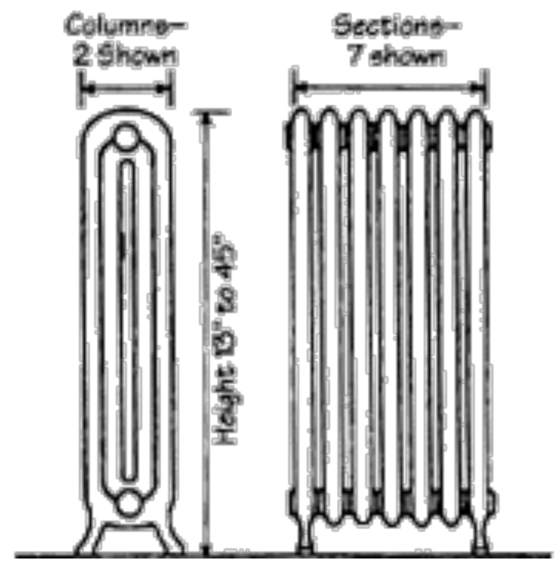
Example…

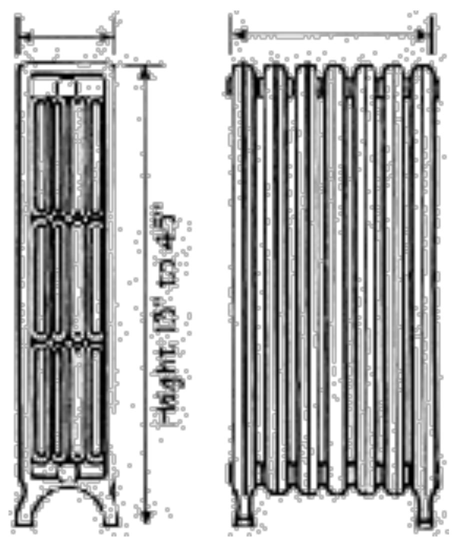
H 11 RADIATOR with Fins					
Height	Order Codes	Length	Output (BTU/hr)	Weight (lbs)	Water Content (gals)
6 Tube 18"	6H11060	23-5/8"	3565	21.2	0.72
	6H11080	31-1/2"	4754	28.2	0.96
	6H11100	39-3/8"	5942	34.4	1.17
	6H11140	55-1/8"	8319	48.5	1.65
	6H11180	70-7/8"	10696	62.6	2.13
8 Tube 24"	8H11060	23-5/8"	4490	28.2	0.96
	8H11080	31-1/2"	5986	37.6	1.30
	8H11100	39-3/8"	7483	45.8	1.60
	8H11140	55-1/8"	10475	64.6	2.20
	8H11180	70-7/8"	13469	83.4	2.84
10 Tube 30"	10H11060	23-5/8"	5385	35.4	1.20
	10H11080	31-1/2"	7181	47.2	1.60
	10H11100	39-3/8"	8976	57.5	1.95
	10H11140	55-1/8"	12566	81.1	2.75
	10H11180	70-7/8"	16156	104.7	3.55

Taco® Do your best work.

Column & Tube Radiators

- Find height, # of tubes or columns
- How many sections?
- Use chart to convert to EDR
  (Equivalent Direct Radiation – 170 BTUH/SF)
- Example…
  - Tube type radiator
  - 5 tubes, 26” high
  - 7 sections





Taco
Do your best work.

	13"	16"	18"	20"	22"	23"	26"	30"	32"	36"	38"	45"
3 Tubes				1.72		2.00	2.33	3.00		3.50	3.50	
4 Tubes				2.25		2.50	2.75		3.50	4.25		
5 Tubes				2.67		3.00	3.50	4.33	4.33	5.00	6.00	
6 Tubes				3.00		3.50	4.00		5.00			
7 Tubes	2.60	3.50		4.20			4.75					
1 Column				1.50		1.67	2.00		2.50		3.00	
2 Cols.				2.00		2.33	2.67		3.33		4.00	5.00
3 Cols.			2.25		3.00		3.75		4.50		5.00	6.00
4 Cols.			3.00		4.00		5.00		6.50		8.00	10.0
5 Cols.	3.00	3.75	4.50	5.00		6.30	7.00		8.50		10.0	

3.5 ft^2 per section × 7 sections = 24.5 ft^2 EDR per radiator

(or 4,165 BTUH)

Convert To Water Content

- Column radiators: 0.114 gallons/sf² EDR
- Tube radiators: 0.056 gallons/sf² EDR

- Example:
  - 24.5 sf² EDR tube radiator × 0.056 gallons/sf² EDR = 1.37 gallons of water content

Sample System

- 1,000’ of ½” PEX in basement
- 140’ of ¾” copper
- 50’ of ¾” fin-tube baseboard
- 30’ of 1’ copper
- 5 tube-type radiators, 120 ft^2 total EDR
- 20 gallon buffer tank
- 0.87 gallons in boiler

just another example

What Do We Have?

• 1,000’ ½” PEX × .917 gal/100’	=	9.17 gallons
• 140’ ¾” Cu × .027 gal/foot	=	3.78 gallons
• 50’ ¾” BB × .027 gal/foot	=	1.35 gallons
• 30’ 1” Cu × .046 gal/foot	=	1.38 gallons
• 120 ft^2 EDR × .056 gal/ft^2 EDR	=	6.72 gallons
• 20 gallon buffer tank	=	20 gallons
• Boiler water content	=	.87 gallons
– Total	=	43.27 gallons

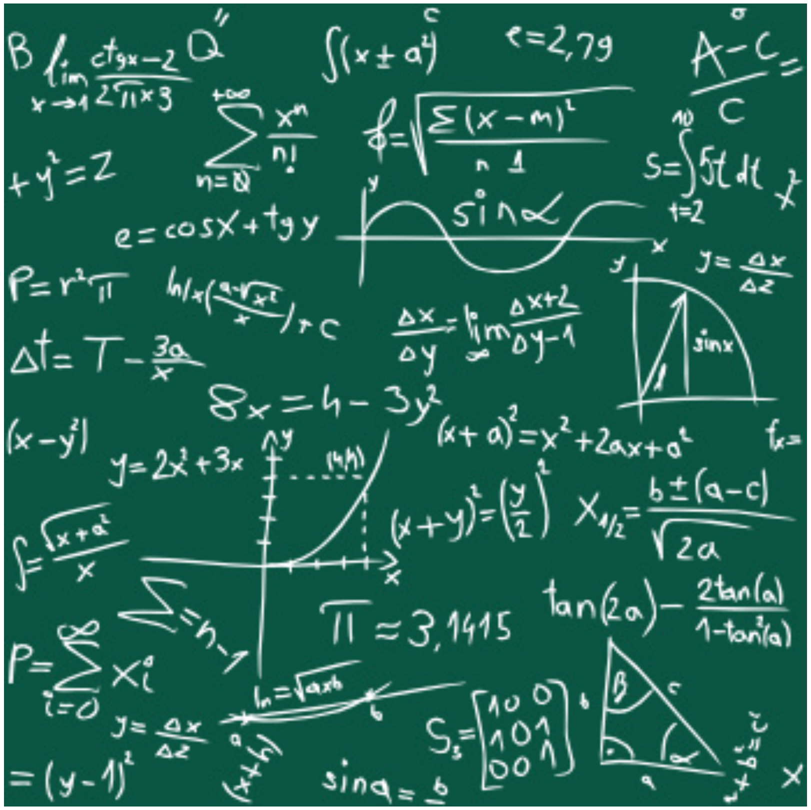
Taco
Do your best work.

The Formula!!!

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$$

Plug It In…

- D_{cold} at 60^{0}f = 62.34
- D_{hot} at 150^{0}f = 61.20
- $P_{reliefvalve}$ = 27 psi
- P_{charge} = 12 PSI



Do your best work.

The Formula!!!

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$$

Taco Do your best work.

The Formula!!!

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$$

$$V = 43.26 \times \left[\frac{62.34}{61.20} - 1\right] \times \left[\frac{27 + 9.7}{27 - 12 - 5}\right]$$

Taco Do your best work.

The Formula!!!

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$$

$$V = 43.26 \times \left[\frac{62.34}{61.20} - 1\right] \times \left[\frac{27 + 9.7}{27 - 12 - 5}\right]$$

$$V = 43.26 \times \left[1.02 - 1\right] \times \left[\frac{36.7}{10}\right]$$

Taco
Do your best work.

The FORMULA!!!

$V = 43.26 \times .02 \times 3.67$

V = 3.18 gallon tank acceptance volume

Check The Specs…

RADIANT EXTROL® Tanks for Radiant Systems

Model Number	Tank Volume (Gallons)	Max. Accept. Volume (Gallons)	A Height (Inches)	B Diameter (Inches)	System Conn.[1] (Inches)	Shipping Weight (lbs.)
RX-15	2.0	0.9	12 5/8	8	3/4 NPTM	5
RX-30	4.4	3.2	15 1/2	11	3/4 NPTM	9
RX-60	10.3	10.3	19 1/4	15 3/8	3/4 NPTF	23

Taco® Do your best work.

DIMENSIONS & CAPACITIES

Model	Capacity Gallons	Maximum Acceptance Volume
HTX 15	2.1	1.0
HTX 30	4.5	2.5
HTX 60	6.0	3.0
HTX 90	15.0	6.0

MODEL	TANK VOL.	ACCEPT. VOL.	CONNECTION
	gal.	*@12 psi*	
ETX-15	2.1	1.0	1/2" MNPT
ETX-30	4.5	2.5	1/2" MNPT
ETX-60	6.0	3.0	1/2" MNPT
ETX-90	15.0	6.0	3/4" MNPT

Just For Giggles, Try 180^{0}F

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1\right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5}\right]$$

$$V = 43.26 \times \left[\frac{62.34}{60.57} - 1\right] \times \left[\frac{27 + 9.7}{27 - 12 - 5}\right]$$

$$V = 43.26 \times \left[1.03 - 1\right] \times \left[\frac{36.7}{10}\right]$$

Taco
Do your best work.

At 180^0F

$V = 43.26 \times .03 \times 3.67$

V = 4.76 gallon tank capacity

Now what size tank?

DIMENSIONS & CAPACITIES

Model	Capacity Gallons	Maximum Acceptance Volume
HTX 15	2.1	1.0
HTX 30	4.5	2.5
HTX 60	6.0	3.0
HTX 90	15.0	6.0

Do your best work.

Want A Simpler Way?

- Tank Volume = System volume × 0.122
- Estimates at 210^0 boiler temp
- *WILL* oversize your tank

Taco
Do your best work.