

# Green Energy Optimizers LLC

## Heating system primer

---

There are two basic types of heating systems

### Hot Water

A hot water based system has a boiler at its core. The boiler heats water. The water is used to transfer energy into the homes living space. There are numerous ways in which that can be achieved.

### Forced Air

A forced air system directly heats air which is then pumped into the home via blowers. The air is blown through a sealed metal manifold within the furnace. The flame heats the manifold and subsequently the air inside it.

### Hot Water variations

Boiler based systems have different ways to transfer the heat into the home. They always involve heating water in a boiler and then using a circulation pump to pump that hot water into a heat exchanger that transfers the energy into the living space.

- 1) *Radiant* – pipes are laid into a floor and hot water is circulated into the pipes. These types of

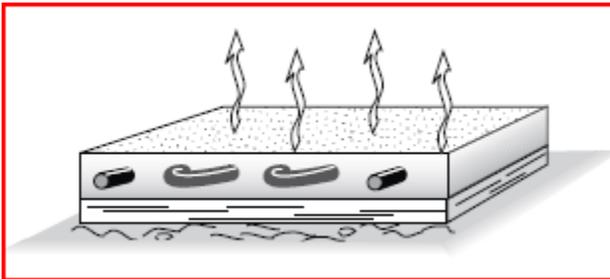


Figure 1 Radiant heat

systems usually are very slow acting and keep the heat for long periods of time. Many such systems do not circulate the hot water directly from the boiler but rather mix it with colder water to not allow the floor to get too hot.

- 2) *Fancoil* – in this sort of system a fan blows on coils containing hot water thereby transfer the heat from the coils into air which is blown through the home. The coils contain water that is heated in the boiler. Circulators pump the water through the coils

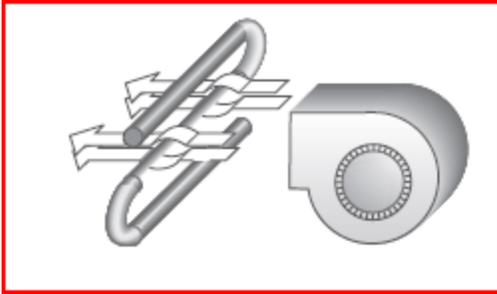


Figure 2 Fan coil

- 3) *Fin tube convector* – Base board made of one solid copper pipe with fins. The hot water flows in the central tube. The fins provide added surface area to allow the convection of heat into the home.

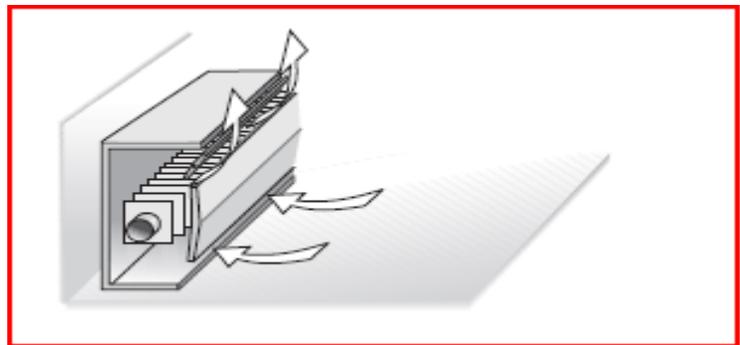


Figure 3 Fin tube

- 4) *Radiator* – large unit (usually iron ) with a large surface area in which water flows.

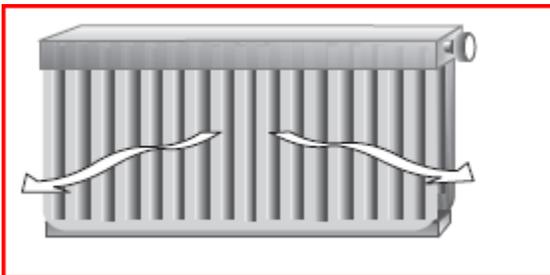


Figure 4 Radiator

- 5) *Baseboard* – like radiators but smaller versions (typically made of iron) usually mounted along the wall.



Figure 5 Baseboard

*Circulator* – In a hot water system the circulator is an electric water pump that moves the hot water into the heat exchanger that then transfers the energy into the home. The circulator is mounted on the return path of the water. That is the circulator is mounted on the cold side of the boiler pushing the cold water into the boiler to be heated.

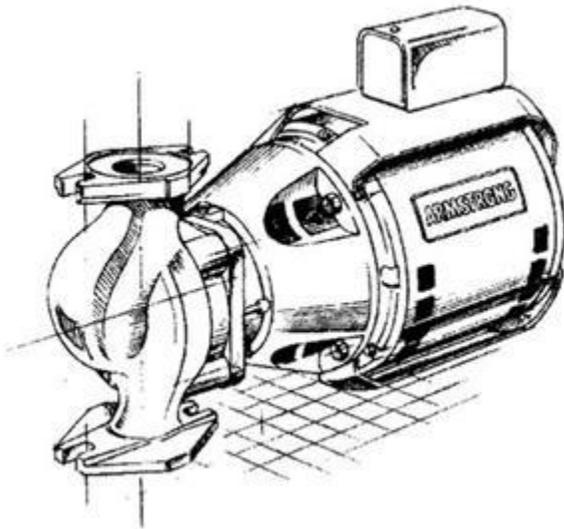


Figure 6 Circulator pump

*Zones* - The regions of a house that are independently controlled. Each zone will have its own thermostat and circulator. The thermostat for each zone maintains the temperature in that zone at a constant setting. For example a two story house may have one zone as the first floor and the second zone as the second floor.

*Mixing valve* - In radiant heating the mixing valve ensures that the water temperature going to the radiant system is not the typical 180 deg F but a lower value. It does this by mixing the hot water from the boiler with colder water to achieve the target temperature.

*Electrical Power* - Most forced air systems use 24 Volts for switching. Water based systems are 24 and 110V based. The GEO system can control systems that are either 24 or 110/220V and can itself be powered by 24 V or 110/220V.

*Two stage heater* – two stage or multi stage heaters are those that use two or more boilers to heat the home. Based on the demand one or more stages may be turned on to allow the efficiency to be increased in applications where there isn't a great need for large amounts of heat to heat the home. The two boilers may be one physical boiler with two separate heating sections with valves that direct the water flow into the home from each or both of the sections

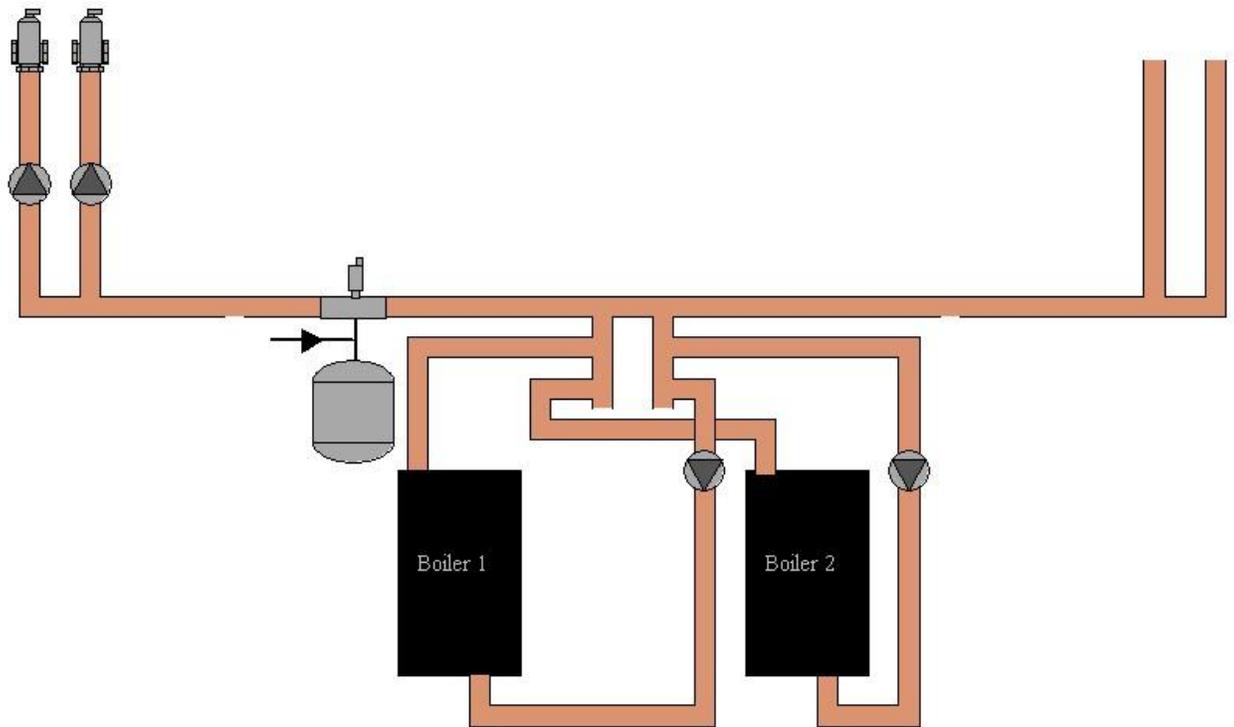


Figure 7 Two stage boiler

*Carbon Monoxide* is a poisonous invisible odorless gas that is the byproduct of any combustion. The chemical abbreviation for Carbon Monoxide is CO. CO is given off by many sources in a home. Any device or appliance that burns fuel creates CO e.g. Clothing driers (gas based), stoves, range top, fireplace, wood burning stove, kerosene heaters etc... According to the CDC (Center For Disease Control a government agency responsible for public health). 15,000 people a year are hospitalized in the US each year in non fire related and non intentional reasons CO exposure cases. 500 of those hospitalized die each year. The most common source of CO exposure and poisoning is the home furnace. It accounts for 18.5% of the exposures with 42.8% of all cases coming from unknown causes. (source <http://www.cdc.gov/Mmwr/preview/mmwrhtml/mm5402a2.htm#tab2>) Note that the predominant

danger in CO exposure from a heating system is from a furnace (forced air). Because the forced air system pumps air directly from the furnace into the home. A cracked heat exchanger or blocked chimney will cause the CO to be pumped into the home living space with the air stream.



Figure 8 CO detector

*Domestic Hot Water* – DHW is the supply of hot water for showers, dishwasher, cloth washer etc. In some homes the boiler system supplies the domestic hot water and in others the DHW is supplied by a secondary hot water heater. In systems where the boiler supplies the DHW it is usually supplied by an independent water path within the boiler. Generally the DHW path heats a small amount of water e.g. 5 gallons. The boiler is designed in such a way as it can supply a constant stream of hot water through the boiler at a low flow rate. In some homes the boiler supplied hot water is sent into a holding tank that holds the hot water ( e.g. a 80 gallon hot water tank) to be able to supply larger amounts of hot water for homes where the DHW demand cannot be fully satisfied by the small boiler DHW path.

*Short Cycle* - Boiler “short cycling” occurs when an oversized boiler quickly satisfies process or space heating demands, and then shuts down until heat is again required. Short cycling reduces efficiency because the boiler is starting and stopping so many times. Think of a car that is driven in a stop and go fashion vs a car that is driven at a constant speed.

*Call* – A call is when the heating system determines that there is a need for the flame to turn on.

*Aquastat* – the aquastat is a control system that maintains the boiler temperature at a set temperature. The aquastat has a temperature probe that measures the water temperature inside the boiler. The aquastat determines when the flame needs to be turned on to maintain the water temperature of the boiler. A typical aquastat temperature would be 180 Degrees F.

*Aquastat Differential* – The aquastat differential is the range of at which the aquastat turns on the flame. The setting of the differential prevents short cycling. For example a 180F boiler aquastat may have a 10F differential. That means that when the boiler temperature is below 170F the flame is turned on and when the boiler reaches 180F the boiler turns off.

Thermostat – is a combination thermometer and switch. The thermostat measures the temperature in the living space and calls the heating system to turn on the flame, circulators or air blowers to bring heat into the living space.



BTU – (British Thermal Unit) a BTU is a unit of energy it is also commonly used to refer to a unit of power which is unfortunately also called a BTU but is in actuality a BTU per Hour. For metric folks  $1 \text{ Watt} = 3.4 \text{ BTU/Hr}$

Heat Exchanger – The heat exchanger transfers heat energy from one medium to another. In a forced air system the heat exchanger is the manifold that is heated by the flame through which the hot air flows into the house. In a boiler system the heat exchanger is the manifold inside the boiler through which water flows. A Radiator is also an example of a heat exchanger.

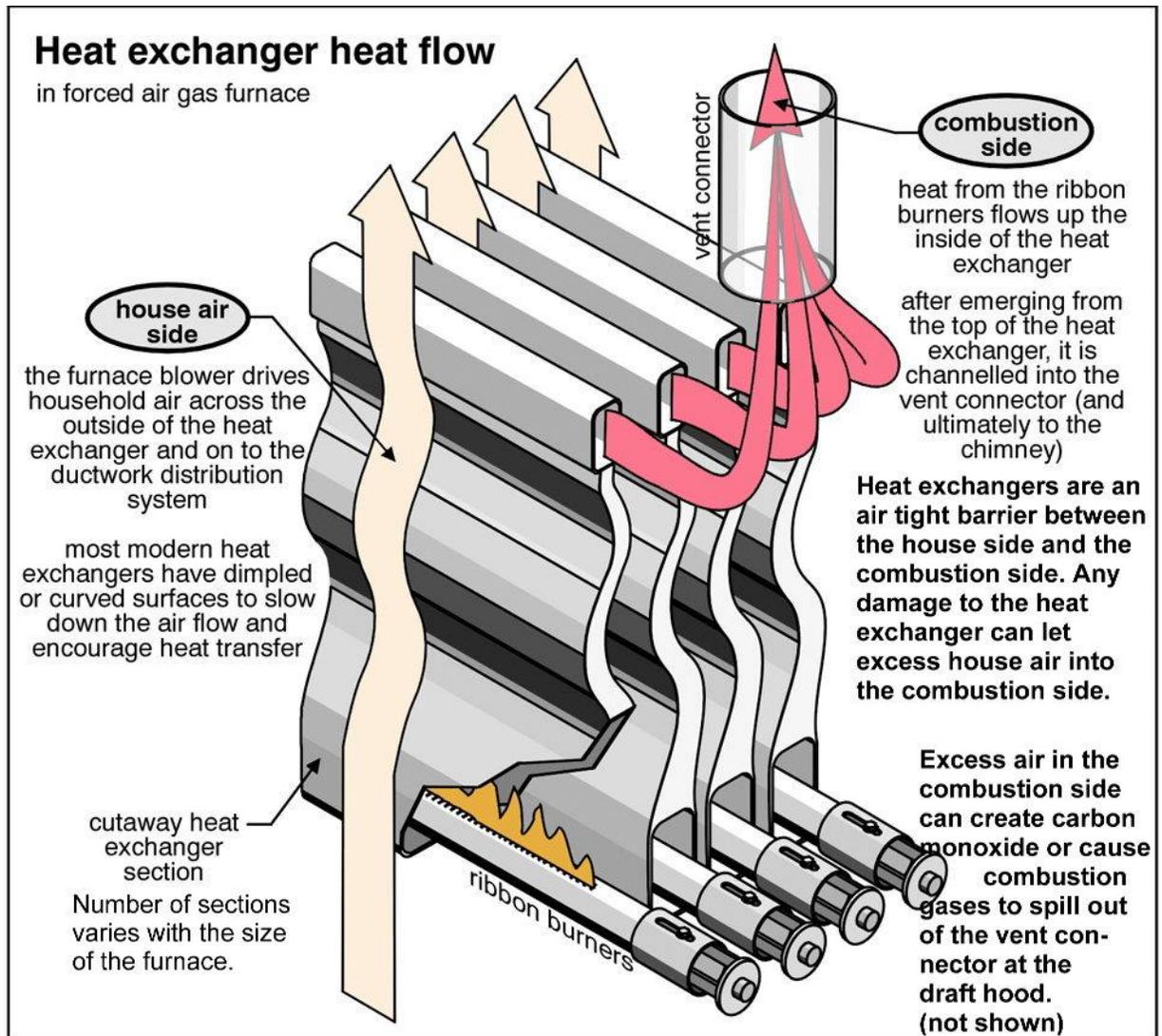


Figure 9 Heat Exchanger