TECHNICAL SERVICE DEPARTMENT
Technical Service Bulletin
1-800-432-8373

Formulas and Facts

1 gallon of water weighs 8.33 lbs

1 gallon of water has a volume of 231 cubic inches

1 cubic foot of water weighs 62.38 lbs and contains 7.48 gallons of water

100 feet of 3/4“ copper pipe contains 2.5 gallons of water; 1” pipe contains 4.3 gallons

8.33 BTU will raise 1 gal of water 1 degree F at 100% efficiency (electricity

11 BTUs are required to raise 1 gallon of water 1°F at 75% efficiency (gas)

3,412 BTU equals 1 kilowatt hour (Kwhr)

1 Kwhr will raise 410 gallons of water 1 degree F at 100% efficiency

1 BTU X 0.293 = watts

1 KW = 1000 watts

2.42 watts are required to raise 1 gallon of water 1 ° F

1 Kwhr will raise 10.25 gal of water 40 degrees F at 100% efficiency
1 Kwhr will raise 6.8 gal of water 60 degrees F at 100% efficiency
1 Kwhr will raise 5.1 gal of water 80 degrees F at 100% efficiency
1 Kwhr will raise 4.1 gal of water 100 degrees F at 100% efficiency

Formulas:

ELECTRIC	GAS
Energy Costs:	**Energy Costs:**
Kwhr x fuel costs = energy costs	Cubic feet x fuel costs = energy costs
If I use 100 kilowatt hours of electricity, how much will it cost if each kilowatt hour costs $.05?	If I use 100 cubic feet of gas, how much will it cost if each cubic foot costs $.075?
100 x .05 = $5.00	100 x .075 = $7.50
To obtain gallons per hour (GPH) recovery	**To obtain gallons per hour (GPH) recovery**
WATTS 2.42 x (temp rise ° F)	HOURLY INPUT (BTUs) 11.0 x (temp rise ° F)
I have a 30 gallon electric heater, non-simultaneous operation, 4500 watt elements. What is the recover GPH if my cold water is 40° F and my thermostat is set to 120° F?	I have a 30 gallon gas heater rated at 40,000 BTUs. What is the recover GPH if my cold water is 40° F and my thermostat is set to 120° F?
4500 2.42 x 80 = 23 gallons per hour	40,000 11.0 x 80 = 45 gallons per hour

Formulas and Facts

Temperature Rise (°F)	**Temperature Rise (°F)**
WATTS 2.42 x GPH	HOURLY INPUT (BTUs) 11.0 x (GPH)
I have a 30 gallon electric heater, non-simultaneous operation, 4500 watt elements. What is the maximum temperature rise if the heater can recover 23 gallons per hour?	I have a 30 gallon gas heater rated at 40,000 BTUs. What is the maximum temperature rise if the heater can recover 45 gallons per hour?
$\frac{4500}{2.42 \times 23}$ = 80 degrees temp rise	$\frac{40{,}000}{11.0 \times 45}$ = 80 degrees temp rise

Formula for mixing hot water

$\frac{M-C}{H-C}$ = PERCENT OF HOT WATER REQUIRED TO PRODUCE DESIRED MIXED TEMPERATURE

Where M = mixed water temperature; C = cold water temperature; H = hot water temperature

For example: How much of a shower is hot water and how much is cold water? My shower temperature is 105° F, my water heater thermostat is set on 120° F and the cold water inlet temperature is 50° F.

$\frac{105 - 50 = 55}{120 - 50 = 70}$ = 79% of the shower is 120° hot water

This formula for mixing hot water is important when explaining a NOT ENOUGH HOT WATER trouble call and the water heater is functioning properly.

Electric Working Formulas that apply to Water Heaters

To verify circuit breaker OR amp draw on the heater:

amp draw = $\frac{\text{watts}}{\text{voltage}}$

amp draw = $\frac{\text{4500 watts (heating elements shown on rating plate total)}}{\text{240 volts (shown on the rating plate}}$

amp draw = 18.8 amps (circuit breaker should be 20% higher or 25 amp breaker

Now that you have solved for amps, what is the OHMS resistance of the heating element? (If a heating element has no resistance, then it is *open*, or broken.)

ohms resistance = $\frac{\text{voltage}}{\text{amps}}$

ohms resistance = $\frac{\text{240 volts (shown on the rating plate)}}{\text{18.8 (answer from previous problem)}}$

ohms resistance = 12.8 ohms