Unit 2 Steam power plant

Session Plan 1

**Recap:** high pressure and super critical boilers

Quiz: 1. Efficiency of high pressure is high

2. Heat transfer rate is more

**Fuel and ash handling circuit**

<http://www.slideshare.net/abhatripathi/thermal-power-plant>



**In a modern steam power plant, the following system employed for ash handling**

* Mechanical system
* Hydraulic system
* Pneumatic system
* Steam jet system

Conclusion & Summary:

1. In plant coal handling includes Coal delivery, unloading, loading, preparation, transfer, weighing and measuring

2. Give the methods of ash handling

Mechanical system, Hydraulic system, Pneumatic system, Steam jet system

**Session Plan 2**

Recap: **Working of Fuel and ash handling circuit**

**Quiz:** 1. In plant coal transfer is by means of Belt conveyer

2. Hydraulic system of ash removal includes water medium

**Kinematics of combustion reaction**

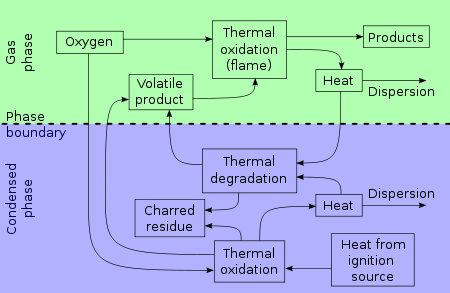
<http://en.wikipedia.org/wiki/Chemical_kinetics>

<http://www.slideshare.net/valyou1/combustion-reaction-3091119>

### Solid fuels

The act of combustion consists of three relatively distinct but overlapping phases:

* Preheating phase, when the unburned [fuel](http://en.wikipedia.org/wiki/Fuel) is heated up to its flash point and then [fire point](http://en.wikipedia.org/wiki/Fire_point). Flammable gases start being evolved in a process similar to [dry distillation](http://en.wikipedia.org/wiki/Dry_distillation).
* Distillation phase or gaseous phase, when the mix of evolved flammable gases with oxygen is ignited. Energy is produced in the form of heat and light. [Flames](http://en.wikipedia.org/wiki/Flame) are often visible. Heat transfer from the combustion to the solid maintains the evolution of flammable vapours.
* Charcoal phase or solid phase, when the output of flammable gases from the material is too low for persistent presence of flame and the [charred](http://en.wikipedia.org/wiki/Charring) fuel does not burn rapidly and just glows and later only [smoulders](http://en.wikipedia.org/wiki/Smoulder).

[](http://en.wikipedia.org/wiki/File:Disfig1.svg)

A general scheme of [polymer](http://en.wikipedia.org/wiki/Polymer) combustion

**Combustion management**

Efficient [process heating](http://en.wikipedia.org/wiki/Furnace#Industrial_process_furnaces) requires recovery of the largest possible part of a fuel’s [heat of combustion](http://en.wikipedia.org/wiki/Heat_of_combustion) into the material being processed. There are many avenues of loss in the operation of a heating process. Typically, the dominant loss is [sensible heat](http://en.wikipedia.org/wiki/Sensible_heat) leaving with the [off gas](http://en.wikipedia.org/wiki/Exhaust_gas) (i.e., the [flue gas](http://en.wikipedia.org/wiki/Flue_gas)). The temperature and quantity of off gas indicates its heat content ([enthalpy](http://en.wikipedia.org/wiki/Enthalpy)), so keeping its quantity low minimizes heat loss.

In a perfect [furnace](http://en.wikipedia.org/wiki/Furnace), the combustion air flow would be matched to the fuel flow to give each fuel molecule the exact amount of oxygen needed to cause complete combustion. However, in the real world, combustion does not proceed in a perfect manner. Unburned fuel (usually CO and H2) discharged from the system represents a heating value loss (as well as a safety hazard). Since combustibles are undesirable in the off gas, while the presence of unreacted oxygen there presents minimal safety and environmental concerns, the first principle of combustion management is to provide more oxygen than is theoretically needed to ensure that all the fuel burns. For methane (CH4) combustion, for example, slightly more than two molecules of oxygen are required.

The second principle of combustion management, however, is to not use too much oxygen. The correct amount of oxygen requires three types of measurement: first, active control of air and fuel flow; second, off gas oxygen measurement; and third, measurement of off gas combustibles. For each heating process there exists an optimum condition of minimal off gas heat loss with acceptable levels of combustibles concentration. Minimizing excess oxygen pays an additional benefit: for a given off gas temperature, the [NOx](http://en.wikipedia.org/wiki/NOx) level is lowest when excess oxygen is kept lowest.

Adherence to these two principles is furthered by making material and heat balances on the combustion process. The [material balance](http://en.wikipedia.org/wiki/Material_balance) directly relates the [air/fuel ratio](http://en.wikipedia.org/wiki/Air/fuel_ratio) to the percentage of O2 in the combustion gas. The heat balance relates the heat available for the charge to the overall net heat produced by fuel combustion. Additional material and heat balances can be made to quantify the thermal advantage from preheating the combustion air, or enriching it in oxygen.

**Conclusion:**

The session is concluded by question and answer

1. Give the methods of solid fuel burning Stoker firing and pulverised firing
2. Give the types of stoker firing Over feed stoker and underfeed stoker

**Session Plan 3**

Recap: **Mechanism of solid fuel combustion**

Quiz: 1. Phases of combustion in solid fuel is Preheating phase, gaseous and solid phase

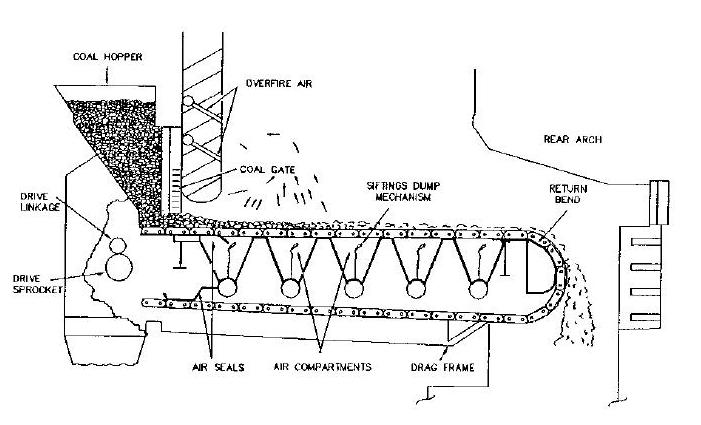
2. Stoker firing is classified into overfeed and under feed

**Combustion equipment for burning coal**

http://www.crushersouthafrica.com/mining-equipment/combustion-equipment-for-burning-coal.html

**Multi retort stoker**

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**Traveling grate stoker **

* Travelling grate stoker consists of grate which moves from one end of the furnace to the other end
* A bar grate stoker is made up of a series of cast iron grate bars mounted on carrier bars which are joined together to form a endless belt riding over two set of sprocket wheels
* The air required for the combustion is supplied through the air inlet situated below the grate

Over fire air (secondary air) is supplied through the port provided at the deflection walls

**Conclusion:**

1. Initial cost traveling grate stoker is low
2. travelling grate stoker is not suitable for high capacity boiler

**Session Plan 4**

Recap: **Fuel bed combustion, mechanical stokers**

**Quiz:**

1. The air required for the combustion is supplied through the air inlet situated below the grate
2. Travelling grate stoker consists of grate which moves from one end of the furnace to the

other end

**Pulverized coal firing system**, PPT

<http://www.iitk.ac.in/ame/files/me301/Steam%20power%20plant%202.pdf>

<http://en.wikipedia.org/wiki/Pulverized_coal-fired_boiler>

The concept of burning coal that has been pulverized into a fine powder stems from the belief that if the coal is made fine enough, it will burn almost as easily and efficiently as a gas. The feeding rate of coal according to the boiler demand and the amount of air available for drying and transporting the pulverized coal fuel is controlled by computers. Pieces of coal are crushed between balls or cylindrical rollers that move between two tracks or "races." The raw coal is then fed into the pulverizer along with air heated to about 650 degrees F from the boiler. As the coal gets crushed by the rolling action, the hot air dries it and blows the usable fine coal powder out to be used as fuel. The powdered coal from the pulverizer is directly blown to a burner in the boiler. The burner mixes the powdered coal in the air suspension with additional pre-heated combustion air and forces it out of a nozzle similar in action to fuel being atomized by a fuel injector in modern cars. Under operating conditions, there is enough heat in the combustion zone to ignite all the incoming fuel.

**Cyclone furnace, fluidized bed combustion**

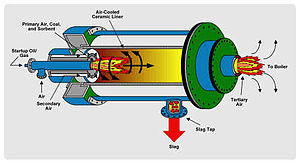
<http://en.wikipedia.org/wiki/Fluidized_bed_combustion>

Fluidized bed combustion (FBC) is a combustion technology used in power plants. [Fluidized beds](http://en.wikipedia.org/wiki/Fluidized_bed_reactor) suspend solid fuels in upward-blowing jets of air during the combustion process. The result is a turbulent mixing of gas and solids. The tumbling action, much like a bubbling fluid, provides more effective chemical reactions and heat transfer. FBC technology was adapted to burn petroleum coke and coal mining waste for power generation in the early 1980s in the US. At that time, US regulations first provided special incentives to the use of renewable fuels and waste fuels. FBC technology spread to other parts of the globe to address specific fuel quality problems. The technology has proved well suited to burning fuels that are difficult to ignite, like petroleum coke and anthracite, low quality fuels like high ash coals and coal mine wastes, and fuels with highly variable heat content, including biomass and mixtures of fuels.

The technology burns fuel at temperatures of 1,400 to 1,700 °F (760 to 930 °C), a range where nitrogen oxide formation is lower than in traditional [pulverized coal units](http://en.wikipedia.org/wiki/Pulverized_coal-fired_boiler). But increasingly strict US regulations have led to the use of ammonia DeNOx systems even on FBCs.

Fluidized-bed combustion evolved from efforts in Germany to control emissions from roasting sulfate ores without the need for external emission controls (such as scrubbers-flue gas desulfurization). The mixing action of the fluidized bed brings the flue gases into contact with a [sulfur](http://en.wikipedia.org/wiki/Sulfur)-absorbing chemical, such as [limestone](http://en.wikipedia.org/wiki/Limestone) or [dolomite](http://en.wikipedia.org/wiki/Dolomite). More than 95% of the sulfur pollutants in the fuel can be captured inside the boiler by the sorbent. The sorbent also captures some heavy metals, though not as effectively as do the much cooler wet scrubbers on conventional units.

Developed in the early 1942 by [Babcock & Wilcox](http://en.wikipedia.org/wiki/Babcock_and_Wilcox) to take advantage of coal grades not suitable for [pulverized coal combustion](http://en.wikipedia.org/wiki/Pulverized_coal-fired_boiler), cyclone furnaces feed coal in a spiral manner into a combustion chamber for maximum combustion efficiency.

[](http://en.wikipedia.org/wiki/File:Cyclone_combustor.jpg)

A typical cyclone combustor

During coal combustion in a furnace, [volatile](http://en.wikipedia.org/wiki/Volatility_%28chemistry%29) components burn without much difficulty. Fuel carbon “char” particles (heavier, less volatile coal constituents) require much higher temperatures and a continuing supply of oxygen. Cyclone furnaces are able to provide a thorough mixing of coal particles and air with sufficient [turbulence](http://en.wikipedia.org/wiki/Turbulence) to provide fresh air to surfaces of the coal particles.

Cyclone furnaces were originally designed to take advantage of four things

1. Lower fuel preparation time and costs
2. Smaller more compact furnaces
3. Less [fly ash](http://en.wikipedia.org/wiki/Fly_ash) and convective pass slagging
4. Flexibility in fuel types

Conclusion & Summary:

1. cyclone furnaces are compact furnaces
2. In pulverized coal firing the coal is pulverized into fine power

**Session Plan 5**

Recap: **Cyclone furnace, fluidized bed combustion**

**Quiz:**

1. Cyclone furnace has the flexibility of fuel type
2. [Fluidized beds](http://en.wikipedia.org/wiki/Fluidized_bed_reactor) suspend solid fuels in upward-blowing jets of air during the combustion process.

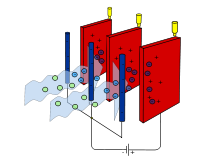
**Working of Electrostatic precipitator** PPT

<http://en.wikipedia.org/wiki/Electrostatic_precipitator>

An electrostatic precipitator (ESP), or electrostatic air cleaner is a [particulate](http://en.wikipedia.org/wiki/Particulate) collection device that removes particles from a flowing gas (such as air) using the force of an induced [electrostatic charge](http://en.wikipedia.org/wiki/Electrostatic_charge). Electrostatic precipitators are highly efficient [filtration](http://en.wikipedia.org/wiki/Filtration) devices that minimally impede the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream.

In contrast to [wet scrubbers](http://en.wikipedia.org/wiki/Wet_scrubber) which apply energy directly to the flowing fluid medium, an ESP applies energy only to the particulate matter being collected and therefore is very efficient in its consumption of energy (in the form of electricity)

## Plate precipitator

[](http://en.wikipedia.org/wiki/File:Electrostatic_precipitator.svg)

Conceptual diagram of an electrostatic precipitator The most basic precipitator contains a row of thin vertical wires, and followed by a stack of large flat metal plates oriented vertically, with the plates typically spaced about 1 cm to 18 cm apart, depending on the application. The air or gas stream flows horizontally through the spaces between the wires, and then passes through the stack of plates.

A negative voltage of several thousand [volts](http://en.wikipedia.org/wiki/Volt) is applied between wire and plate. If the applied voltage is high enough, an electric [corona discharge](http://en.wikipedia.org/wiki/Corona_discharge) ionizes the gas around the electrodes. [Negative ions](http://en.wikipedia.org/wiki/Negative_ions) flow to the plates and charge the gas-flow particles.

The ionized particles, following the negative electric field created by the power supply, move to the grounded plates. Particles build up on the collection plates and form a layer. The layer does not collapse, thanks to electrostatic pressure (due to layer resistivity, electric field, and current flowing in the collected layer).

**Working Fabric filters and bag houses**

<http://en.wikipedia.org/wiki/Baghouse>

<http://en.wikipedia.org/wiki/dustcollector>

A baghouse (BH, B/H) or fabric filter (FF) is an air pollution control device that removes particulates out of air or gas released from commercial processes or combustion for electricity generation. Power plants, steel mills, pharmaceutical producers, food manufacturers, chemical producers and other industrial companies often use baghouses to control emission of air pollutants. Baghouses came into widespread use in the late 1970s after the invention of high-temperature fabrics (for use in the filter media) capable of withstanding temperatures over 350°F.

Unlike [electrostatic precipitators](http://en.wikipedia.org/wiki/Electrostatic_precipitators), where performance may vary significantly depending on process and electrical conditions, functioning baghouses typically have a particulate collection efficiency of 99% or better, even when particle size is very small

Conclusion & Summary

1. A bag house is an air pollution control device which removes particulates from air
2. Collection efficiency of bag houses is very high

**Session Plan 6:**

Recap: **Working Fabric filters and bag houses**

1. Bag houses typically have a particulate collection efficiency of 99%
2. fabric filter (FF) is an air pollution control device that removes particulates out of air

**Draught – different types of draught**

<http://en.wikipedia.org/wiki/Stack_effect>, (<http://en.wikipedia.org/wiki/Chimney>)

There are three types of mechanical draught:

* ***Induced draught*:** This is obtained one of three ways, the first being the "stack effect" of a heated chimney, in which the flue gas is less dense than the ambient air surrounding the boiler. The denser column of ambient air forces combustion air into and through the boiler. The second method is through use of a steam jet. The steam jet oriented in the direction of flue gas flow induces flue gasses into the stack and allows for a greater flue gas velocity increasing the overall draught in the furnace. This method was common on steam driven locomotives which could not have tall chimneys. The third method is by simply using an induced draught fan (ID fan) which removes flue gases from the furnace and forces the exhaust gas up the stack. Almost all induced draught furnaces operate with a slightly negative pressure.
* ***Forced draught*:** Draught is obtained by forcing air into the furnace by means of a fan (FD fan) and ductwork. Air is often passed through an air heater; which, as the name suggests, heats the air going into the furnace in order to increase the overall efficiency of the boiler. Dampers are used to control the quantity of air admitted to the furnace. Forced draught furnaces usually have a positive pressure.
* ***Balanced draught*:** Balanced draught is obtained through use of both induced and forced draught. This is more common with larger boilers where the flue gases have to travel a long distance through many boiler passes. The induced draught fan works in conjunction with the forced draught fan allowing the furnace pressure to be maintained slightly below atmospheric.

Conclusion & Summary:

1. what are the different types of draught?

Natural, forced and induced draught

1. Balanced draught is obtained through use of both induced and forced draught

**Session Plan 7**

Recap: **Working of different types of draught**

1. Forced draught is obtained by forcing air into the furnace by means of a fan (FD fan)
2. Induced draught is by using an induced draught fan (ID fan) which removes flue gases from the furnace and forces the exhaust gas up the stack

**Surface condenser – types**

http://www.thefullwiki.org/Surface\_condenser

**Surface condenser** is the commonly used term for a water cooled [shell and tube heat exchanger](http://www.thefullwiki.org/Shell_and_tube_heat_exchanger) installed on the exhaust [steam](http://www.thefullwiki.org/Steam) from a [steam turbine](http://www.thefullwiki.org/Steam_turbine) in [thermal power stations](http://www.thefullwiki.org/Thermal_power_station). These [condensers](http://www.thefullwiki.org/Condenser_%28heat_transfer%29) are [heat exchangers](http://www.thefullwiki.org/Heat_exchangers) which convert steam from its gaseous to its liquid state at a pressure below [atmospheric pressure](http://www.thefullwiki.org/Atmospheric_pressure). Where cooling water is in short supply, an air-cooled condenser is often used. An air-cooled condenser is however significantly more expensive and cannot achieve as low a steam turbine exhaust pressure as a surface condenser.

Surface condensers are also used in applications and industries other than the condensing of steam turbine exhaust in power plants.

**Working of Surface condenser**

http://en.wikipedia.org/wiki/Surface\_condenser

A **shell and tube heat exchanger** is a class of [heat exchanger](http://www.thefullwiki.org/Heat_exchanger) designs. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large [pressure vessel](http://www.thefullwiki.org/Pressure_vessel)) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. The set of tubes is called a tube bundle, and may be composed by several types of tubes: plain, longitudinally finned, etc.

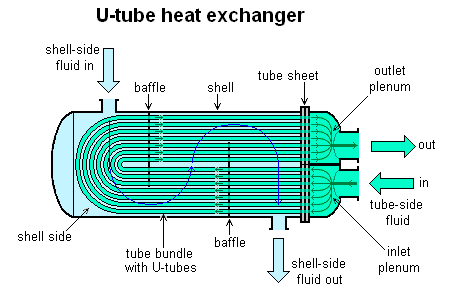
## Theory and Application

Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side). Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can be either [liquids](http://www.thefullwiki.org/Liquid) or [gases](http://www.thefullwiki.org/Gas) on either the shell or the tube side. In order to transfer heat efficiently, a large [heat transfer](http://www.thefullwiki.org/Heat_transfer) area should be used, leading to the use of many tubes. In this way, waste heat can be put to use. This is an efficient way to conserve energy.

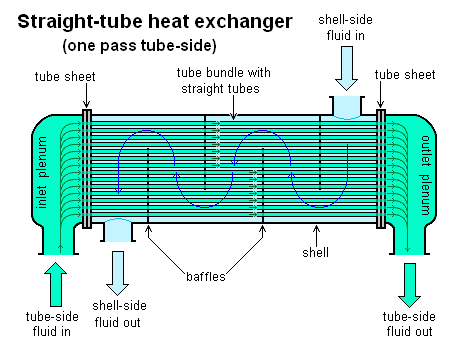
Heat exchangers with only one [phase](http://www.thefullwiki.org/Phase_%28matter%29) (liquid or gas) on each side can be called one-phase or single-phase heat exchangers. Two-phase heat exchangers can be used to heat a liquid to boil it into a gas (vapor), sometimes called [boilers](http://www.thefullwiki.org/Boiler), or cool a vapor to condense it into a liquid (called [condensers](http://www.thefullwiki.org/Condenser)), with the phase change usually occurring on the shell side. Boilers in steam engine [locomotives](http://www.thefullwiki.org/Locomotive) are typically large, usually cylindrically-shaped shell-and-tube heat exchangers. In large [power plants](http://www.thefullwiki.org/Power_plant) with steam-driven [turbines](http://www.thefullwiki.org/Turbine), shell-and-tube [surface condensers](http://www.thefullwiki.org/Surface_condenser) are used to condense the exhaust [steam](http://www.thefullwiki.org/Steam) exiting the turbine into condensate [water](http://www.thefullwiki.org/Water) which is recycled back to be turned into steam in the steam generator.

## Shell and tube heat exchanger design

There can be many variations on the shell and tube design. Typically, the ends of each tube are connected to **plenums** (sometimes called **water boxes**) through holes in **tube sheets**. The tubes may be straight or bent in the shape of a U, called U-tubes.



In nuclear power plants called [pressurized water reactors](http://www.thefullwiki.org/Pressurized_water_reactor), large heat exchangers called [steam generators](http://www.thefullwiki.org/Steam_generator) are two-phase, shell-and-tube heat exchangers which typically have U-tubes. They are used to boil water recycled from a surface condenser into steam to drive a [turbine](http://www.thefullwiki.org/Steam_turbine) to produce power. Most shell-and-tube heat exchangers are either 1, 2, or 4 pass designs on the tube side. This refers to the number of times the fluid in the tubes passes through the fluid in the shell. In a single pass heat exchanger, the fluid goes in one end of each tube and out the other.



Conclusion & Summary:

1. Shell and tube is an example of surface condenser
2. A surface condenser is a non contact type

**Session Plan 8**

Recap: **Working of Surface condenser**

1. **Surface condenser** is the commonly used term for a water cooled [shell and tube heat exchanger](http://www.thefullwiki.org/Shell_and_tube_heat_exchanger)
2. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side)

**Direct contact condenser**

<http://en.wikipedia.org/wiki/Talk:Surface_condenser>

* A [surface condenser](http://en.wikipedia.org/wiki/Surface_condenser) is an example of such a heat-exchange system. It is a [shell and tube heat exchanger](http://en.wikipedia.org/wiki/Shell_and_tube_heat_exchanger) installed at the outlet of every [steam turbine](http://en.wikipedia.org/wiki/Steam_turbine) in [thermal power stations](http://en.wikipedia.org/wiki/Thermal_power_station). Commonly, the [cooling water](http://en.wikipedia.org/wiki/Cooling_water) flows through the tube side and the steam enters the shell side where the condensation occurs on the outside of the heat transfer tubes. The condensate drips down and collects at the bottom, often in a built-in pan called a *hotwell*. The shell side often operates at a [vacuum](http://en.wikipedia.org/wiki/Vacuum) or partial vacuum, often produced by attached air [ejectors](http://en.wikipedia.org/wiki/Ejector). Conversely, the vapour can be fed through the tubes with the coolant water or air flowing around the outside.
* Larger condensers are also used in industrial-scale distillation processes to cool distilled [vapor](http://en.wikipedia.org/wiki/Vapor) into liquid distillate. Commonly, the coolant flows through the tube side and distilled vapor through the shell side with distillate collecting at or flowing out the bottom.
* Direct contact condenserIn this type of condenser, [vapors](http://en.wikipedia.org/wiki/Vapors) are poured into the liquid directly. The vapors lose their [latent heat](http://en.wikipedia.org/wiki/Latent_heat) of vaporization; hence, vapors transfer their heat into liquid and the liquid becomes hot. In this type of condensation, the vapor and liquid are of same type of substance. In another type of direct contact condenser, cold water is sprayed into the vapour to be condensed.

Conclusion & Summary:

1. In direct contact condenser vapour and liquid are of same type of substance
2. In direct contact condenser the vapour lose their latent heat of vaporization

**Session Plan 9**

Recap: **Working of direct contact Surface condenser**

1. In contact condenser cold water is sprayed into the vapour to be condensed
2. In direct contact condenser the coolant flows through the tube side and distilled vapor through the shell side

**Cooling tower – working**

<http://en.wikipedia.org/wiki/Cooling_tower>

Cooling towers are heat removal devices used to transfer process [waste heat](http://en.wikipedia.org/wiki/Waste_heat) to the [atmosphere](http://en.wikipedia.org/wiki/Atmosphere). Cooling towers may either use the [evaporation](http://en.wikipedia.org/wiki/Evaporation) of water to remove process heat and cool the working fluid to near the [wet-bulb air temperature](http://en.wikipedia.org/wiki/Wet-bulb_temperature) or, in the case of *closed circuit dry* cooling towers, rely solely on air to cool the working fluid to near the [dry-bulb air temperature](http://en.wikipedia.org/wiki/Dry-bulb_temperature).

Common applications include cooling the circulating water used in [oil refineries](http://en.wikipedia.org/wiki/Oil_refineries), [petrochemical](http://en.wikipedia.org/wiki/Petrochemical) and other [chemical plants](http://en.wikipedia.org/wiki/Chemical_plant), [thermal power stations](http://en.wikipedia.org/wiki/Thermal_power_station) and [HVAC](http://en.wikipedia.org/wiki/HVAC) systems for cooling buildings. The main types of cooling towers are natural draft and induced draft cooling towers. The classification is based on the type of air induction into the tower.

Cooling towers vary in size from small roof-top units to very large [hyperboloid structures](http://en.wikipedia.org/wiki/Hyperboloid_structure) (as in the adjacent image) that can be up to 200 metres (660 ft) tall and 100 metres (330 ft) in diameter, or rectangular structures (as in Image 3) that can be over 40 metres (130 ft) tall and 80 metres (260 ft) long. The hyperboloid cooling towers are often associated with nuclear power plants, although they are also used to some extent in some large chemical and other industrial plants. Although these large towers are very prominent, the vast majority of cooling towers are much smaller, including many units installed on or near buildings to discharge heat from [air conditioning](http://en.wikipedia.org/wiki/Air_conditioning).

### Industrial cooling towers

[](http://en.wikipedia.org/wiki/File:Cenk_Endustri_Field_Erected_Industrial_Cooling_Tower.JPG)

Industrial cooling towers for a power plant

Industrial cooling towers can be used to remove heat from various sources such as machinery or heated process material. The primary use of large, industrial cooling towers is to remove the heat absorbed in the circulating [cooling water](http://en.wikipedia.org/wiki/Cooling_water) systems used in [power plants](http://en.wikipedia.org/wiki/Power_plants), [petroleum refineries](http://en.wikipedia.org/wiki/Oil_refinery), [petrochemical](http://en.wikipedia.org/wiki/Petrochemical) plants, [natural gas](http://en.wikipedia.org/wiki/Natural_gas) processing plants, food processing plants, semi-conductor plants, and for other industrial facilities such as in condensers of distillation columns, for cooling liquid in crystallization, etc. The circulation rate of cooling water in a typical 700 MW [coal-fired power plant](http://en.wikipedia.org/wiki/Coal-fired_power_plant) with a cooling tower amounts to about 71,600 cubic metres an hour (315,000 US gallons per minute) and the circulating water requires a supply water make-up rate of perhaps 5 percent (i.e., 3,600 cubic metres an hour).

If that same plant had no cooling tower and used once-through cooling water, it would require about 100,000 cubic metres an hour and that amount of water would have to be continuously returned to the ocean, lake or river from which it was obtained and continuously re-supplied to the plant. Furthermore, discharging large amounts of hot water may raise the temperature of the receiving river or lake to an unacceptable level for the local ecosystem. Elevated water temperatures can kill [fish](http://en.wikipedia.org/wiki/Fish) and other aquatic organisms (see [*thermal pollution*](http://en.wikipedia.org/wiki/Thermal_pollution)). A cooling tower serves to dissipate the heat into the atmosphere instead and wind and air diffusion spreads the heat over a much larger area than hot water can distribute heat in a body of water. Some coal-fired and [nuclear power plants](http://en.wikipedia.org/wiki/Nuclear_power_plant) located in [coastal](http://en.wikipedia.org/wiki/Coastal) areas do make use of once-through ocean water. But even there, the offshore discharge water outlet requires very careful design to avoid environmental problems.

Petroleum refineries also have very large cooling tower systems. A typical large refinery processing 40,000 metric tonnes of crude oil per day (300,000 barrels (48,000 m3) per day) circulates about 80,000 cubic metres of water per hour through its cooling tower system.

The world's tallest cooling tower is the 202 metres (663 ft) tall cooling tower of Kalisindh Thermal Power Plant in Jhalawar, Rajasthan, India.

[](http://en.wikipedia.org/wiki/File:Package_Type_Induced_Draft_Counter_Flow_Cooling_Towers.jpg)

[magnify-clip](http://en.wikipedia.org/wiki/File:Package_Type_Induced_Draft_Counter_Flow_Cooling_Towers.jpg)

Package type cooling towers

[](http://en.wikipedia.org/wiki/File:Cenk_Endustri_Field_Erected_Cooling_Tower.JPG)

[magnify-clip](http://en.wikipedia.org/wiki/File:Cenk_Endustri_Field_Erected_Cooling_Tower.JPG)

Field erected cooling towers

Conclusion & Summary:

1. Common applications of cooling tower include cooling the circulating water used in [oil refineries](http://en.wikipedia.org/wiki/Oil_refineries), [petrochemical](http://en.wikipedia.org/wiki/Petrochemical) and other [chemical plants](http://en.wikipedia.org/wiki/Chemical_plant), [thermal power stations](http://en.wikipedia.org/wiki/Thermal_power_station)
2. Cooling towers are heat removal devices used to transfer process [waste heat](http://en.wikipedia.org/wiki/Waste_heat) to the [atmosphere](http://en.wikipedia.org/wiki/Atmosphere).