

Superheaters and Reheaters

Superheaters are one of the most important accessories of boiler that improves the thermal efficiency.

In super heaters there should not be any fins as it increases the thermal stresses and careful should be taken when choosing the super-heater material that is stand for high temp and corrosion resistance.

Super-heater types

1. Convection super-heater: it is the earliest type of super-heater and it is located above or behind banks of water tubes to protect them from direct flam or fire

Parameters that increase the convection

- a. Increasing the fuel-and air flow (combustion gas flow).
- b. Increasing the mass flow rate of the steam.

Convection super-heaters are used for low temperature.

Radiant Super heater

They are placed exposed to the heat source which requires the improvement of metal temperatures.

Radiation is proportional to $T_f^4 - T_w^4$ where T_f and T_w are the flame and tube wall absolute temperature. T_f is greater than T_w so radiation is mainly dependent on the flame temperature. As the steam flow rate increases the exit temperature become lower as T_w goes up.

Radiant and convective super-heaters and re-heaters are used for high-temperature steam.

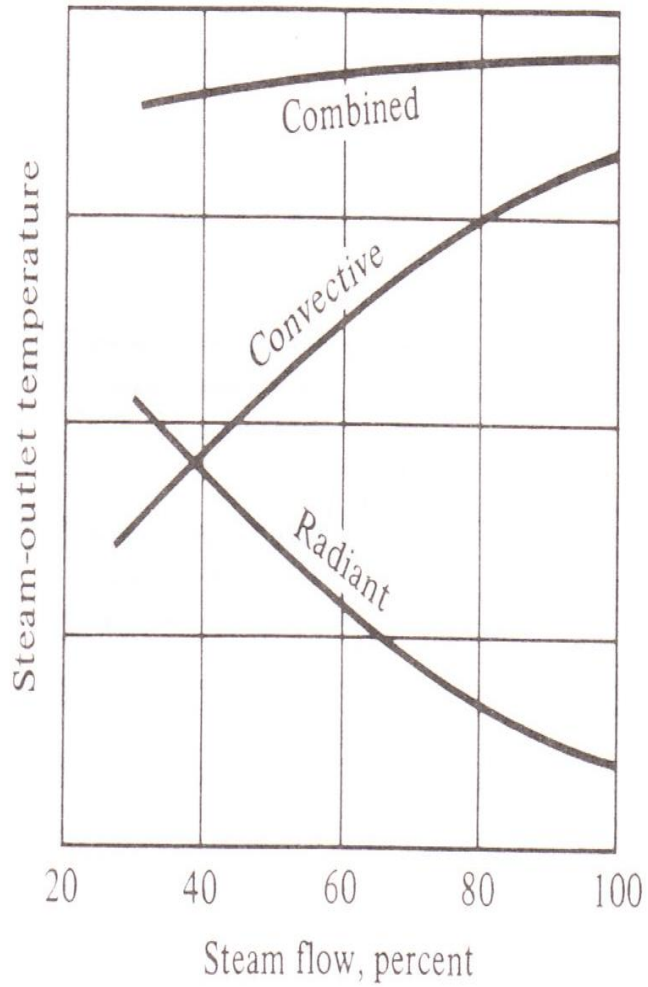
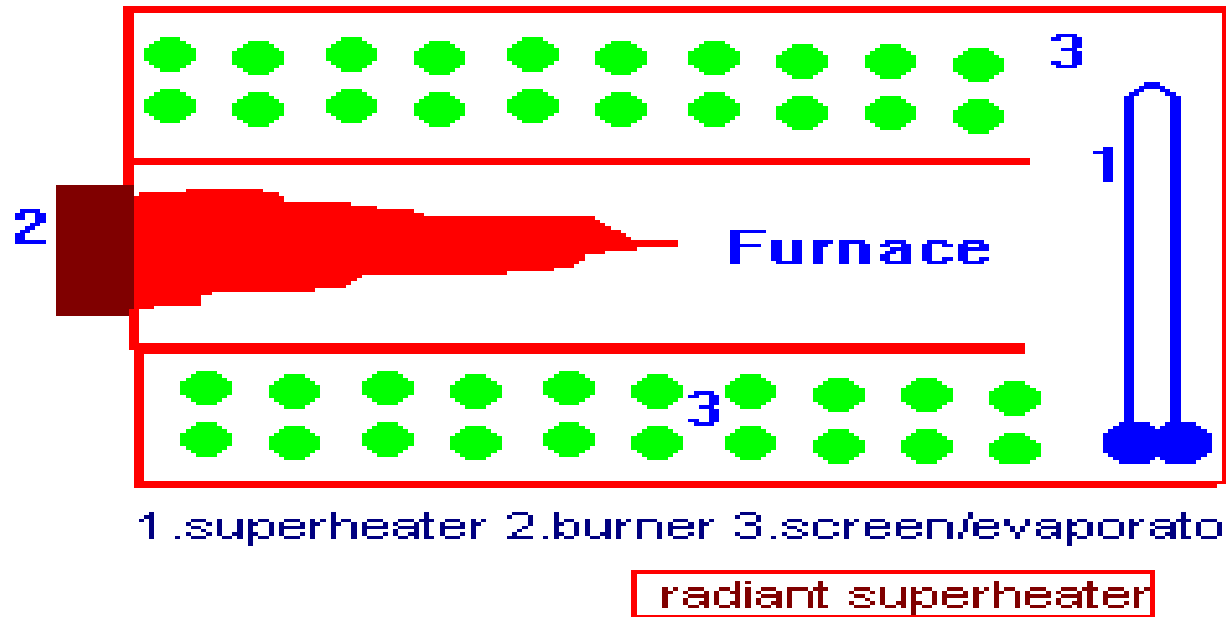
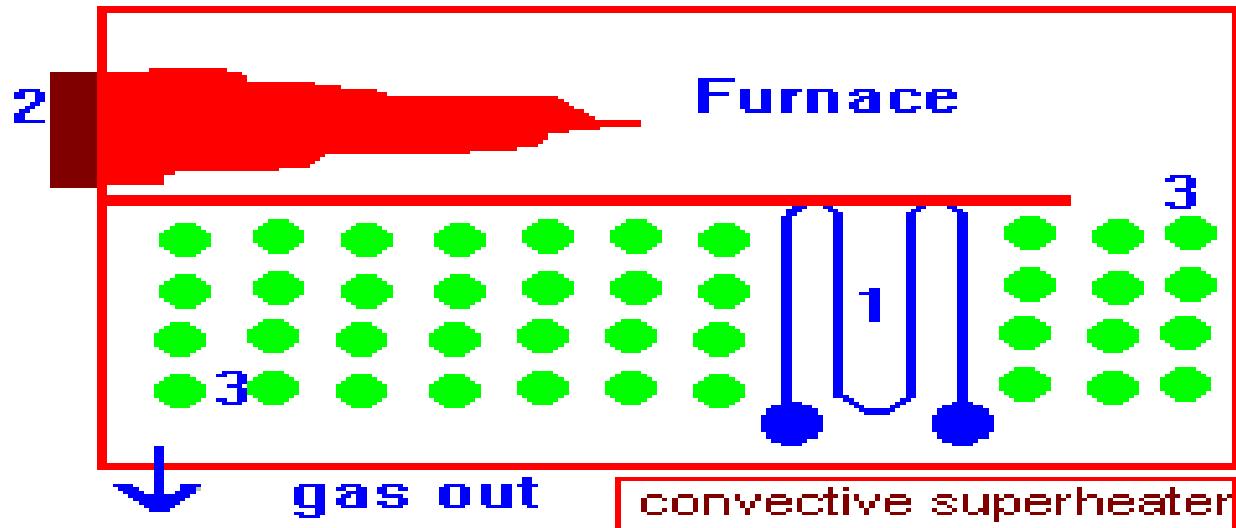
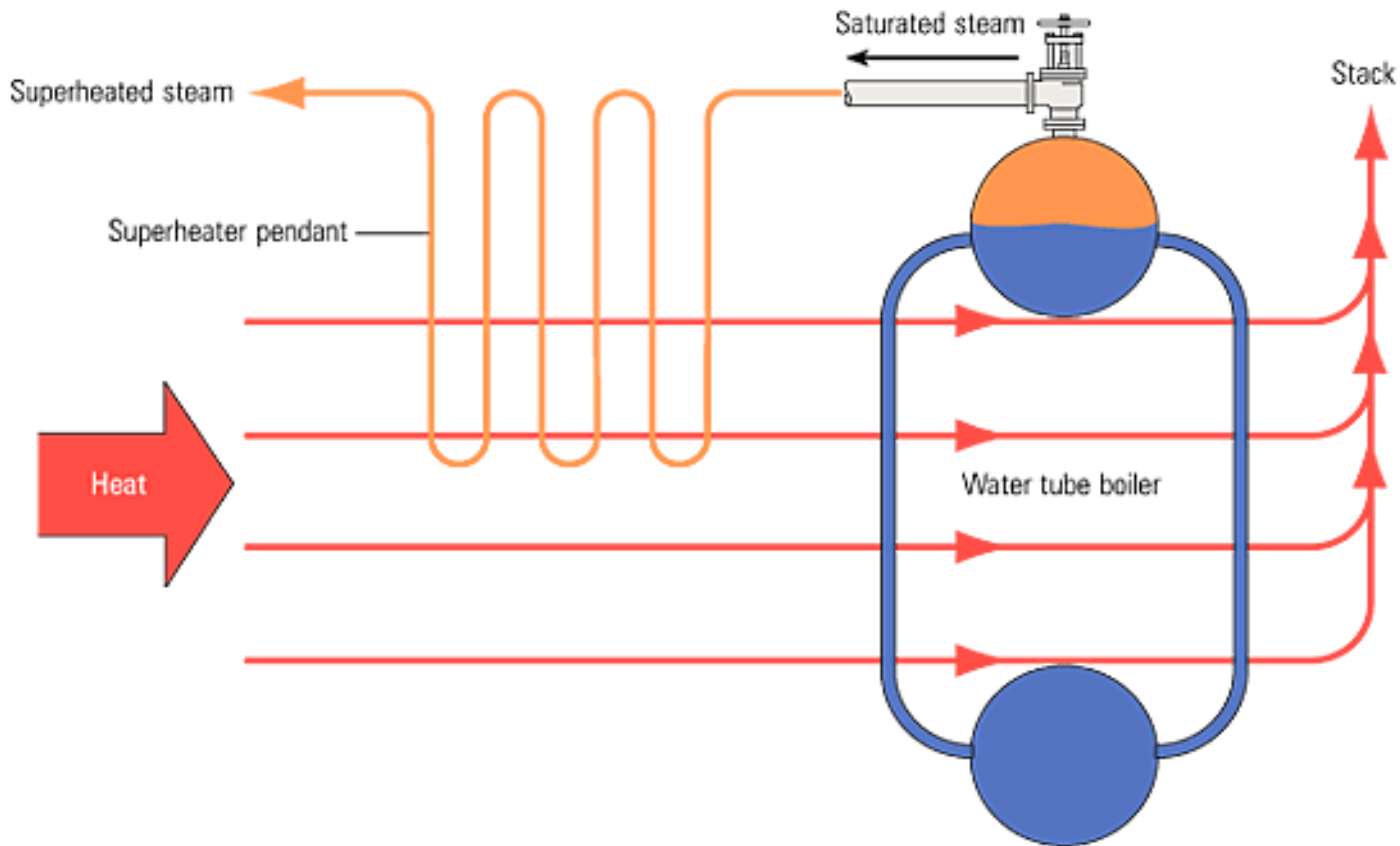


Figure 3-10 Exit-temperature response of convective, radiant, and combined (in-series) superheaters.





A super-heater unite



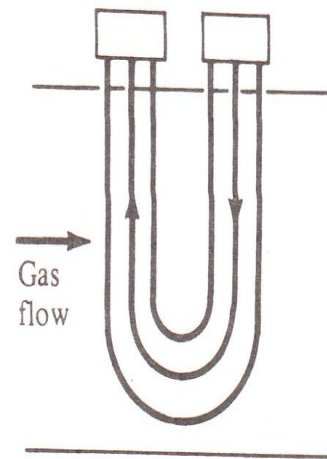
A water tube boiler with a super-heater

Re-heaters

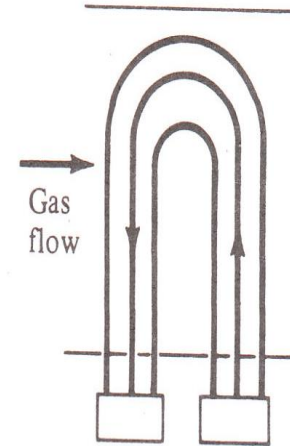
They are the same as the super-heaters but as their exit temperature is a little bite less than super-heaters and their pressure is 20%-25% less than the super-heater, they can stand less quality material alloys.

Mechanical construction of the Super-heater sections

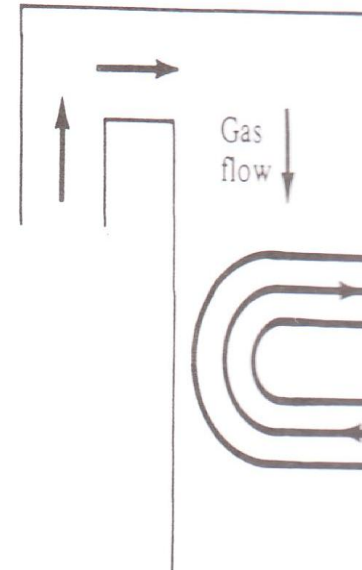
1. Pendant
2. Inverted
3. horizontal



(a)



(b)



(c)

Figure 3-11 Schematic diagram showing (a) pendant, (b) inverted, and (c) horizontal superheaters.

Comparison Between Different Mechanical Supports of Superheaters and Re-heaters

Type	Advantages	Disadvantages	Supporting method
Pendant-type	<ol style="list-style-type: none"> 1. Firm structural support 	<ol style="list-style-type: none"> 1. Flow blockage by condensed steam 2. Needs slow restart to purge the water that accumulates in the bottom. 	supported from above
Inverted-type	<ol style="list-style-type: none"> 1. Proper drainage of the condensed steam 	<ol style="list-style-type: none"> 1. Lack the structural rigidity, especially in high speed gas flow. 	Supported from below
Horizontal -type	<ol style="list-style-type: none"> 1. Proper drainage 2. Good structural rigidity. 	<ol style="list-style-type: none"> 1. They do not view the flam directly so they are mainly from the convective type 	Usually supported in the vertical gas ducts parallel to the main furnace.

Economizers

- The economizer is the heat exchanger that raises the temperature of the water leaving the highest-pressure feed-water heater to the saturation temperature corresponding to the boiler pressure, which is done by the gases leaving the last super-heater or re-heater that still have enough heat to transfer before it leaves to the stack, that is why it is called economizer.
- Economizer tubes are commonly 1.75-2.75 inch in OD and made in vertical sections of continuous tubes, between inlet to outlet headers, with each section formed into several horizontal paths connected by 180° bend for proper drainage.
- Sections are placed side by side on 1.75-2-inch. The spacing depends on the fuel type, as the smaller ashes the cleaner the fuel such as the natural gas.

- Economizers are come plain or with extended surfaces to enhance heat transfer.
- Economizers are generally placed between the last super heater re-heater and the air pre-heater.
- Economizers functions better with feed-water heater, as without them cold water is entering the economizer, which results in condensation and corrosion at the outer surfaces.
- Using the deaerating (DA) feedwater heater is considered beneficial for the economizer as it releases most of the oxygen that may react and cause fouling.
- Chemical and water washing when cleaning the economizer in the shut down time of the station.

Air Pre-heaters

- They are simply heaters that heat the air before it enters the combustor, thence result in the fuel consumption and increasing the thermal efficiency.
- The fuel savings are nearly directly proportional to the air temperature rise in the pre-heater. Typical savings are 4% for a 200⁰F air temperature rise and about 11% for a 500⁰F temperature rise in the pre-heater.
- Air pre-heater are also a requirement for the operation of pulverized-coal furnaces to dry that fuel.

Types of air pre-heaters.

- Recuperative air pre-heaters: they have heat transferred directly from the hot gases to the air across the heat exchanger. They are commonly tubular units in shell and tube form, where the hot gases flow inside the tubes and the forced air is around in the shell.
- Regenerative air pre heaters: are those in which heat is transferred from hot flue gases firstly to an intermediate heat storage medium then to air. The most common type is the rotary air pre-heater known as the Ljungstorm pre-heater